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15 Kasım 2017 Çarşamba	
08:00	**KAYIT**
09:30	**SAYGI DURUŞU VE İSTİKLAL MARŞI, AÇILIŞ KONUŞMALARI**
11:30	**COĞRAFİ BİLGİ TEKNOLOJİLERİ YAZILIM FUARI AÇILIŞ TÖRENİ**
12:00	**ÖĞLE YEMEĞİ**
13:00	**PANEL 1: DÜNYADA MEKÂNSAL UYGULAMALAR VE CBS** **Moderatör:** Dr. Orhan Ercan, FIG Başkan Yrd. **Panelistler:** Chryssy Potsiou (FIG Başkanı), James Kavanagh
15:00	**ARA**
15:30	**PANEL 2: TAŞINMAZ DEĞERLEME VE CBS** *(Taşınmaz Değerlemede mevcut durum, konumsal veri altyapısı ihtiyacı, açık veri, yasal mevzuat, sorunlar, çözüm önerileri)* **Moderatör:** Ertuğrul Candaş (HKMO Genel Başkanı) **Panelistler:** Dr. Hasan Şanlı (TRGM), Ümit Yıldız (TKGM), Doç. Dr. Volkan Çağdaş (YTÜ)
19:00	**KOKTEYL**
16 Kasım 2017 Perşembe	
08:40	**TO1: 3B CBS, 3B KENT MODELLERİ** (Mithat Özsan Amfisi A Salonu) **Oturum Başkanı:** Doç. Dr. Sedat DOĞAN
	Konumsal Veri Modellerinin 3B Bir Kadastro İçin Kullanılabilirliklerinin İncelenmesi *Fatih Döner, Samet Şirin*
	Konut Edinmede Web Tabanlı Mekansal Karar Verme Yaklaşımı: "Emekli" *Hakan Emekli, Caner Güney, Fatih Terzi, Ali Güneş*
	3 Boyutlu Kent Modellerinin Üretimi ve Arazi Yönetiminde Kullanımı *Metin Soylu, Ekrem Ayyıldız, Hülya Tuna, Levent Özmüş, Sedat Bakıcı*
	3B Kent Modelleri İçin Yeni Bir Silüet Analizi Modülünün Geliştirilmesi *Sebahat Temuçin Kılıçer, Çetin Cömert, Halil Akıncı*

	Generating 3D City Models at Condominium Level *Ziya Usta, Çetin Cömert*
08:40	**TO2: TARIM, HAVZA YÖNETİMİ, RİSK HARİTALAMA** (Mithat Özsan Amfisi B Salonu) **Oturum Başkanı:** Doç. Dr. Derya ÖZTÜRK
	Tarım Bilgi Sistemi Kapsamında Geliştirilen Coğrafi Bilgi Sistemleri Modülü *Sebahattin Keskin*
	Doğu Akdeniz'de Web-tabanlı Turunçgil Bilgi Sistemi Oluşturulması *Süha Berberoğlu, Merve Şahingöz, Ahmet Çilek*
	The Use of GIS For Watershed Management *Rawaa Abdulfattah Abdulhussein, Ahmet Özgür Doğru*
	Ortadoğu Toz Kaynaklarının Tespiti ve Fırat-Dicle Nehri Havzası (Suriye-Irak) Tarım Alanlarına Etkisinin Değerlendirilmesi *Ayhan Ateşoğlu, Metin Tunay, Talha Berk Arıkan, Saffet Yıldız*
	CBS ve AHP Yöntemiyle Taşkın Afetinin Analiz Edilmesi: Trabzon-Beşikdüzü Örneği *Ceren Apaydın, Büşra Ün*
10:40	**TO3: WEBCBS, SEMANTİK WEB, ARTIRILMIŞ GERÇEKLİK, GÖNÜLLÜ COĞRAFİ BİLGİ** (Mithat Özsan Amfisi A Salonu) **Oturum Başkanı:** Doç. Dr. Halil AKINCI
	NetCAD Birlikte Çalışabilirlik Platformu *Dinçer Uygun*
	Turkish Topographic Vector Database (TOPOVT) Real Time Updating System *Altan Yılmaz, Mustafa Canıberk, Bekir Yüksel*
	Potential of Spatial Semantics for Developing Multi-Representation Spatial Databases *Abdulkadir Memduhoğlu, Melih Başaraner*
	Kentsel Sorunların Yönetimi İçin Bir Gönüllü Coğrafi Bilgi Mobil Uygulaması Geliştirilmesi *Talha Taşkanat, Abdullah Karaağaç, Erkan Beşdok, Bülent Bostancı*
10:40	**TO4: ALTYAPI YÖNETİMİ** (Mithat Özsan Amfisi B Salonu) **Oturum Başkanı:** Yrd. Doç. Dr. Caner GÜNEY
	Karayolları Genel Müdürlüğü Görüntü Tabanlı Bilgi Yönetim Sistemi Projesi *Önder Çelik*
	Enerji Nakil Hatlarında Arızaların Önceden Tahmin Edilmesinde CBS Kullanımı: SÜPERGÖZ Projesi *Tuba Yalçın*

	Yatırım Planlama, Müşteri İlişkileri Şikayet Yönetimi ve Pazarlama Faaliyetlerinde Karar Destek Sistemi Olarak CBS Kullanımı Örnek Uygulaması *Sultan Gökçen Bilgen, Ender Sunerli, Güzin İncedal, Şerife Sarı Gedik*
	Sensor Verilerinin Kent Otomasyonunda Bütünleşik Kullanımı *Emin Bank*
12:20	**ÖĞLE YEMEĞİ**
13:30	**PANEL 3: ÜLKE VE KENT YÖNETİMİNDE CBS; TMMOB YAKLAŞIMLARI** *(Planlama, plan uygulama, yapı denetimi gibi, TMMOB ve bağlı odaların ilgi alanlarına giren işlerde CBS ve konumsal veri altyapılarının rolü: Mevcut durum, yasal mevzuat, mesleki arakesitler, sorunlar, öneriler)* **Moderatör:** A. Fahri Özten (TMMOB Yürütme Kurulu Üyesi) **Panelistler:** Prof. Dr. İlhami Bayramin (Ziraat MO), Doç. Dr. Tolga Can (Jeoloji MO), Yrd. Doç. Dr. Semih Emür (Şehir Plancıları O), Nizamettin İnsel (Maden MO)
15:30	**ARA**
15:45	**PANEL 2: ÖZGÜR VERİ, ÖZGÜN BİLGİ, UKVA (TUCBS)** *(Ulusal Konumsal Veri Altyapısı ve açık veri alanında mevcut durum, politikalar)* **Moderatör:** Prof. Dr. Çetin Cömert (HKMO CBS Kom. Bşk.) **Panelistler:** Müh. Alb. Altan Yılmaz (HGK), Mert Yasin Öz (TKGM), Güleç Gencer Alır (CBS GM), M. Emre Yıldırım (Mapisso Yazılım)
17:45	**POSTER OTURUMU 1** (Poster Sunum Alanı) **Oturum Başkanları:** Doç.Dr. Halil AKINCI, Doç.Dr. Sedat Doğan, Yrd.Doç.Dr. Hasan T. Bostancı
	Taşınmazların İş Akış Süreçleri ve Coğrafi Bilgi Sistemlerine Entegre Olarak Yönetilmesi *Taşkın Özkan, Egemen Arslan*
	Harita Destekli Asansör Denetimi Takip Projesi *Yunus Emre Şen*
	QGIS ile Web Tabanlı Arkeolojik Alanlar Bilgi Sistemi Oluşturulması *Mehmet Tok, Nusret Demir*
	Coğrafi Bilgi Sistemlerinde Web Teknolojisinin Kullanılması Kapsamında Örnek Geodata Uygulaması *Murat Çalışkan*
	CORINE 2012 Türkiye Arazi Örtüsü Sınıflandırma Projesi *Kamile Kalaycı*
	Acil Sağlık İstasyonları Yer Seçiminde Konumsal Analizlerin Kullanılabilirliği: Ordu İli Örneği *Abdullah Özdemir, Aysun Gül, Arzu Özdemir*
	Üç Boyutlu, Web Tabanlı Coğrafi Bilgi Sistemi Tasarımı ve Uygulaması (YTÜ İnşaat Fakültesi) *Fatih Sazan, Ümit Gümüşay*

	Automatic Design of Cartographic Projections *Müge Şenel*
	Hidrometeorolojik Gözlem Ağının Havzayı Temsil Ediciliği Sorunu ve Havza Su Potansiyeli Hesaplamalarına Etkisi *Ahmet Hamdi Sargın, Mehmet Ekmekçi*
	Mezarlık Bilgi Sistemi: Sivas İli Örneği *Sefa Sarı, Gürkan Veysi Özçağlar, Atilla Altun, Esra Makara, İlhami Işık, Gökhan Polat, Adem Seller, Tarık Türk*
	Doğal Afetlerde Riskli Alanların Değerlendirilmesinde CBS Kullanımı: Adana İli Örneği *Bülent Bostancı, Abdurrahman Geymen, Ahmet İlvan*
	Coğrafi Bilgi Sistemleri ve AHP Yöntemi Kullanılarak Rüzgar Enerji Santrallerinin Kurulacağı Alanların Belirlenmesi *Murat Çolakoğlu, Halil Akıncı, Sebahat Temuçin Kılıçer, Yalçın Yılmaz, Elif Beyza Çatalbaş*
17 Kasım 2017 Cuma	
08:40	**TO5: YEREL YÖNETİMLERDE CBS** (Mithat Özsan Amfisi A Salonu) **Oturum Başkanı:** Prof. Dr. Süleyman Savaş DURDURAN
	Süreç Yönetimine CBS Penceresinden Bakmak; "OBB BSK Süreç Yönetim Sistemi" *Abdullah Özdemir, Selin Ataman, Arzu Özdemir*
	Belediyelerde Bir Halkla İlişkiler Aracı Olarak CBS *Abdullah Özdemir, Murat Aygün, Arzu Özdemir*
	İzmir Büyükşehir Belediyesi CBS Uygulamaları *Zeynep Özege, Mehmet Erenoğlu, Ufuk Kansu, U. Burak Erdugan, Özcan Danışman*
	Bursa Büyükşehir Belediyesi AYKOME Bilgi Sistemi *Cüneyt Taşkesen*
	Bütünleşik Bilgi Sistemleri: Silifke İlçesi Örneği *Fikri Haşal, Serhat Kalkan, Anıl Bilici, Yusuf Doğan, Halime Yılmaz*
08:40	**TO6: KONUMSAL ANALİZ** (Mithat Özsan Amfisi B Salonu) **Oturum Başkanı:** Prof. Dr. Süha BERBEROĞLU
	Coğrafi Bilgi Sistemleri ile Kentsel Büyümenin Geleceğe Yönelik Modellenmesinde En Yaygın Kullanımlar *Ceren Yağcı, Fatih İşcan*
	Coğrafi Bilgi Sistemleri İle İklim Değişikliklerinin İzlenmesi: İzmir İli Örneği *Anıl Can Birdal, Engin Korkmaz, Gökhan Erşen, Tarık Türk, Rutkay Atun*

	Landslide Susceptibility Mapping of Ilkadım (Samsun) District Using Frequency Ratio Method *Cem Kılıçoğlu, Sedat Doğan, Halil Akıncı*
	Ekosistem Temelli Havza Yönetimi Sürecinde Çok Kriterli Karar Verme Yöntemlerinin Değerlendirilmesi *Şevki Danacıoğlu, Şermin Tağıl*
	Dinamik Çığ Tehlike Değerlendirmesi İçin Bayes Ağlarının CBS'ye Entegrasyonu: UKVA Perspektifi *İpek Yılmaz, Derya ÖZTÜRK*
10:40	**TO7: ULUSAL KONUMSAL VERİ ALTYAPISI, SİSTEM TASARIMI** (Mithat Özsan Amfisi A Salonu) **Oturum Başkanı:** Doç. Dr. Melih BAŞARANER
	Değişen Mekansal Veri Altyapıları ve Yeni Nesil Mekansal Bilgi Sistemleri ile Modern Karar Verme Süreçleri *Caner Güney, Rahmi Nurhan Çelik*
	CBS Projelerinde Çevik Yaklaşımlar: MERBIS Örneği *Tuba Yalçın*
	Türkiye'de Standart Adres Kullanımına Yönelik Bir Araştırma *Batuhan Kılıç, Fatih Gülgen*
	SPK Değerleme Rapor Formatının XML Şeması *Birol Alas*
	NSDI or Open Data, Which Way to Go? *Çetin Cömert, M. Emre Yıldırım*
10:40	**TO8: KONUMSAL ANALİZ, GEOTASARIM, VERİ ÜRETİMİ** (Mithat Özsan Amfisi B Salonu) **Oturum Başkanı:** Prof. Dr. Murat YAKAR
	Peyzaj Görünürlüğünün Sayısal Analizi ve Haritalanması *Hakan Alphan*
	İnsansız Hava Aracı (İHA) ve Uçak Platformlarından Elde Edilen Görüntülerin Ortofoto Üretiminde Karşılaştırılması *Ekrem Ayyıldız, Metin Soylu, Hülya Tuna, Levent Özmüş, Sedat Bakıcı*
	Bina Detaylarının Yüksek Çözünürlüklü Görüntülerden Aktif Kontur Yöntemi İle Otomatik Çıkarımı *Zeynep Akbulut, Samed Özdemir, Hayrettin Acar, Mustafa Dihkan, Fevzi Karslı*
	Şehirleşme ve Şehirli Algısının Mülkiyet Kavramı Üzerinden Yenilenmesi Kapsamında "Kentsel Dönüşüm" Uygulamalarında Coğrafi Bilgi Sistemleri ve Geotasarım Teknolojilerinin Kullanımı *Saffet Erdoğan, Recep Aslan*
12:00	**ÖĞLE YEMEĞİ**
13:30	**PANEL 5: CBS ÖZEL SEKTÖRÜ: MEVCUT DURUM, SORUNLAR VE ÇÖZÜM ÖNERİLERİ** *(CBS özel sektörünün projeleri ve sektörün büyümesi için önerileri, yasal mevzuat, açık veri, CBS eğitiminden beklentiler)*

	Moderatör: Yrd. Doç. Dr. Hasan Tahsin Bostancı **Panelistler:** Emin Bank (NetCAD), Abdullah Efe (Başarsoft)
15:30	**ARA**
15:45	**PANEL 6: KENT BİLGİ SİSTEMLERİ: YEREL YÖNETİMLERDE CBS** *(Yerel yönetim bilgi sistemleri için işleyiş modeli ne olmalıdır? Mevcut durum, sorunlar, yasal mevzuat, açık veri)* **Moderatör:** Hasan Zengin **Panelistler:** Fikri Haşal (Teracity Yazılım Tek.), Lütfi Doğan (Adana Büyükşehir Belediyesi), Abdullah Özdemir (Ordu Büyükşehir Belediyesi)
17:45	**POSTER OTURUMU 2** (Poster Sunum Alanı) **Oturum Başkanları:** Doç.Dr. Halil AKINCI, Doç.Dr. Sedat Doğan, Yrd.Doç.Dr. Hasan T. Bostancı
	İstanbul Kara Surları'nın Somut ve Somut Olmayan Kültürel Niteliklerinin Coğrafi Bilgi Sistemlerinde Modellenmesi *Figen Kıvılcım Çorakbaş, Alper Çabuk*
	Kent ve Ülke Ölçeğinde Doğal Kaynakların Korunmasında Coğrafi Bilgi Sistemleri Teknolojilerinin Kullanımı *Burak İpek*
	Rüzgâr Enerjisi Santrali Kurulabilecek Alanların CBS İle Belirlenmesi: Sivas İli Örneği *Rutkay Atun, Önder Gürsoy, Anıl Can Birdal*
	Yerel Yönetimlerde Etkin Bir Denetim Aracı Olarak CBS *Abdullah Özdemir, Haluk Gürsoy*
	Landslide Susceptibility Assessment of Hopa (Artvin) District Using GIS-based Frequency Ratio Method *Halil Akıncı, Esra Tunç Görmüş, Ayşe Yavuz Özalp, Cem Kılıçoğlu*
	Türkiye'nin Kentiçi Ulaşım Veri Tabanının Oluşturulması İçin GIS Temelli Bir Yöntem Önerisi *Candan Sağıroğlu, Ebru Vesile Öcalır Akünal*
18 Kasım 2017 Cumartesi	
09:00	**TO9: EN İYİ BİLDİRİ OTURUMU** (Mithat Özsan Amfisi A Salonu) **Oturum Başkanı:** Prof. Dr. Mahmut Onur KARSLIOĞLU
	Kızılırmak Deltası ve Lagünlerinin Kıyı Paterninin Fraktal Analizi *Azize Uyar, Derya Öztürk*
	Türkiye İçin Aylık Güneşlenme Süresinin Uydu Verileri ve Coğrafik Parametreler Kullanılarak Tahmin Edilmesi *Kazım Kaba, M. Tülin Zateroğlu, H. Mustafa Kandırmaz*
	Appraising Generalized Additive Models (GAMs) in GIS Framework *Bülent Tütmez*

	Hierarchical Blockchain Architecture for A Relaxed Hegemony on Cadastre Data Management and Update: A Case Study For Turkey *Abdulvahit Torun*
	Gezgin Satıcı Problemi'ne Coğrafi Bilgi Sistemleri'nden Bir Çözüm: TRIO (TRavel Itinerary Organizer) *Serhat Yılmaztürk*
11:00	**KAPANIŞ OTURUMU** (Mithat Özsan Amfisi A Salonu) **Oturum Başkanı:** Prof. Dr. Çetin CÖMERT

CONTENTS

Examination of the Usability of Spatial Data Models for a 3D Cadastre

Fatih Döner[1, *], Samet Şirin[2]

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Abstract

Urbanization density and the increasing complexity of the utilities necessitate more effective registration and representation of the legal situation of public and private immovable properties especially in urban areas. In recent years, this necessity has led to the cadastral systems to refer to a space containing a vertical dimension (third dimension) instead of a two-dimensional horizontal plane for registration. On the other hand, many spatial data models have been developed that can support the modeling of complex three-dimensional (3D) situations. Some of them are CityGML (City Geography Markup Language), Industry Foundation Classes (IFC), IndoorGML and Land Administration Domain Model (LADM). It is not easy to clearly show the legal boundaries of different sections in a building as 3D. However, in recent years, 3D digital environments have begun to offer more possibilities so that these boundaries can be shown to users and understood easily. When it comes to immovable properties that make up the issue of the cadastre, it is necessary to consider the difference between physical boundaries and legal boundaries. While data models such as CityGML, IndoorGML and IFC aim at phsical representation of buildings, data models such as LADM are intended to model not only physical objects but also legal boundaries of immovables. In this study, it is aimed to examine the usability of the above mentioned data models in a 3D approach to enrich the scope and content of the cadastre. By examining the sample applications, the legal and technical feasibility of the models has been compared.

Keywords

NSDI, Spatial Data Models, Building Information Modeling, Cadastre, CityGML, LADM

1. Introduction

Nowadays more and more applications need three-dimensional (3D) data. One of the applications areas is cadastre. The currently two-dimensional (2D) cadastral parcels are not suitable for organizing and modeling the information of complex commodities and interests in land (Döner et al., 2010 and Döner at al., 2011, Bennett et al. 2008, Kalantari et al. 2008).

The main 3D objects in cadastral systems are apartments, complex constructions, above ground utilities and underground constructions such as tunnels, shopping malls and utilities. Changing over time, currently individual apartments are usually not visible on the cadastral map, only the outline of the apartment building as related to the ground being visible. However, the rights are attached to the individual apartments and some countries/ municipalities have developed solutions for 3D/volumetric representation of individual units as shown in Figure 1 (Döner et al, 2008).

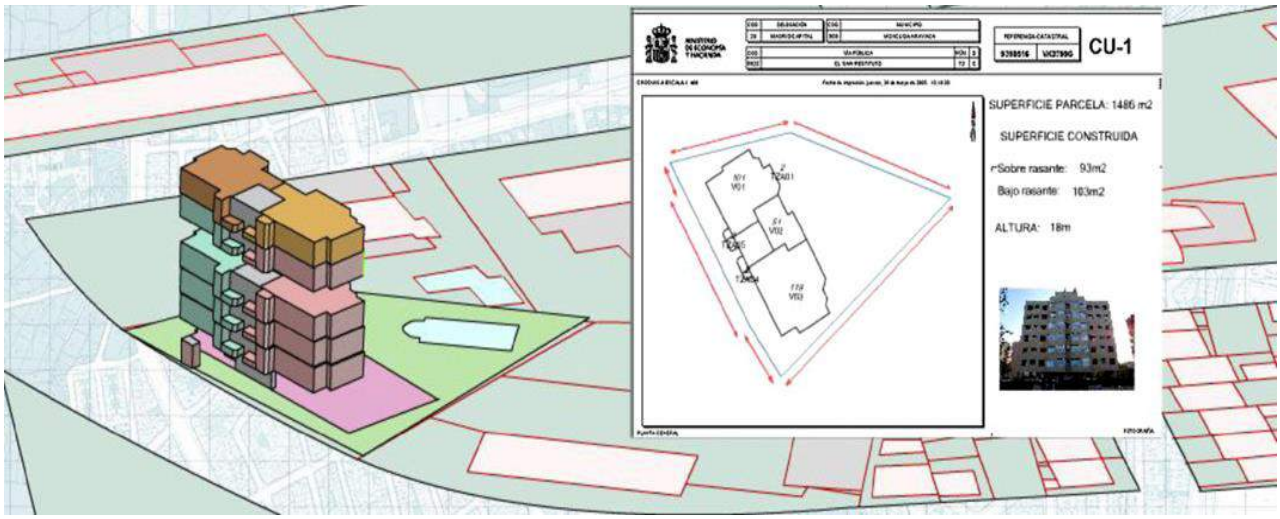

Figure 1: 3D impression of individual units with floor sketch, photography and relevant attributes (courtesy to the Spanish cadastre).

Urbanization density and the increasing complexity of the utilities necessitate more effective registration and representation of the legal situation of public and private immovable properties especially in urban areas. In recent

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years, this necessity has led to the cadastral systems to refer to a space containing a vertical dimension (third dimension) instead of a two-dimensional horizontal plane for registration. On the other hand, many spatial data models have been developed that can support the modeling of complex three-dimensional (3D) situations. Some of them are CityGML (City Geography Markup Language), Industry Foundation Classes (IFC), IndoorGML and Land Administration Domain Model (LADM). It is not easy to clearly show the legal boundaries of different sections in a building as 3D. However, in recent years, 3D digital environments have begun to offer more possibilities so that these boundaries can be shown to users and understood easily. When it comes to immovable properties that make up the issue of the cadastre, it is necessary to consider the difference between physical boundaries and legal boundaries. While data models such as CityGML, IndoorGML and IFC aim at phsical representation of buildings, data models such as LADM are intended to model not only physical objects but also legal boundaries of immovables.

In this study, it is aimed to examine the usability of the above mentioned data models in a 3D approach to enrich the scope and content of the cadastre. By examining the sample applications, the legal and technical feasibility of the models has been compared. The remainder of this article is organized as follows: Section 2 gives a general overview on 3D cadastre; Section 3 introduces the spatial data models; Section 4 presents the applications of the spatial models in cadastral domain. The last section presents the concluding remarks.

2. 3D Cadastre

Global economic, social, technological factors and need for sustainable development are having a substantial impact on cadastral systems. As a result of this impact, the content and role of cadastre have changed significantly during the last few decades. Cadastres must show the complete legal situations of land, including public rights and restrictions (Kaufmann and Steudler, 1998). All these rights, restrictions and responsibilities related to land are often overlapping, therefore, current 2D cadastral systems have shown limitations in certain 3D situations. The increasing complexity of modern land use requires that cadastres need to manage information on the third dimension. However, traditionally cadastres are based on a representation of the division of land in 2D, obscuring the 3D aspects of land ownership in cadastral registers and maps (UN and FIG 1999, van der Molen 2003, Stoter 2004, van Oosterom et al. 2006). Several researchers have discussed options for transition of 2D cadastres to 3D (Döner at al., 2011, Drobež at al, 2017, Lee at al., 2015, Gatta at al, 2017, Shojaeia at al, 2016, Paulsson and Paasch, 2013, Hespanha et al. 2006, van Oosterom et al. 2006).

From a conceptual point of view, one of the foundations of the land parcel based cadastre is that there must be no gaps or overlaps in the spatial representation of the parcel coverage. A planar partition of the earth surface implies that property volumes defined by the space columns above and below the ground surface parcel also form a partition of space. The same foundation (a partition of space with no overlaps or gaps) is also the basis of the conceptual thinking with respect to 3D cadastre. The most advanced implementation would be a system supporting a complete 3D topological structure based on volumes, faces, edges and nodes, as extension of the current systems based on a 2D topology with faces, edges and nodes; however for practical reasons this conceptual view is not necessarily directly translated into an equivalent 3D implementation (Döner et al, 2010).

Various studies have shown that in many countries the parcel of the basic unit of the cadastral system. Accordingly, the ownership of land is defined by the boundaries on the surface, and there is no explicit limitation on the vertical dimension for ownership. Often the ownership of the land includes all the buildings below and above the parcel, as well as all the buildings permanently located on this land. As a result, the registration process is performed by two-dimensional parcels, while the use of vertical dimension is determined by the restrictions imposed by the establishment of easement rights, condominium rights or public laws. While the ownership of land includes the vertical dimension for many years, the question of whether the cadastral expansion to the third dimension is necessary has recently come to the fore. One of the major reasons for this is the significant increase in the value of immovable properties in areas where the population is large and land use is intense. Nowadays it is expected that the cadastre will clearly guarantee the right of ownership. This is possible if the cadastre takes into account the property boundaries in all dimensions. Another reason that brings the three-dimensional cadastre to the agenda is the significant increase in the number of infrastructure facilities such as multi-purpose buildings (underground car park, shopping center, etc.), tunnels and subways, water, electricity, sewage and telephone. Two-dimensional cadastral systems are insufficient in defining and displaying complex structures and infrastructure facilities. In addition to these, developments in areas such as three-dimensional GIS and three-dimensional planning made the three-dimensional cadastral approaches technologically possible (Döner and Bıyık, 2007).

Enriching the content of the cadastre to include the third dimension will enable the implementation of various applications, which require three dimensional geographical information: In city planning and management, the effect of new building and infrastructure facilities on the existing situation can be seen on a three dimensional environment, taxations of buildings according to the heights, visual analysis of changes in land surface, maintenance and renovation of infrastructure facilities, in the modeling and analysis of pollution types such as noise and air pollution, detection of land and buildings that may be affected by floods, determining appropriate locations for distribution stations of mobile

phone networks, modeling of natural resources and underground, creating three-dimensional visualization for location based services on internet for application areas such as shopping, tourism (Lemmen and Oosterom, 2003).

International discussion of the 3D cadastre issue was first undertaken in 2001 under the supervision of the seventh Commission of the FIG, in a workshop named 3D Cadastre in Delft, the Netherlands. As a result of this workshop, it was decided to establish a working group named 3D cadastre in the FIG and share experiences of different countries in this way. The main findings of this 3D Cadastre Working Group, which its logo shown in Figure 2, can be summarized as follows (URL-1):

Figure 2: Logo of FIG 3D Cadastres Working Group

There are differences between countries in terms of legal systems; however, the common point is that in every country there are some rights related to the use of the third dimension. For a generally accepted definition of 3D ownership, many countries will need to make changes to legislation. In many countries, according to the law, property in the land is already three dimensional. The property covers everything from the parcel surface to the center of the earth and everything on the parcel. However, the present spatial registration is restricted to two dimensions. It may not be sensible to collect 3D data only for cadastral purposes. At this point, the use of multi-purpose 3D data in application areas such as urban planning and city management which require 3D representation should be considered. The sharing of 3D data should be evaluated within the context of spatial data infrastructures. As in the case of two-dimensional registration, the main purpose of 3D registration of ownership is to secure the legal rights and to provide a legal basis for the transactions to be carried out with respect to these rights. The creation of this basis will in real sense stimulate interest in the land market and enable the effective use of the three-dimensional space. In practice, economic factors should also be considered. When viewed from an economic standpoint, it may be difficult to form a 3D cadastre soon. In time increasing technological opportunities will help to make the 3D cadastre a reality.

3. Spatial Data Models

3.1. City Geography Markup Language CityGML

CityGML (City Geography Markup Language) is an internationally recognized common information model for the representation of 3D city objects. CityGML defines class and relations of urban objects by considering the geometric, topological, semantic and appearance properties. Unlike other vector formats, CityGML is based on a generic rich information model in addition to geometry and graphics. This makes it possible to use 3D models for complex analysis in different areas. Some of the uses of CityGML are urban planning, architectural design, tourism, 3D cadastre, environmental simulation, disaster management, pedestrian navigation. As an open model, CityGML, is implemented with the GML application schema. GML is an extendable standard for the exchange of spatial data and is published by the Open Geospatial Consortium (OGC) and the International Organization for Standardization - Technical Committee - Geographic information / Geomatics (ISO TC 211) (Biljecki et al. 2015).

The CityGML data model enables the representation of the same city object in different degrees of resolution through the notion of level-of-detail (LOD). The following five levels are specified: LOD0 the coarsest level is the digital terrain model. LOD1 provides the block model, without any roof structures. LOD2 is the block model with roof structures, texture and larger building installations. LOD3 provides detailed architectural models. Finally, LOD4 enriches LOD3 by adding interior structure objects (Kolbe, 2005).

3.2. Industry Foundation Classes (IFC)

The IFC (Industry Foundation Classes) standard is an open and platform independent data model for the storage and exchange of BIM (Building Information Modeling) models. The aim of this standard is to provide interoperability and exchange of BIM models between different platforms. The EXPRESS data model language is the basis for this open

BIM model. Numerous spatial and semantic concepts are used in IFC to model buildings. IFC can store geographic coordinates, datum heights, the address of the buildings as attributes, as well as representing land surface. The physical elements modeled in IFC are not just geometric and topological structures, but also the semantic connection between them (such as walls and ceilings). IFC also supports the hierarchical division of buildings as well as the non-hierarchical connection of building elements to each other. This approach is particularly useful when several legal rights are distributed to different parts of the building. If a private property right includes units in different parts of the building such as an independent section (apartment), parking lot and warehouse, it is possible with IFC to associate this property right with other units (Atazadeh et al. 2017a).

3.3. IndoorGML

IndoorGML is a fairly new 3D standard developed by the Open Geospatial Consortium (OGC) for network analysis in indoor areas. This physical data model contains basic topological and semantic entities for navigation in closed spaces. The partition of the interior space and the connections, closeness and relationships of these sections are defined in IndoorGML. Indoor areas and their boundaries can be modeled by the relationships provided by this physical model. In this way it may be possible to represent the legal boundaries of the usage status in the building (Atazadeh vd., 2017b).

IndoorGML consists of an open data model and XML schema and it has two modules. The first one is Core module (see Figure 3). Basically it is about a topological representation of cellular spaces. These spaces and their boundaries correspond to CellSpace and CellSpaceBoundary. Other two primary classes of State and Transition link to CellSpace and CellSpaceBoundary according to Poincar´e Duality, respectively (Zlatanova et al. 2017). States and Transitions represent nodes and edges of the dual graph of indoor space. IndoorGML is designed as a common schema framework for indoor navigation applications. In general, IndoorGML defines and expresses the network of indoor spaces (e.g., connectivity graph) and indoor paths. In addition, space semantic features are defined which can be used to enrich the semantics of indoor network and paths (Lee et al., 2014).

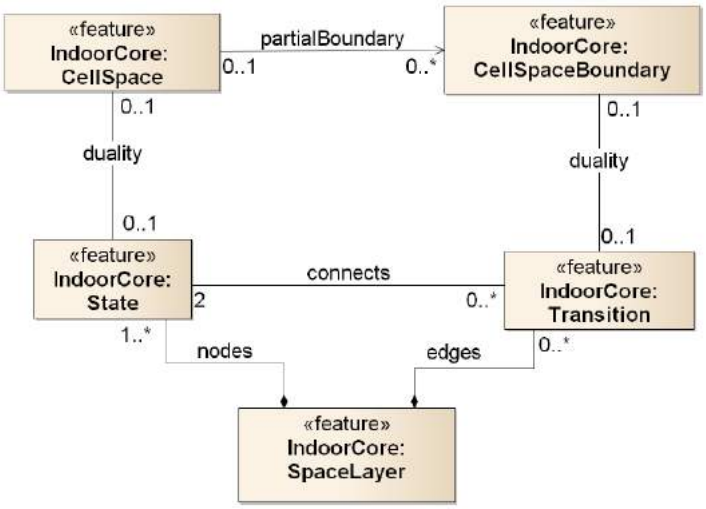

Figure 3: Main classes of Core module of IndoorGML (Lee et al., 2014)

3.4. Land Administration Domain Model (LADM)

LADM is an ISO (International Organization for Standardization) standard and provides a conceptual model covering the information component of land administrations. This model covers land, space above and below the land and also water bodies. One of the main objectives of the LADM is to provide an extendable basis for the development of land management systems. The LADM consists of the parties, the spatial units, the administrative units and the spatial sources. The UML class diagram is represented in Figure 4. The three main packages of the LADM consist of the Party package (green), the Administrative package (yellow) and the Spatial Unit package (blue) with its sub package Representation and Survey (red). The parties represent persons and institutions in legal proceedings. Spatial units represent legal interests related to land, buildings or property. The basic spatial units are land parcels, buildings or volumetric legal spaces around utilities. Administrative units are defined on the basis of legal rights associated with spatial units. For example, private property in a building is regarded as an administrative unit consisting of three spatial units such as legal space of condominium, a parking lot and a warehouse. Spatial sources include data acquisition methods used to represent the boundaries of spatial units. The most common spatial sources can be listed as terrestrial measurements, photogrammetric methods and point cloud data. There are two approaches to defining the boundaries of

positional units in the LADM. While the first is for defining 2D areal spatial units the second is for defining bounded volumetric spatial units (Lemmen et al. 2015).

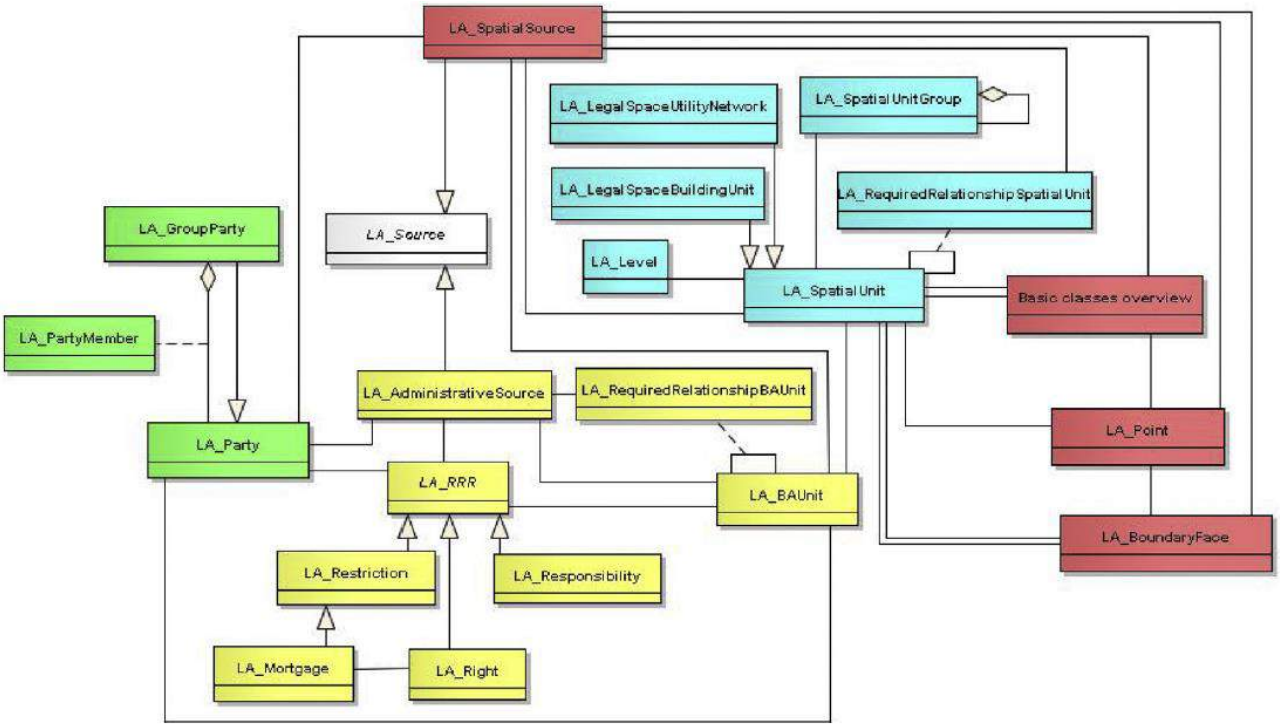

Figure 4: The Land Administration Domain Model (Lee et al., 2014)

4. Applications of Spatial Data Models in Cadastre

A number of studies have been conducted in recent years based on the data models mentioned in the above section for the purposes of 3D management of information on the legal and physical status of real estates. In Atazadeh et al. (2017a), case studies were implemented for representing individual units in cadastre (in Australia) as 3D, by using different data models and these models were then compared. In these case studies, data models are grouped into legal, physical and integrated models. These groups were compared according to criteria such as display speed, semantic query speed, number of geometries included. In Figure 5, individual units are shown on the plan and on the BIM-based model, in this study.

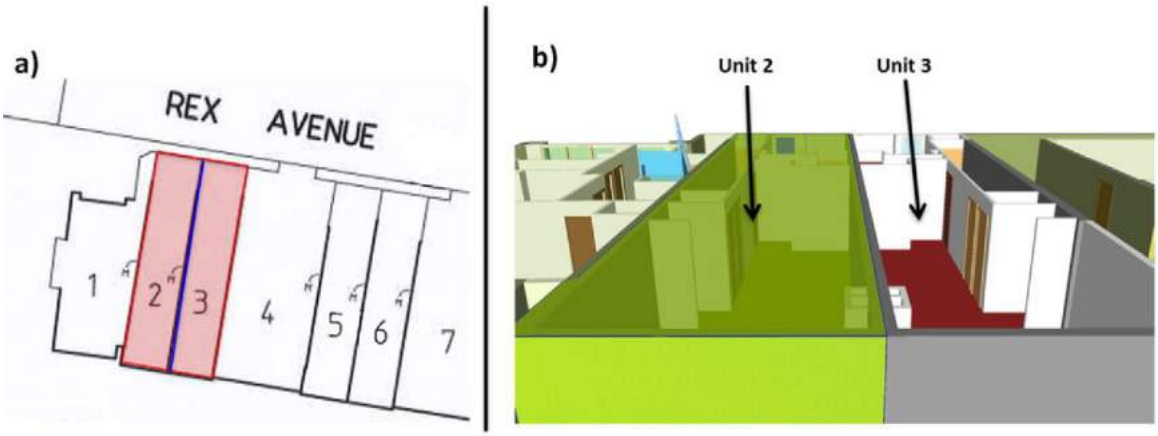

Figure 5: Boundary, a) plan version, b) in BIM environment (Atazadeh et al., 2017b)

In Dsilva (2009), a study was conducted to investigate the usability of CityGML to show the parcels with buildings on the Netherlands together with these buildings in the cadastral database. For this purpose, a CityGML extension was developed to represent legal information related to buildings and individual units. A method has been proposed that

automatically retrieves the information on the scanned images in the current cadastral system and transfers them to CityGML (Dsilva, 2009). In Çağdaş, (2013), the CityGML data model has been proposed to be extended with an ADE (Application Domain Extension) for real estate taxation in Turkey. It is stated that this proposed 3D data model will provide a more efficient taxation process in addition to urban planning and facility management. This extension has three new classes. These are: PropertyUnit, CadastralParcel, and CondominiumUnit classes. The PropertyUnit class contains property and tax information for any property unit. The CadastralParcel class contains information such as parcel number, area and value. The CondominiumUnit class contains information such as the owner's name, taxpayer, shares, etc., which are used to model parts of the building that are independently owned (Scarponcini et al. 2016). Apart from traditional 2D cadastral parcels in Australia's Queensland province, it is possible to measure 3D property units and represent them in cadastre. There are also institutional arrangements for how to measure and register these property units, which are defined as "volumetric parcels". Detailed measurement plans of legally identifiable volumetric parcels are added to the deeds. In this the state, explanations available for defining the 3D parcels and easement rights and how to make the registration procedures are detailed in the regulations by examples. In Thompson et al. (2017), it was aimed to model complex situations in XML and GML formats using 3D survey plans. Figure 6 shows examples prepared for the representation of complex situations.

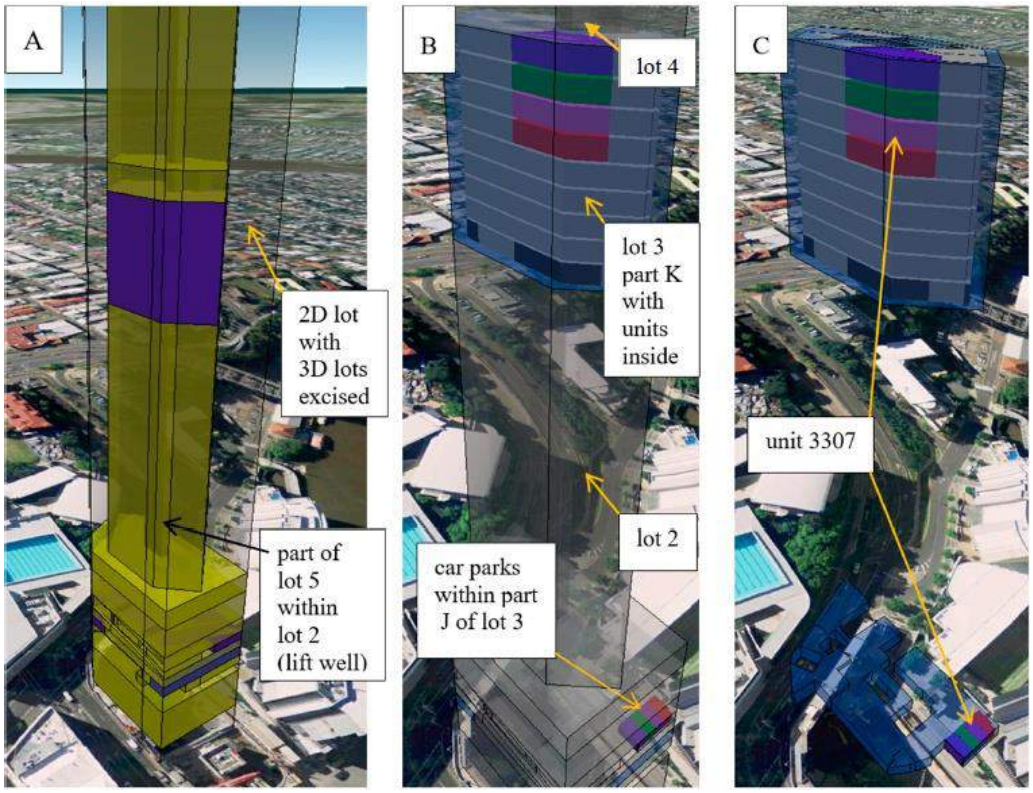

Figure 6: Examples of complex situations (Thompson et al. 2017)

In Zlatanova et al (2016), two alternatives for cadastral use of IndoorGML have been proposed. The first is to define a new cadastral layer in IndoorGML. The second alternative defines an external connection between IndoorGML and an existing 3D cadastral standard. It has been shown that a connection between the spatial unit concept of the LADM and the CellSpace class of IndoorGML can be established in the case study.

Thompson (2015) discussed the development of a LADM-based digital cadastral database for Australia. In Mader et al. 2015, the use of LADM for the organization of cadastral data, which is under the responsibility of different institutions in Croatia, has been demonstrated. In Zhuo et al. (2015), a LADM-based model was proposed for the integration of registration information on land and housing in China. In Lee et al. (2015), LADM was used to create a 3D cadastral model for Korea. Gogolou and Dimopoulou (2015) proposed a model to reference the LADM for registration in the land management system of immovables with historical value in Greece. Paixao et al. (2015) proposed modeling of traditional land property rights with LADM in Brazil. In Bydłosz (2015), a study was undertaken with reference to the LADM in order to correlate the data in the registration and mapping units under different institutions' responsibilities in Poland. In Zulkifli (2015), a data model with reference to LADM was presented in the creation of a land management system to support Malaysian land policy.

Extending the scope and content of the cadastre with 3D models to accommodate the third dimension will also support the applications that require 3D spatial data. Biljecki et al. (2015) includes some applications where 3D models

are used (Figure 7). Some of these applications can be listed as follows: Estimation of the solar irradiation, Energy demand estimation, Estimation of shadows cast by urban features, Estimation of the propagation of noise in an urban environment.

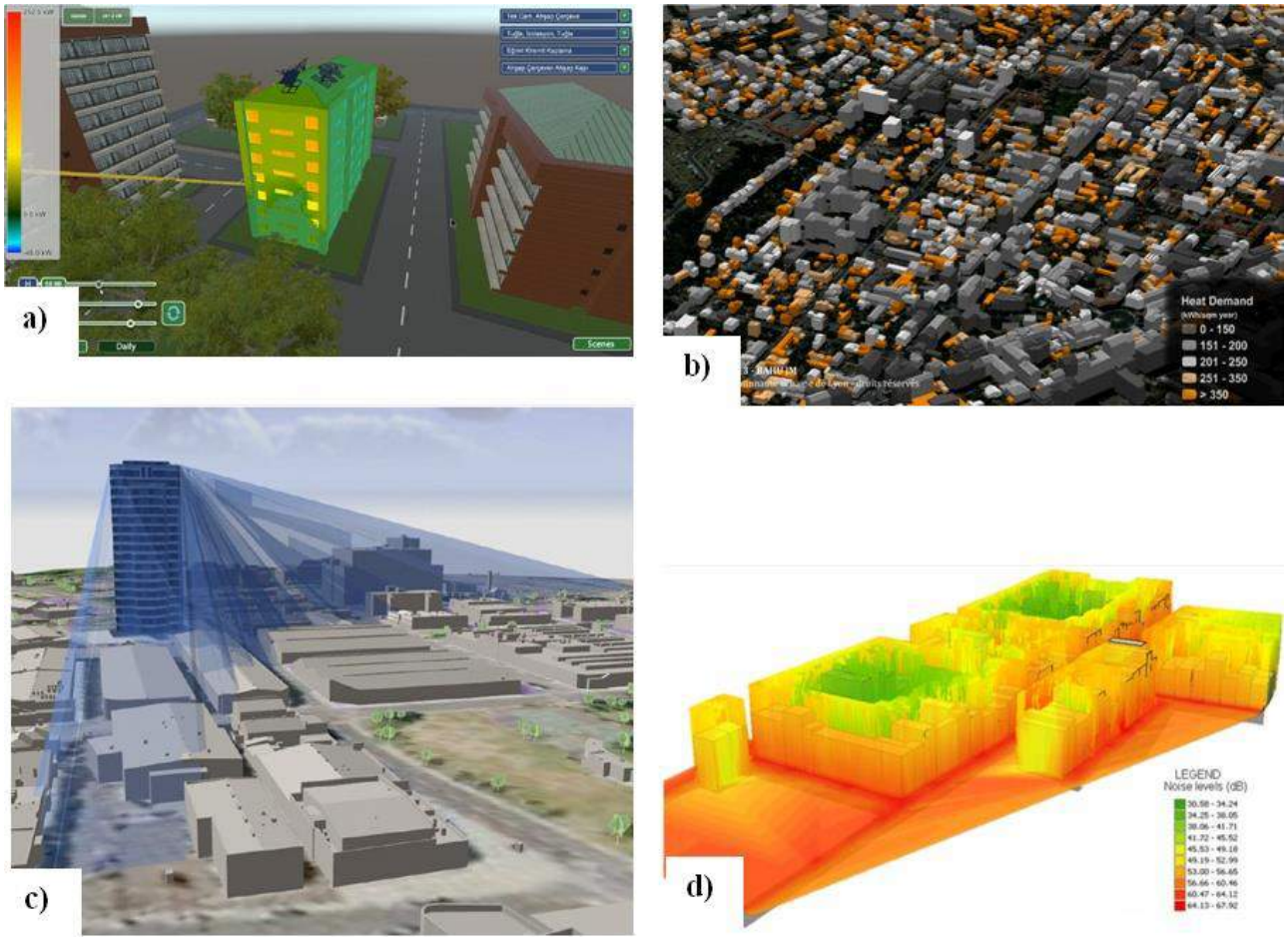

Figure 7: Examples of applications with 3D models. a) Estimation of the solar irradiation, b) Energy demand estimation, c) Estimation of shadows cast by urban features, d) Estimation of the propagation of noise in an urban environment (Biljecki et al. 2015)

5. Conclusions

In recent years, the issue of improving the cadastre to include the third (height) and even the fourth (time) dimension has been on the agenda. One of the main reasons for the intensive handling of this issue is that existing 2D cadastre systems are inadequate to register and represent complex situations which are often located top of each other. From a legal point of view, the cadastre is already in 3D, but the spatial representation is achieved by reducing to plane. Another reason for the growing interest in 3D cadastre is that progress especially in 3D spatial data modeling and display makes a 3D cadastre technically possible. The basic objects that can be considered as 3D in cadastre are buildings and independent sections (condominiums). In the current situation, it is possible to reach the drawings of the condominium (as analogue or digital). However, these are not really part of the cadastral database. For example, it is not possible to represent and query the distributions of condominiums in a building in a 3D environment. When studies on 3D spatial data models discussed in this article are examined, it is seen that important progress has been experienced in recent years. First applications of models both as geospatial-based (such as CityGML) and as BIM-based (such as IFC), in the cadastral domain have been implemented. In addition, LADM (ISO 19152), a conceptual model, in many countries, has been referenced for improving the existing cadastre system or for designing a new cadastral system. Although all the three approaches have advantages and disadvantages compared to each other, the results are promising for the future.

As a result, the use of 3D spatial data models will contribute to the improvement and enhancement of the cadastral content, including the third dimension. In this way, cadastral data can be used in applications that will be carried out in very different areas, mainly real estate valuation, which will more securely represent and register the legal status of the real estate as well as create the infrastructure of the information system.

References

Atazadeh B., Kalantari M., Rajabifard A., Ho S., *Modelling building ownership boundaries within BIM environment: A case study in Victoria, Australia*, Computers, Environment and Urban Systems, 61, 2017b.

Atazadeh B., Rajabifard A. ve Kalantari M., *Assessing Performance of Three BIM-Based Views of Buildings for Communication and Management of Vertically Stratified Legal Interests*, International Journal of Geo-Information, 198 (6), 2017a.

Bennett, R., Wallace, J., Williamson, I.P., 2008. *A Toolbox for Mapping and Managing New Interests Over Land*. Survey Review 40 (307), 43–53.

Biljecki F., Stoter J., Ledoux H., Zlatanova S. ve Çöltekin A., *Applications of 3D City Models: State of the Art Review*, ISPRS International Journal of Geo-Information, 4, 2015.

Bydłosz, J., *The Application of The Land Administration Domain Model In Building a Country Profile For The Polish Cadastre*, Land Use Policy 49 (2015) 598–605.

Çağdaş, V., *An Application Domain Extension to CityGML for immovable property taxation: A Turkish case study*, International Journal of Applied Earth Observation and Geoinformation, 21, 545–555, 2013.

Doner, F. and C. Biyik, *Üç Boyutlu Kadastro*, Hkm - Jeodezi, Jeoinformasyon ve Arazi Yönetimi Dergisi, 97, 53-56 (2007).

Doner, F., R. Thompson, J. Stoter, C. Lemmen, H. Ploeger and P. van Oosterom, "*4D Land Administration Solutions in the Context of the Spatial Information Infrastructure*", FIG Working Week 2008, 14-19 June 2008, Stockholm, Sweden, 2008.

Döner, F., R. Thompson, J. Stoter, C. Lemmen, H. Ploeger, P. van Oosterom and S. Zlatanova, "*Solutions For 4D Cadastre – With A Case Study On Utility Networks*", International Journal of Geographical Information Science, 25(7) 1173-1189 (2011), doi: 10.1080/13658816.2010.520272.

Döner, F., R. Thompson, J. Stoter, C. Lemmen, H. Ploeger, P. van Oosterom and S. Zlatanova, "*4D Cadastres: First Analysis of Legal, Organizational, and Technical Impact-with a Case Study on Utility Networks*" Land Use Policy 27 1068-1081 (2010), doi:10.1016/j.landusepol.2010.02.003.

Drobež, P., Fras, M. K., Ferlan, M., Lisec, A., *Transition from 2D to 3D Real Property Cadastre: The Case of the Slovenian Cadastre*, Computers, Environment and Urban Systems, 62 (2017) 125–135.

Dsilva, M. G., *A Feasibility Study on CityGML for Cadastral Purposes*, MSc Thesis, Eindhoven University of Technology, Department of Mathematics and Computer Science, 2009.

Gattaa, G., Arioti, E., Bitelli, G., *Geomatics Science Applied to Cartographic Heritage and Archive Sources: A New Way to Explore the Xixth Century Gregorian Cadastre of Bologna (Italy), An Ante-Litteram 3D GIS*, Journal of Cultural Heritage 23 (2017) 68–76.

Gogolou, C., Dimopoulou, E., *Land Administration Standardization for the Integration Of Cultural Heritage In Land Use Policies*, Land Use Policy 49 (2015) 617–625.

Guo, R., Li L., Ying, S., Luo, P., He B. and Jiang, R., *Developing a 3D Cadastre for the Administration of Urban Land Use: A Case Study of Shenzhen, China*, 3D Cadastres II, special issue of Computers, Environment and Urban Systems, Volume 40, July 2013, pp. 46-55.

Hespanha, J.P, et al., 2006. *A Modular Standard for the Cadastral Domain: Application to the Portuguese Cadastre*. Computers, Environment and Urban Systems, 30, 562–584.

Kalantari, M., Rajabifard, A., Wallace, J., Williamson, I., 2008. *Spatially Referenced Legal Property Objects*. Land Use Policy 25, 173–181.

Kaufmann J. Ve Steudler D.*: Cadastre 2014 – A Vision for a Future Cadastral System*, FIG Publication, 1998.

Kolbe, T.H., Groger, G., Plumer, L., 2005. *Citygml – Interoperable Access to 3D City Models*. In: van Oosterom, P.J.M., Zlatanova, S., Fendel, E. (Eds.), Proceedings of the Int. Symposium on Geo-information for Disaster Management on 21–23 March 2005 in Delft. Springer Verlag, Berlin.

Lee, B. M., Kim, T. J., Kwak, B. Y., Lee, Y., Choi, J., *Improvement of the Korean LADM Country Profile to Build a 3D Cadastre Model*, Land Use Policy 49 (2015) 660–667.

Lee, J., Li, K., Zlatanova, S., H.Kolbe, T., Nagel, C. and Becker, T., 2014. *OGC IndoorGML Version 1.02*. Document No.14-005r4.

Lemmen C. and van Oosterom P.: *3D Cadastres*, Computers, Environment and Urban Systems 27, 2003, s: 337–343

Lemmen, C., Oosterom, P. van ve Bennett, R., *The Land Administration Domain Model*, Land Use Policy, 49, 2015.

Liu, L., Zlatanova, S., Zhu Q., Li, K., *Towards the Integration of IndoorGML and IndoorLocationGML for Indoor Applications*, Volume IV-2/W4, 2017.

Mader, M., Matijevi, H., Roi, M., *Analysis of possibilities for linking land registers and other official registers in the Republic of Croatia based on LADM*, Land Use Policy 49 (2015) 606–616.

Paixao, S., Hespanha, J. P., Ghawana, T., Carneiro, A. F. T., Zevenbergen, J., Frederico, L. N., *Modeling Indigenous Tribes' Land Rights with ISO 19152 LADM: A Case From Brazil*, Land Use Policy 49 (2015) 587–597.

Paulsson J. and Paasch, J., *3D Property Research from a Legal Perspective*, 3D Cadastres II, special issue of Computers, Environment and Urban Systems, Volume 40, July 2013, pp. 7-13.

Scarponcini, P., Gruler, H. -C., Stubkjær, E., Axelsson, P., &Wikstrom, L. (2016). *OGC® Land and Infrastructure Conceptual Model Standard*, (LandInfra).

Shojaeia, D., Olfata, H., Rajabifardb, A., Darvilla, A. and Briffa, M., *Assessment of the Australian Digital Cadastre Protocol (ePlan) In Terms of Supporting 3D Building Subdivisions*, Land Use Policy 56 (2016) 112–124.

Stoter, J.E., 2004. *3D Cadastre. PhD Thesis*. TU Delft, September 2004.

Thompson, R. J., *A Model for the Creation and Progressive Improvement of a Digital Cadastral Data Base*, Land Use Policy 49 (2015) 565–576.

Thompson, R. J., Oosterom, van P.,Soon, K. H., *LandXML Encoding of Mixed 2D and 3D Survey Plans with Multi-Level Topology*, ISPRS Int. J. Geo-Inf., 6, 171, 2017.

UN ve FIG: *The Bogor Declaration*, UN Interregional Meeting of Experts on the Cadastre, Bogor, Indenosia, 1996.

URL-1: http://www.gdmc.nl/3dcadastres/, the FIG Working Group on 3D Cadastres

van der Molen, P., 2003. *Institutional Aspects of 3D Cadastres*. Computers, Environment and Urban Systems, 27, 383–394.

van Oosterom, P., Ploeger, H., Stoter, J., Thompson, R., Lemmen, C., 2006. *Aspects of a 4D Cadastre: A First Exploration*. In: Proceedings XXIII FIG Congress, October2006, Munich, Germany.

Zhuo, Y., Ma, Z., Lemmen, C., Bennett, R. M., *Application of LADM for the Integration of Land and Housing Information in China: The legal dimension*, Land Use Policy 49 (2015) 634–648.

Zlatanova, S., Oosterom, van P., Lee, J., Lic, K. J., Lemmen, C., *LADM and IndoorGML for Support of Indoor Space Identification*, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume IV-2/W1, 2016.

Zulkifli, N. A., Rahman, A. A., Oosterom, van P., Choon, T. L., Jamil, H., Hua, T. C., Seng, L. C., Lim, C. K., *The Importance of Malaysian Land Administration Domain Model Country Profile In Land Policy*, Land Use Policy 49 (2015) 649–659.

The Geographic Information Systems Module Developed Within the Scope of Project of the Agricultural Information Systems

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Abstract

In 2013, Geographical Information Systems (GIS) module was developed within the Agricultural Information System (TBS) by using web technology through open source software available on internet, as a base for the support payments made by our Ministry to the farmers. This application was developed for the active use, control and updating of agricultural parcels in provinces and districts by digitizing the lands within the cadastral parcel borders, which are used only for agricultural purposes. In 2017, with the contribution of experience and informative developments that occurred in the administration and users level, GIS system interface renovated in design, capabilities, applications and its more user-friendly structure with the new technologies developed in the framework of ideas which bring new needs and as leaving many applications' administration to the user's initiative. With the new application, the map imaging technology has been completely changed and has achieved high speed. For this reason, the management logic applied to GIS in the past has been changed to implement the latest technologies developed in OpenLayers3 and browsers. Within the application, Agricultural Parcels, Land Use Capability Classes (AKK) in Soil Map, Slope, Cadastral Parcel, Landowner and Support Information can be displayed as separate sections. For the newly created parcel in the system, AKK and Slope values are automatically calculated and transferred to the supporting software. The Software Attribute Query Feature provides to make various queries from the database. Along with the new software, the ability to edit data on maps can be done on all vector layers (including WFS services and database access) as well as agricultural parcels. Geographical sub-structure database which can be used throughout our country without a need of desktop software and can be integrated with various systems provides high level of working environment for agricultural areas.

Keywords

Agricultural Information System (TBS), Geographical Information Systems Module, Open Source Coded Software, Web Page

1. Introduction

In 2013, Geographical Information Systems (GIS) module was developed within the Agricultural Information System by using web technology through open source softwares available on internet, as a base for the support payments made by our Ministry to the farmers Figure 1, Figure 2.

2. Material and Method

This application was developed for the active use, control and updating of agricultural parcels in provinces and districts by digitizing the lands within the cadastral parcel borders, which are used only for agricultural purposes. The main objectives in the application;

1. To create a web based geographical information systems that it allows a sub-structured system which can benefit from the remote sensing capabilities of the Agricultural Production Registration System (TKSAS) and the Farmer Registration System (ÇKS) within the Agricultural Information System (TBS), that enable agricultural parcel regulation in provinces and districts and can be integrated with the mobile applications in the field.

2. To ensure that Farmer Registration System (ÇKS) payments are given appropriately to the right farmer and eventually to the correct fields. Also, to manage better the policies of food, agriculture and livestock with agricultural statistics.

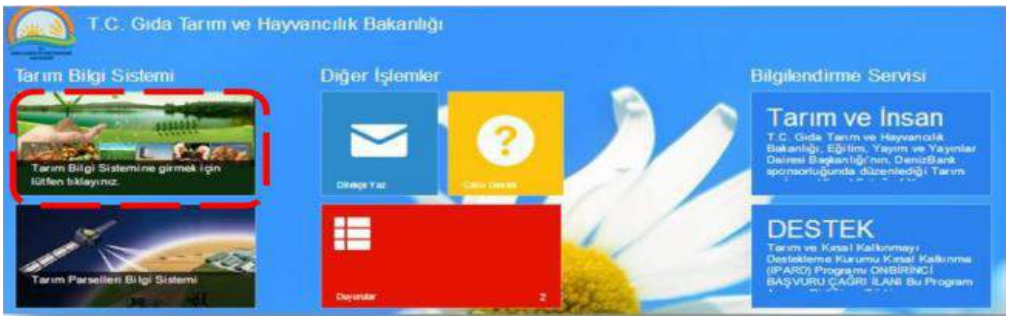

Figure 1: Agricultural Information System Input View

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In 2017, with the contribution of experience and informative developments that occurred in the administration and users level, GIS system interface renovated in design, capabilities, applications and its more user-friendly structure with the new technologies developed in the framework of ideas which bring new needs and as leaving many applications' administration to the user's initiative Figure 3, Figure 4.

Figure 2: Agricultural Information System Login View

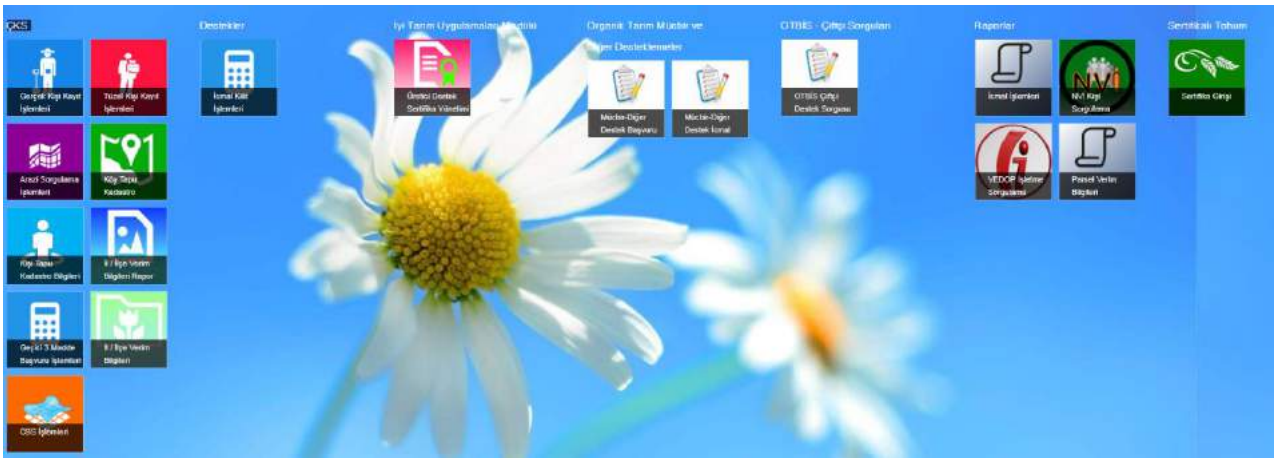

Figure 3: Agricultural Information System Main View

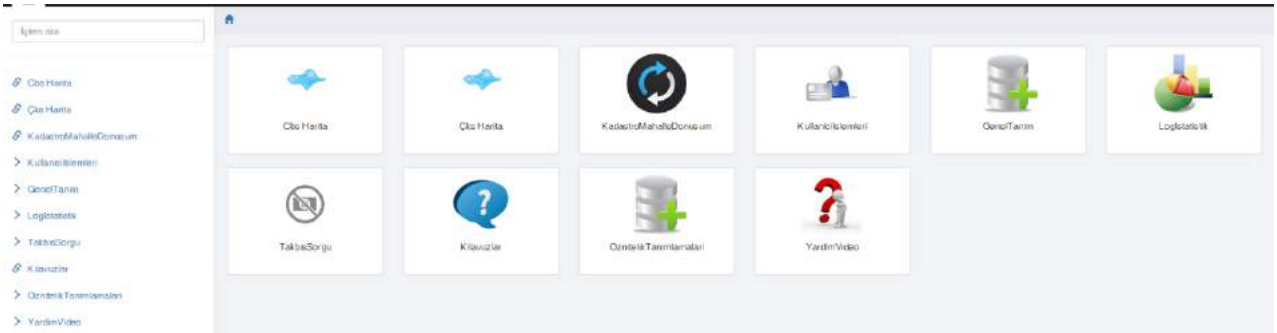

Figure 4: Admin View

Thus, the software has become a general web-based geographical data management platform which is able to organize, analyze and present all the geographical data of our Ministry, instead of using a software that determines the agricultural parcels only with the help of remote sensing.

The Geographic Information Systems' interface provides the opportunity to work at all points which have internet access and while it allows the updated data to be seen by other users within the authority, in the meantime it delivers the innovations will be made in application to all the authorities.

Despite the challenges of numerically presenting, updating, and querying performance-orientedly millions of geographical data in this great geographical region, it has gained a structure that is developed on the basis of rules that determine the operating principles and performance of the system in terms of user management.

3. Results and Discussion

With the new software, it is possible to determine which layer can be edited in an authorized user-defined format and in that way our Ministry's GIS software has become a general web-based data management platform in which all the geographical vector data of the Ministry of Agriculture can be edited Figure 5.

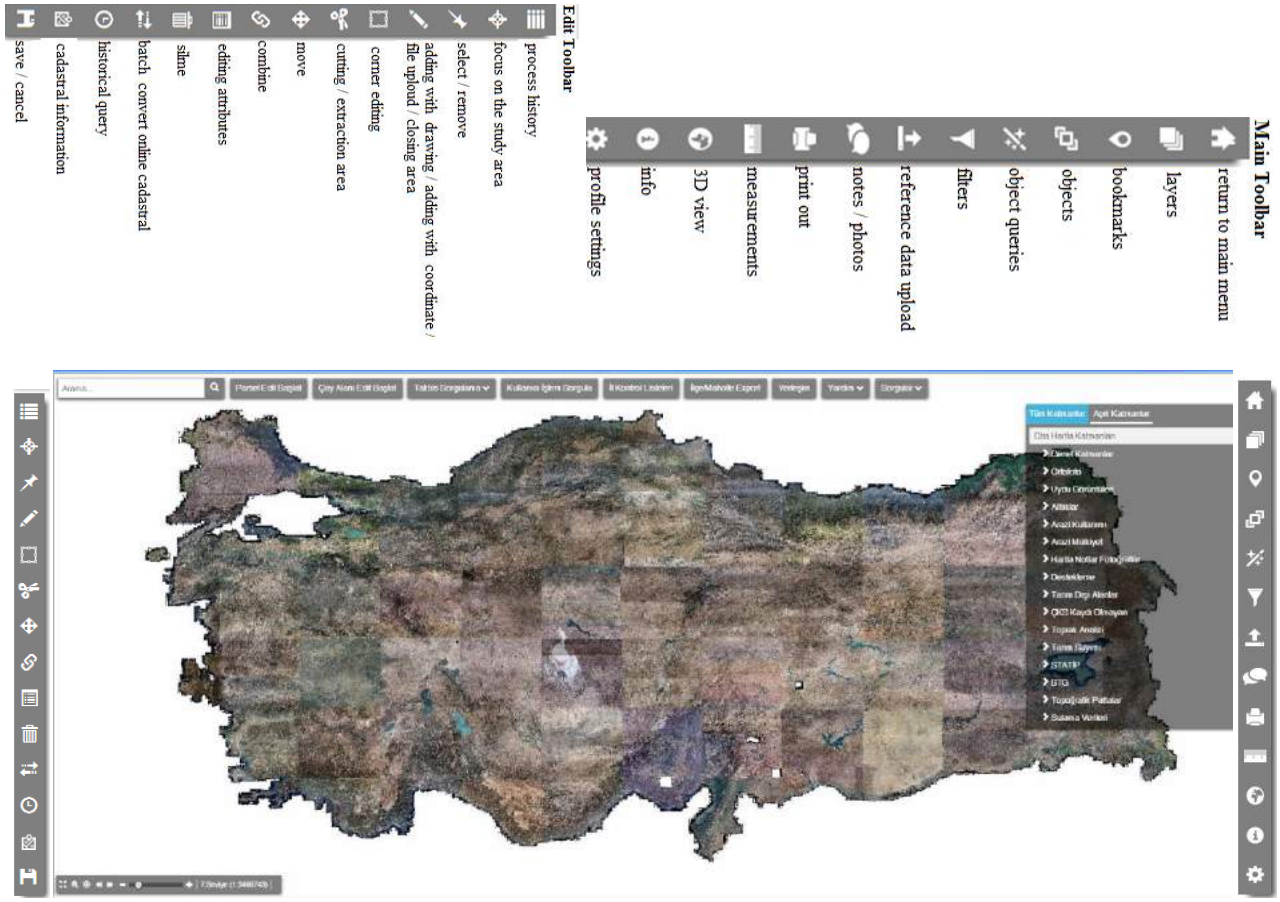

Figure 5: Geographical Information Systems Map Works

Information Views can be defined without writing the software in which layer in which attribute data will be displayed to the user, but a format that can be defined by an XML-based authorized user, by removing hard coded working logic.

With the new system, the responsible user can be identified as the geographical area connected to the administrative settlements by giving them the capability of user identification and authorization in an identifiable manner by the authorized administrator Figure 6.

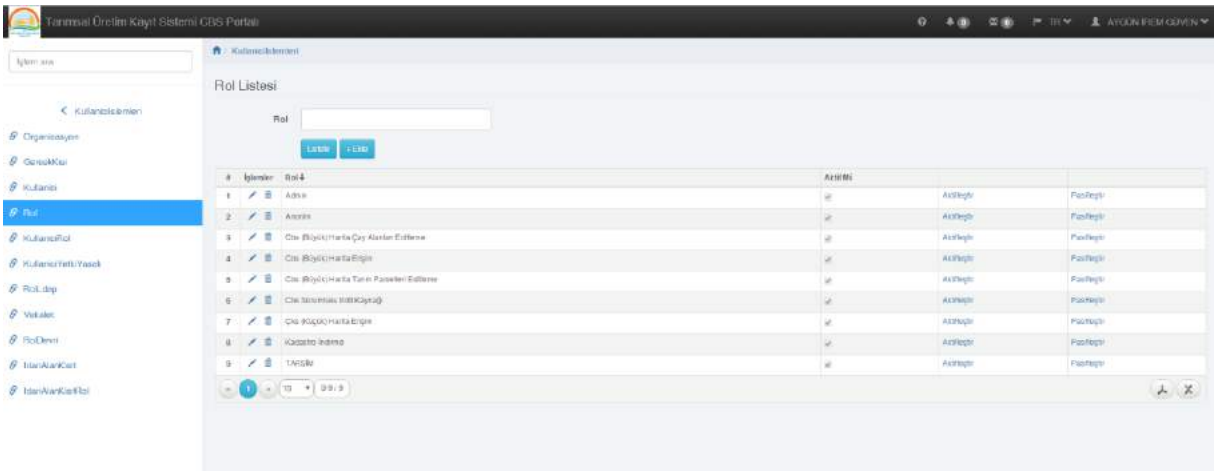

Figure 6: User Operations

With layer management, it is possible for authorized users to specify in which order the layers will be sent and in which names they will be published in the system. And users can draw out the layers they work on most in the layer management and can remove the layers they will not work Figure 7.

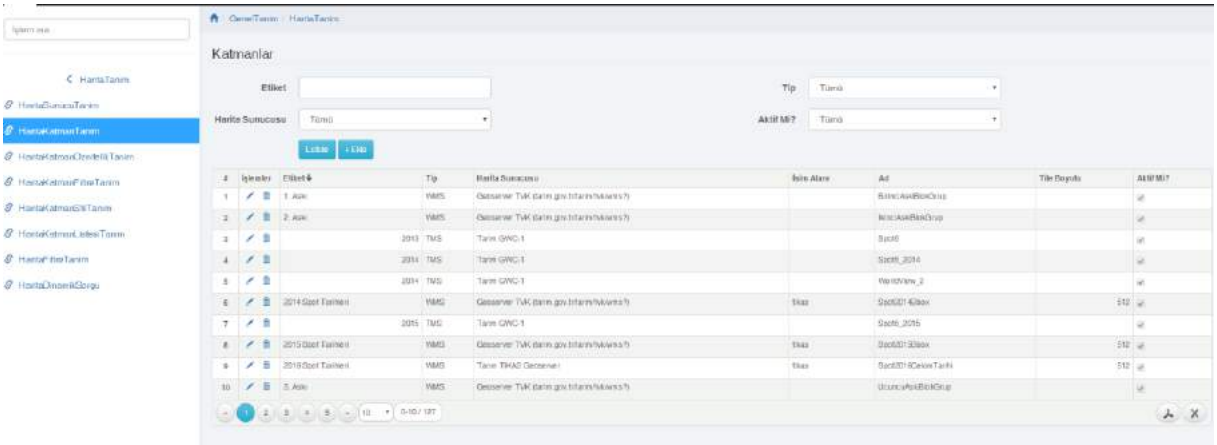

Figure 7: Layer Management

Under the content of the protocol made with the General Directorate of Land Registry Cadastre (TKGM), an online cadastral service can be displayed at the interface and the changes made by TKGM are automatically transferred into the system. On the basis of these changes, agricultural parcels can be automatically generated from neighborhood or from the individual cadastral parcels, and arrangements can be made for non-agricultural areas, and all changes can be instantly monitored by other users on the authority basis Figure 8.

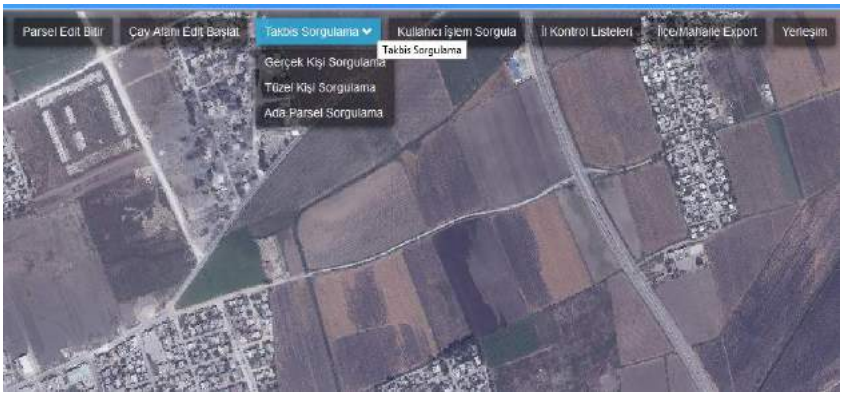

Figure 8: TAKBİS Query Tool

Within the application, Agricultural Parcels, Land Use Capability Classes (AKK) in Soil Map, Slope, Cadastral Parcel, Landowner and Support Information can be displayed as separate sections. For the newly created parcel in the system, AKK and Slope values are automatically calculated and transferred to the supporting software Figure 9.

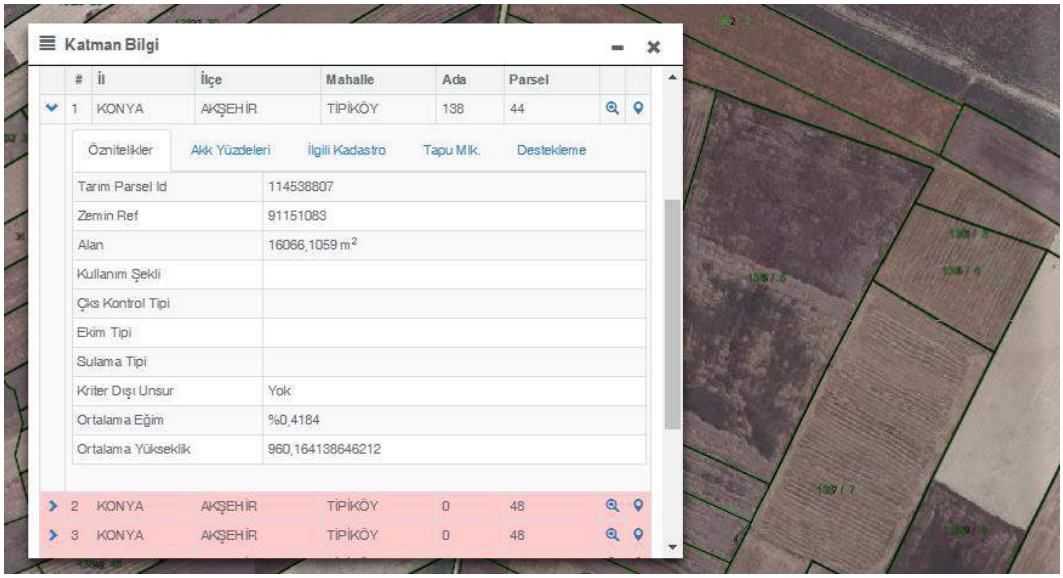

Figure 9: Layer Information View

The Software Attribute Query Feature provides to make various queries from the database Figure 10, Figure 11.

Figure 10: Queries Tool

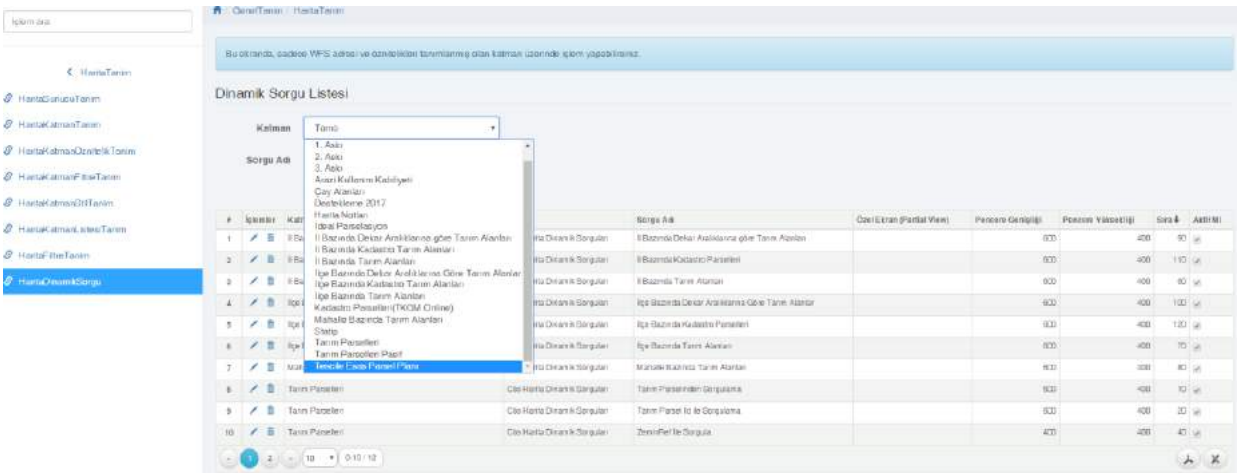

Figure 11: Query Preparation View

Bookmarks can also be added into the system as user-friendly areas and it can be focused by selecting the name given to the desired location whenever it is needed Figure 12.

Figure 12: Bookmarks

With the help of a button, photos related to the land can be uploaded and displayed on the system, and desired photos can be monitorized and information can be obtained quickly Figure 13.

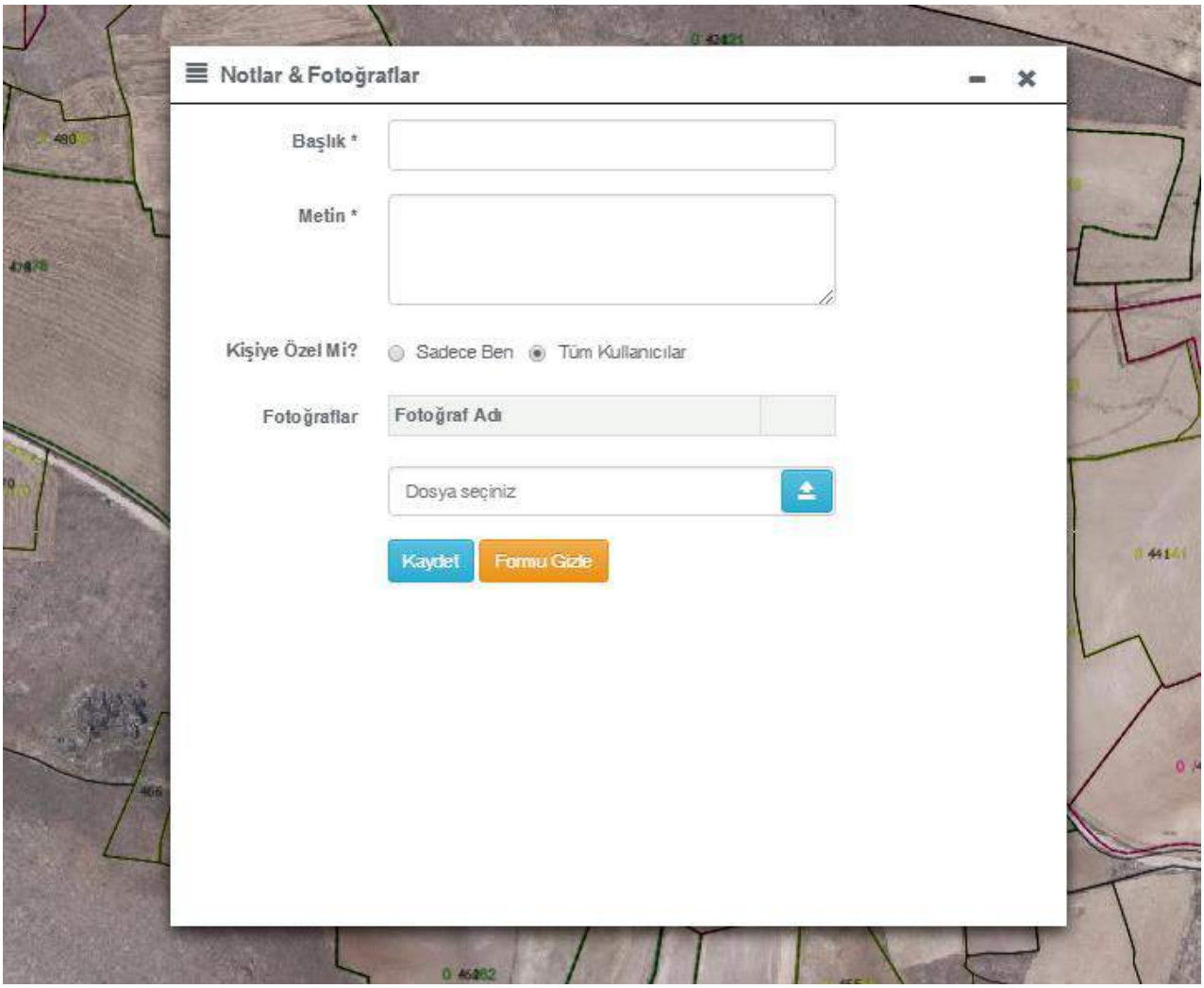

Figure 13: Add Note/Foto View

With the new application, the map imaging technology has been completely changed and has achieved high speed. For this reason, the management logic applied to GIS in the past has been changed to implement the latest technologies developed in OpenLayers3 and browsers.

The queries have a dynamic structure in the new software and authorized users can create what the query scenario they want on the visual views and can save it into the system. Thus, the desired number of query Views can be created dynamically and all users can see them within the authorities.

Layers have the ability to change cartographic properties by filtering color, line type and thickness, symbol assignments.

In the new system, the records of which functions are how often used in the system are kept in detail and the transactions that users have made can be interrogated and reported in the desired date range Figure 14.

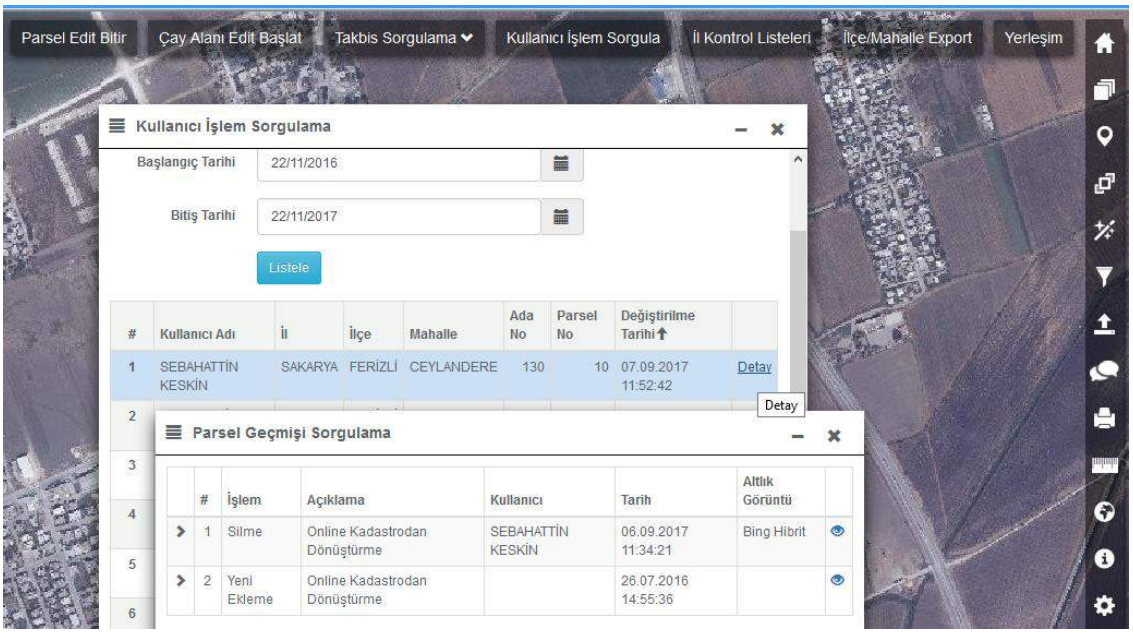

Figure 14: User Operation Query View

All query results can be downloaded into the user's computer in both PDF and desired text-based format (docx, txt, dbf) Figure 15.

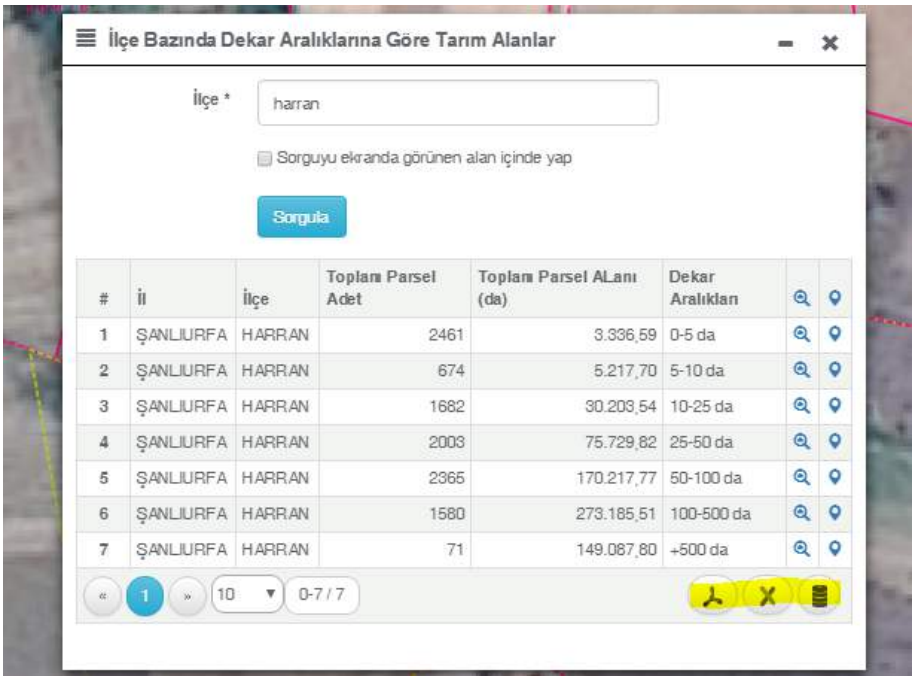

Figure 15: Query Result Data Download

Moreover, a confirmation View has been developed in which the parcel arrangements made at the operator level on the system are transferred to the system after being checked by the provincial directorates. The parcel information is displayed on the View at the determined ratios and the arrangements made according to the expected accuracy ratios are transferred to the system Figure 16, Figure 17.

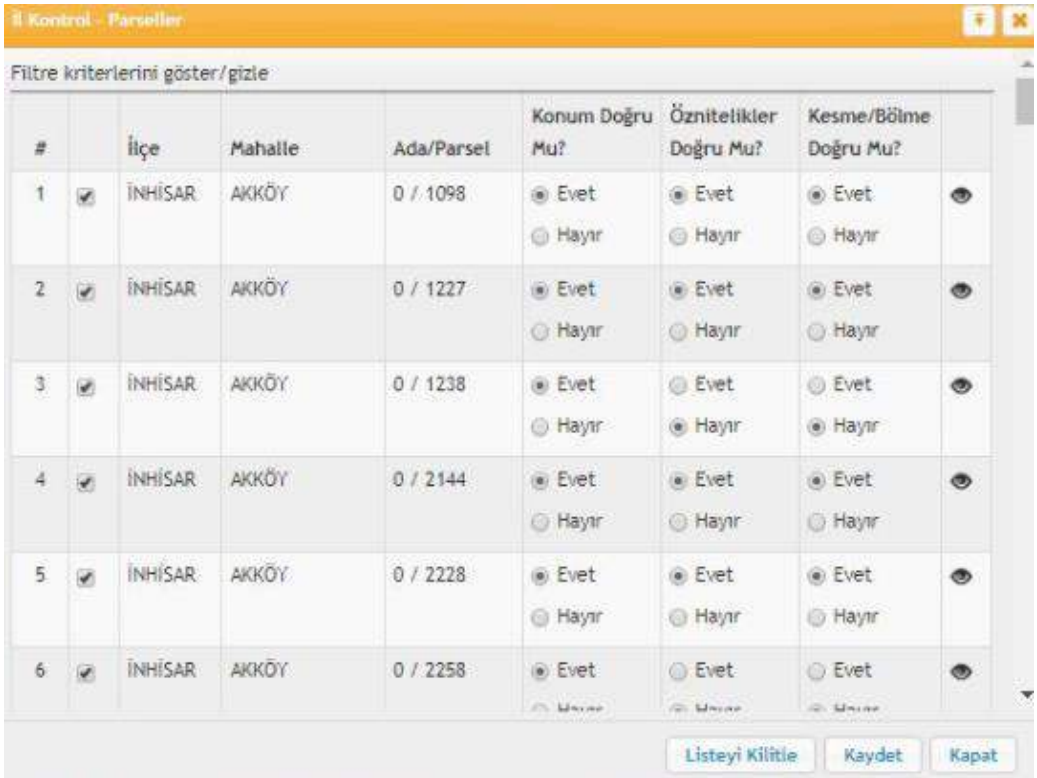

Figure 16: Province Control Parcel View

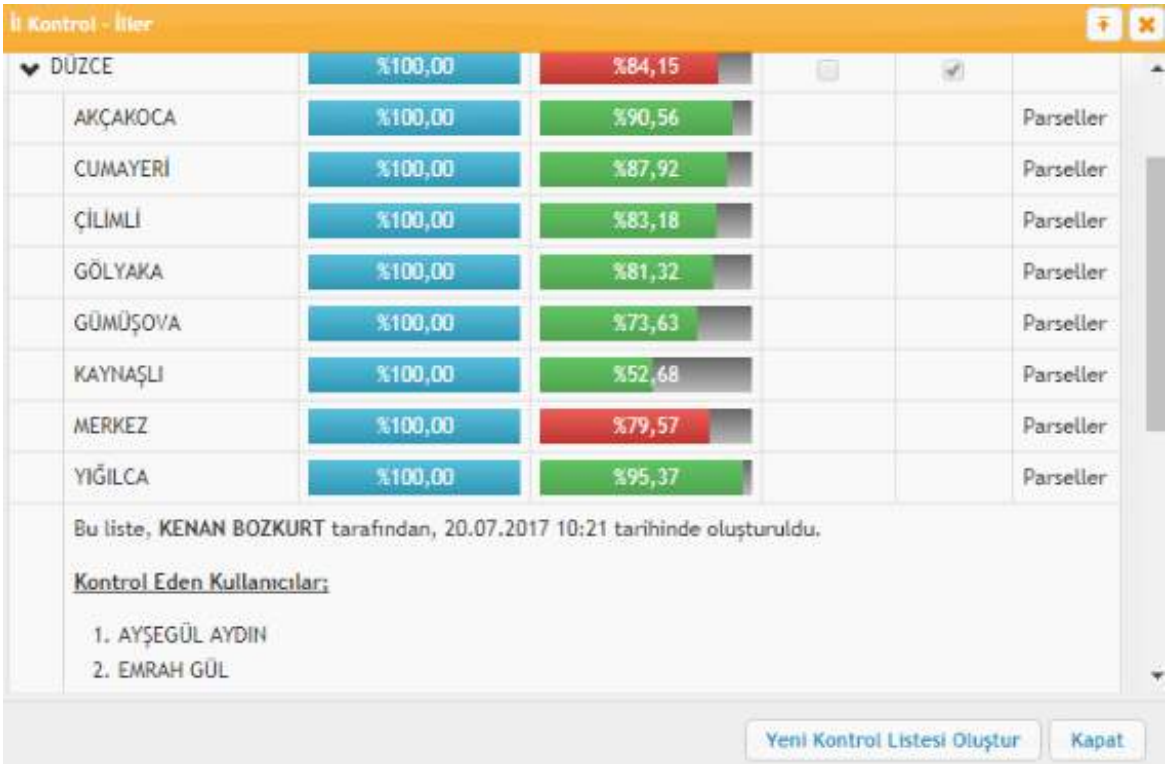

Figure17: Province Control View / Accuracy Rate

The new system has been designed with the idea of "Mobile-first" to be able to work well in all mobile devices (Initially with mobile devices then after with desktop- browsers).

The new system supports multiple language options and portal administrators can add any language they want into the system.

Along with the new software, the ability to edit data on maps can be done on all vector layers (including WFS services and database access) as well as agricultural parcels. To be able to ensure this, a generic data editing capability that can work on all layers that satisfy the essential conditions has been developed. Tools to be used in layer data editing can be selected by the system administrators and the data arrangement of each layer can be individually authorized.

4. Conclusions

Since the system is used by approximately 3500 users in 81 provinces, help contents, videos and FAQ (frequently asked questions) sections have been created and uploaded to the system. In addition, Geographic information system's help desk was created within our Ministry in order to provide a live help. Moreover, communication between users and responsible personals was provided also with the use of e-mail and telephone. Geographical sub-structure database which can be used throughout our country without a need of desktop software and can be integrated with various systems provides high level of working environment for agricultural areas.

References

GTHB, 2008. Integrated Agricultural Monitoring and Information System Project (TARBIL), http://www.tarim.gov.tr/Konular/Cografi-Bilgi-Sistemleri/Projeler

The Use of GIS for Watershed Management

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Abstract

Water is one of the most invaluable resources in the world. It affects living conditions, controls population growth, and defines biodiversity (Beheim, *2012). Water is the most* essential *component in the watershed structure. Within any given watershed, water professionals always want to be able to manage ground and surface water over the scale of an entire watershed. Some public agencies offer the data from different periods, at different scales, and often in different coordinate systems.* However, *this situation results a challenge of incorporating all these data to form* an *integrated view of the watershed. The power of the Geographic Information System (GIS) is that the user can reach and manipulate information linked with geographic features and find temporal and spatial relationships and patterns. Its ability to analyze, manage, and integrate, large volumes of data,* especially over *very large areas is the key advantage of GIS for watershed management* (*Jordan*, 2004*). This paper aims to define the role of GIS for watershed management. Firstly, it will define the entire main and sub components of the watershed management in order to provide a fully understanding to the social, ecological, and economic* factors related *to watershed sustainability. The result was four main components: water quantity and quality management, land management, and biodiversity* management, *each one of them subdivide to other three minor components. Consequently, this paper further extends to determine the types of data that GIS requires to manage each component.*

Keywords
Watershed management, Geographic information systems, Environmental management

1. Introduction

Awareness to contributory watershed management is growing across the developing world, as sediment close the reservoirs and irrigation infrastructure, soil erosion keep to diminish agricultural land. Generally, there is a large degradation in water quantity and quality across the world. The recognition of the importance of watersheds is crucial for sustainable utilization particularly in developing countries where economies and rural livelihoods are highly dependent on the utilization of natural resources (Gunya, 2009).

Watershed management deals with various resources types including water, soil, forest, human resource and integrated of water quality knowledge in management. Mismanagement impact therefore bring about many problems such as floods, droughts, soil nutrients loss, soil erosion, deforestation and degradation of water quality etc. This leading to degrading humanity living conditions, thus, appropriate watershed management is essential for human and exceedingly required (Seesomonn, 2010).

For several decades, sustainable and integrated watershed management has been proposed and tried in several countries in the world, as an effective technique to address complex water and land resource challenges. Yet, its implementation has not been successful in most cases, due to various obstacles such as the lack for the fully understanding of the watershed management components and the way they interact together, also the lack for well-prepared watershed inventory, which list all the kind of data required for a certain watershed management project. Finally, the shortage in some required data will directly led to mismanagement for any watershed project (Habtamu, 2011).

This paper aims to cover and investigate all the components of the watershed management in order to provide a fully understanding to the social, ecological, and economic factors that related to watershed sustainability. Mainly this study end up with four essential components of the watershed management, they are water quantity management, water quality management, land management, and biodiversity. Furthermore, the study covers the sub sections of each component.

Practitioners of watershed management are more and more turning to computer models to understand and make decisions about the different watershed problems. Such models can provide vision into how human interactions with the landscape affect water quantity and quality. Additional modeling tools trace how those effects ripple through economies, ecosystems, and other systems (Dietz, 2000).

An emerging trend for watershed management to link them to a Geographic Information System (GIS), which provides the basis for integrating data, algorithms, and methods from each discipline of interest. This integration capability makes GIS a very powerful tool for the watershed manager (Dietz, 2000). Therefore, this study farther extend to investigate the different kinds of data that GIS required to manage each component of watershed management. These data includes water demand, land cover, land use, climate, lake morphology (depth, shoreline, area, and residence time), receiving water quality and quantity, etc.

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2. Background

2.1. What's Watershed

A watershed is an area of the ground that discharges all rain and streams and collects them in a common estuary such as the mouth of a bay, outflow of a reservoir, or any point along a stream channel. The word watershed is sometimes refers to catchment or drainage basin. Surface waters, groundwater, reservoirs, streams, lakes, and wetlands are all components of watersheds. Large watersheds have a range of small watersheds. All according to outflow point, mainly all the lands that discharge the water to the outflow point are expressed as land within the watershed boundaries. Watersheds are very important because people and objects that occur above watershed areas directly affect the quantity and quality of water (USGS, 2017).

2.2. Watershed as a Unit Measurement

Watershed is the region formed naturally by hydrological outlines. It contain a collection of natural resources that depend on the water quantity and quality of the watershed. This region helps to manage the quality of the water and find suitable settlings to environmental problems.

Watersheds (originating from the German word for "water parting") are areas or zones that have natural hydrological borders darning to a specific waterbody or watercourse. The stream System or waters of a stream are drawn from the Watershed, which is considered as catchment basins drainage basins for this stream. Human, animals, ground water, surface water, and soils vegetation are all components of the watershed structure.

Environmental experts indicate that the most important factor that reflect the quality of the water is the health of our natural resources within the watershed. Generally, we will have a better air, lands, and wildlife if we improve the quality of the streams, lakes, rivers, wetlands, and ponds. Therefore, it is essential to manage and control the human actions within watershed borders to improve or even protect water quality. There is many ways to meet this goal such as water quality monitoring and assessment, storm water and other non-point pollution source management, wetlands restoration and protection, hydropower production, water withdrawal, and other associated activities (Reimold, 1998).

2.3. Concepts of Watershed Management

The applications of ecological principles to watershed planning has lately become one of the most important subjects of natural resource management discussions. Concern in stabled natural resources (water or land) management has only appear after the people have hardly damaged the natural resources of the earth. Therefore, the extensive human understanding of the watersheds components and their interactions is the main factor to achieve the effective management. To paraphrase the world famous naturalist Aldo Leopold "people cannot understand a system that they did not structure, instead, they should partially destroy and reconstruct it in order to be able to understand and respect this system"

Watershed action now is not limited to the forest or farm within the watershed boundaries; it extends to include fully urban-rural landscape in different regions in the world. The social and economic system directly affected by the low quality of the urban and suburban regions. In rural areas, it is easier to apply effective management while in urban areas the management plan will face many obstacles, such as the big differences in financial value placed on various types of land use; also in urban areas, the social human aspects are so interconnected. Urban region directly affect the water quality and quantity of the watershed because of the difference in agricultural versus within the watershed region, it also directly affects the function and stability of the watershed land.

The activity styles of creatures living in the watershed, water inflow and outflow rate, and materials are the main factors that used to estimate the watershed relative function and stability. In other words as the stream flow through the forest, towns, and fields, so all these are considered as one management unit.

Contemporaneous watershed-based decision-making include four main steps: Collecting the data is the first one, and then estimating the problem, the third step includes prevention, controlling, repairing, and managing alternate goal and priority setting and funding, the last step is defining the implementation roles and stakeholders responsibilities (Reimold, 1998).

2.4. Importance of Watershed Protection

While public awareness has recently been concentrate on watersheds as units of management, consideration of watersheds as management structures is not new Stockholders should all share authority, resources, and expertise in order to achieve an effective watershed management.

General sources of watershed confusion include sanitary sewer overflow discharges, agriculture dairies, combined sewer overflow discharges, dam construction and operation for hydropower, storm sewer overflow discharges, flood control and/or recreation, grazing, urban runoff, hydro modifications for irrigation or fisheries enhancement, and mine tailings (Reimold, 1998).

2.5. Watershed Inventory

Physical features, landforms, climate, soils, infiltration, runoff, streamflow, groundwater, water quality, plant and animal communities, land use, social and economic systems, and values features are all considered as the main components of the watershed inventory. Figure 1 below shows the structure of these components in the watershed inventory.

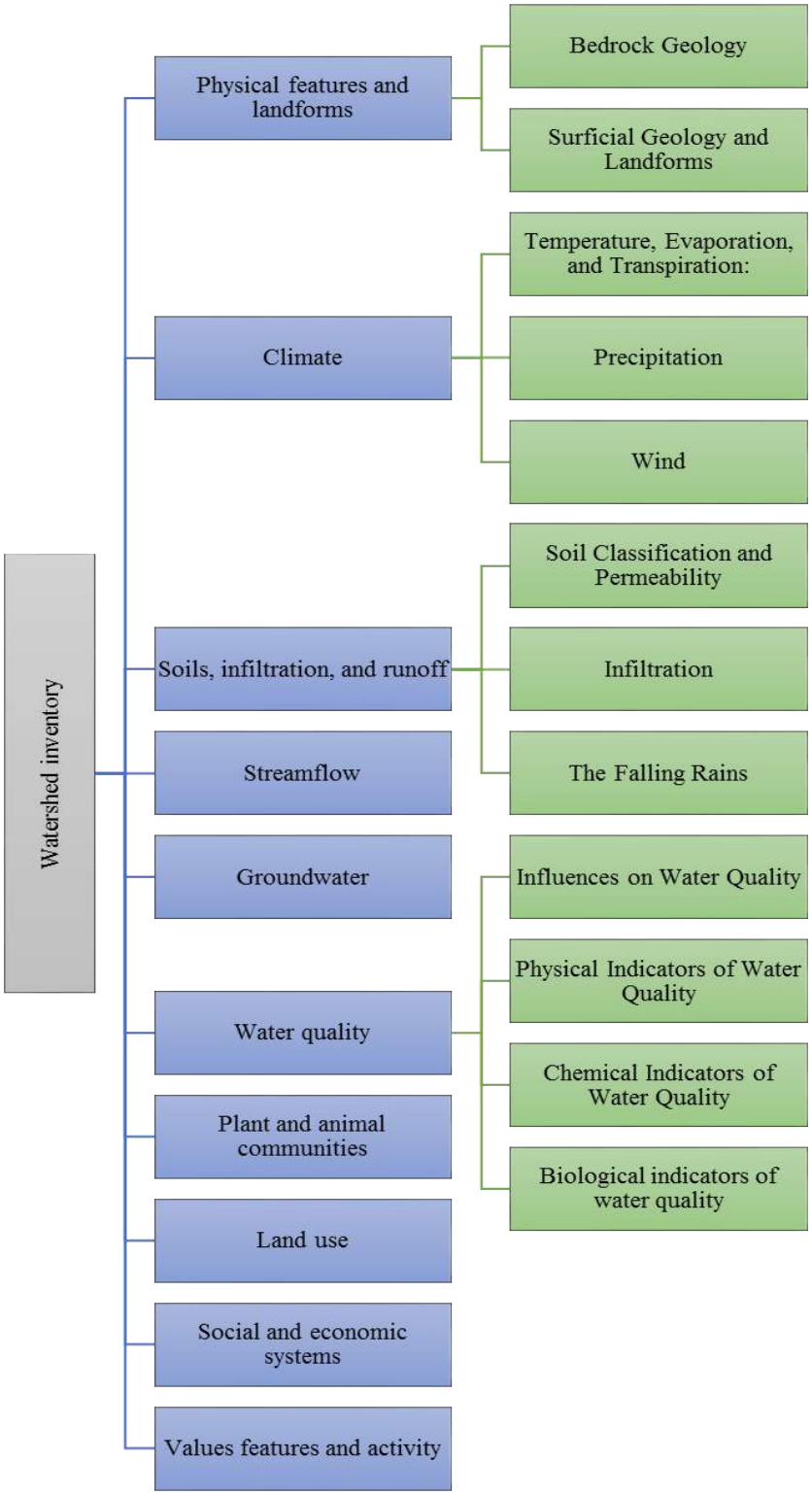

Figure 1: watershed inventory structure.

2.6. Role of GIS in Watershed Management

The main advantages of GIS are the use of advanced computer software and hardware to gather, storage, manipulate for geographic data. GIS prepare a digital representation of landform, which could be used in hydrological modelling. In addition, GIS has the ability to shape spatial data and corresponding attribute information to integrate various types of data in a singular analysis at high speed, which is incompatible with manual methods. GIS plays an important role in information management, analysis, and give solutions to the natural resources planning. The application of GIS for land use mapping and surveys is getting importance, because of its ability to supply reliable and rapid data within a given time framework. Since the early 1990s, Many GIS-based watershed applications have been developed due to data availability, programming languages, advances in desktop GIS capabilities. As well, GIS simplify integration of socioeconomic information with the resources data to realize the local needs. When the available resources and development needs of the watershed are realized, it is possible to improve specific action plan for development of water and land resources. GIS plays major role in implementing water and soil maintenance practices that are important for sustainable agriculture production. It provides technologically proper method for assessment and monitoring of environmental impact of watershed projects, irrigation water management, flood management, delineating different land use patterns, and land resource assessment. GIS also helps in planning hydro-morphological items in the region to find the best sites for water and land harvesting structures in the problematic regions (Aher, 2014).

3. Watershed Management Components

To provide a fully understanding to the social, ecological, and economic factors related to watershed sustainability, four main components have been defined (including water quantity, water quality, land management, and biodiversity). This process farther extends to divide each main component to three sub components (including Surface water quantity, ground water quantity, flood and drought, non-point source pollution, point source pollution, source water protection, wetland, land use practices, riparian areas, protected areas, fish and wildlife, and Native, Nonnative and invasive species). Figure 2 below shows watershed management components.

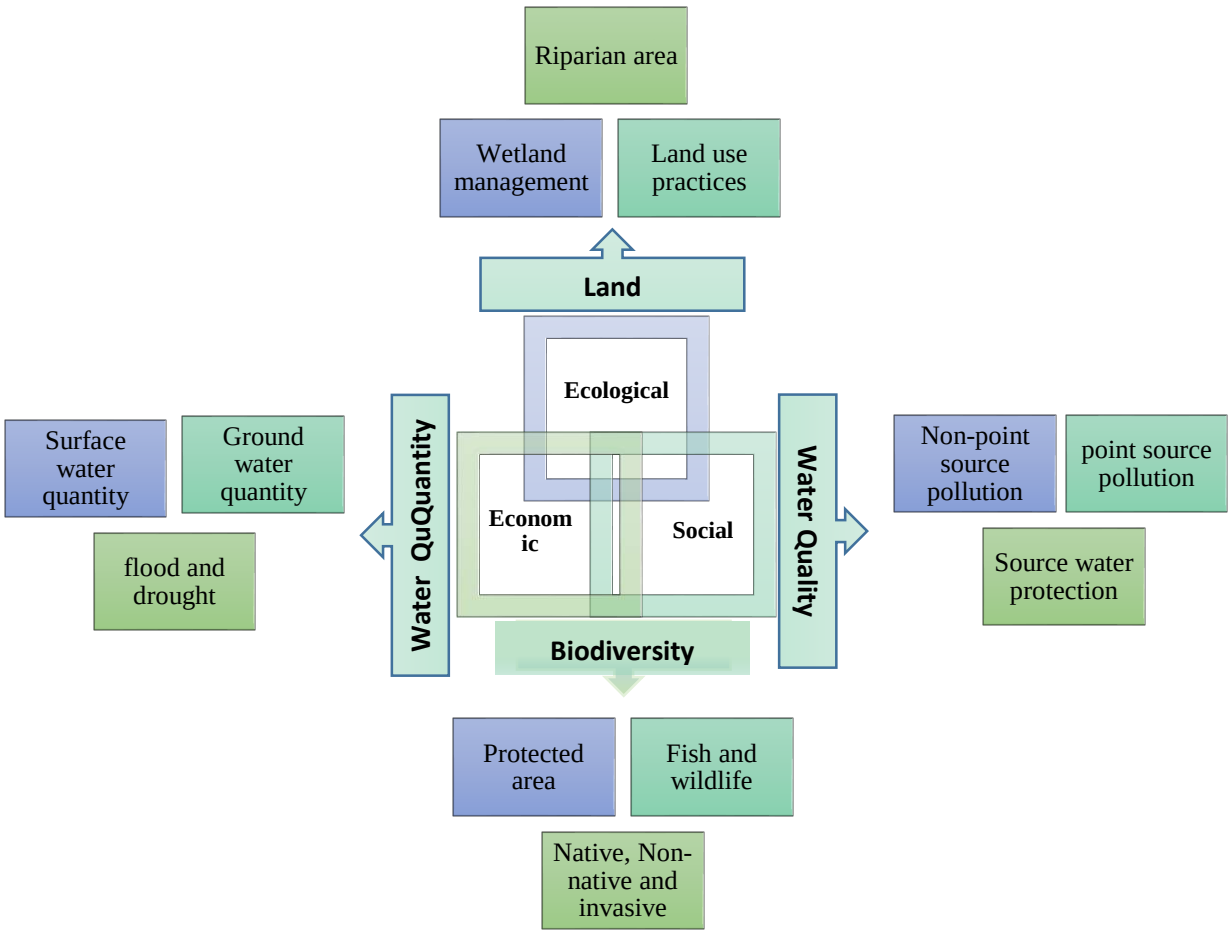

Figure 2: watershed management components. (Battle River, 2017)

3.1. Water Quantity Management

Water and land are the main components of the earth. However, water is much more than land. Water covers more than 70% of the earth surface. It exist not only above the earth, but also accrue as a groundwater in aquifers in the soil and as vapor in the air. (1.400.000.000) km^3 is the total water supply of the world. (74.200) km^3 evaporates into the atmosphere and (119.000) km^3 of water precipitates on land each year. (450.000) km^3 of water falls every year on sea and ocean surface, about (2.200) km^3 flows in the ground, mainly within half a mile from the surface. (135.000) km^3 of the freshwater on Earth, in rivers, soil moisture, lakes, plant and animals, wetlands and marshes. Surface water, ground water, and the water stored in the atmosphere, are all conceder as the main available resource of fresh water. (24.500.000) km^3 of water, forming the 69.5 % of the total fresh water of the Earth is unavailable since it is stored in ice caps and glaciers, generally in the Greenland and in Polar Regions (LENNTECH, 2017). Whether mitigating the effects of drought in shortage times or planning extra water in times of flood, water supply management is an essential component of water conservation. Fresh water management and planning is the main way to support the ranching, habitat, wildlife, and agriculture (NADC, 2017).

3.1.1. Surface Water Quantity Management

The purpose of surface water management is to sustain the needs of both ecosystem and human, through balancing of economic, environmental, and social attention. In order to achieve this target, indexes of both stress on watershed (use) and situation of the water resource (natural variation in water flow) should by identified through the cumulative work (Carver, 2014).

3.1.2. Ground Water Quantity Management

Since about one-third of world's population, use groundwater resources to meet their need of drinking water, it is important to plan and manage the quantity of ground water resources efficiently. Generally, it is a difficult process because the water set under the earth surface and need more effort to manage it. The main objective of groundwater management are: prevent reverse degradation or halt of the groundwater, achieve the sustainable and effective use of the groundwater, provide development or opportunities, generate the most economic and social benefits to the community, and also to involve the community in the management of groundwater resources (Dlwc, 1997).

3.1.3. Flood and Drought Management

Flood Management is the Management Plan contain main goals for managing endangering in the area under the flood risk. These goals can be achieved through the maps of flood risk and flood hazard and some measures from the site. While, Drought Management plans is to lessen the effect of potential droughts, by setting the measures to be taken after, during and before the drought term in order to fix the drought problem as soon as possible (MoFWA, 2012).

3.2. Water Quality Management

Water quality is the measure of the water state according to the requirements of any human or the need of one or more biotic gender. Standard against which compliance can be assessed are considerably used to describe the quality of the water. The drinking water, safety of human contact, and the health of ecosystems are the main standers that used to measure the water quality (Johnson, 1997). To define standards, Agencies set scientific/technical and political designs about how to use water. Since Natural water bodies will differ in reaction to environmental status, the agencies set a logical estimate of main conditions. . Environmental scientists trace water bodies to understand their function, which will help to define contaminants fates and sources. Policymakers and environmental lawyers work to determine legislation with the goal that water is protected at a suitable quality for its identified use. Generally, there are two main facts about water quality; the first is that most of the earth water is not drinkable nor toxic, even if we eliminate the seawater in the oceans (which is overly salty to drink), this perception will still true. The second perception about water quality is that the small property that shows whether water is polluted or not. Actually, water quality is not easy subject, since water is a complicated medium directly affected by the earth ecology. The main sources of water pollution are the untreated sewage and discharge of treated and urban runoff, agricultural areas runoff, Industrial and commercial activities (EPA, 2017). Water quality management including foundation policy, improve water standards and strategic plans as well as observation the quality of the world's water resources that is essential to preserve life cycle on the earth (Saktaywin, 2009).

3.2.1. Nonpoint Source Pollution Management

It is difficult to manage non-point source pollution since its results from building or road construction, using pesticide, lawn fertilizing or any daily activities of different people. On the other side, the point source pollution that result from a single source, like wastewater treatment plant or an industrial operation are easier to control through regulations that require treatment of a facility's wastewater before it is discharged into a nearby lake or stream. The huge number of nonpoint sources and the fact that they are hard to control make the voluntary efforts of service organizations, businesses, citizens, and other groups a fundamental part of the effort to manage nonpoint source pollution (Tceq, 2017).

3.2.2. Point source Pollution Management

If point source pollution did not control and managed efficiently, it will affects human health and lead to degradation in the ecosystems. Traditionally, point sources were the center of the attention of the initial attempts at pollution control. They are easily recognizable, and adverse publicity and economic pressure could be brought to endure on the individual bodies responsible. In many regions, the local or national environmental agency is responsible of the regulation of point source pollution controlling. These controlling tasks include recognizing point sources of pollution discuss, set the allowable levels of pollution allowed from each source, and enforcing the terms of discharge permits (Jining, 2009).

3.2.3. Source Water Management

Source water management is part of a complex approach to save local sources of drinking water. The governments, local, states governments, manufacture and businesses, water agency, individuals and non-governmental community, they all have a role in source water protection. Source water assessments provide community governments, water utilities and others with data needed to protect drinking water sources (EPA, 2017).

3.3. Land Management

In this time of economic downturn, governments are trying to set bailout policies with some awareness to the potentials of soils and land. It is so importance to highlight the Benefits of Sustainable Land Management policies. More than 2 billion people are affected by the drought, land degradation, and desertification. The status might become worsen because of the unsustainable use of water and soil under the new conditions of climate change. The UNCCD 10-year strategy show the importance of knowledge sharing systems. Science and knowledge raising to help policymakers in reversing this trend. Sustainable land management practices including sustainable agriculture provide important global, regional and local advantage. They also work positively to fundamental ecosystem services that help to preserve agrobiodiversity, sequestering carbon, and regulating water cycles (Gabathuler, 2009). Land management is the procedure where the land resources are put into good impact. All activities related with the management of natural resources and land that are required to achieve sustainable development are included in land management. Land Administration Systems are institutional frameworks complicated by the functions they must carry out by technology, judicial and political settings, and national cultural (Enemark, 2005).

3.1.1. Wetland Management

Wetland management means understanding the full vision of actions and measures necessary to maintain the place. It also has to spot the area positively within the society situation and be able to reply to any potentially threatening development that may occur within the area. Particularly, must understand past and present human usage, it is now or future effect, and the means by which optimum usage can be carried out (Mitsch, 2007).

3.1.2. Land Use Practices Management

Land resources management is known as, the real practice of the use of the land by the local people population, which should be sustainable. Land management has a lot of components, such as safeguarding the traditional rights of indigenous people, promoting the role of women and [other] disadvantaged groups in agriculture and rural development, settling of water rights, resolving land tenure issues, administrative and institutional oversight, and land-use planning as agreed between stakeholders (ISPN, 2013).

3.1.3. Riparian Areas Management

Riparian areas management are the plans and strategies that reflect a vision of goals are mainly required for protecting and improving the ecological activities of existing riparian areas and for developing their productivity and sustainability

for future generations. Riparian zones are often the subject of national protection in a Biodiversity Action Plan. These are also known as a "Plant or Vegetation Waste Buffer" (NRC, 2002).

3.4. Biodiversity Management

Biodiversity is defined as the "variability among living organisms from all sources including, marine, terrestrial, inter alia, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity between species and of ecosystems, and diversity within species". This definition shows that according to the genetic, ecological, and taxonomic diversity, every biota can be define and categorized and that the way these dimensions of diversity differ over time and space, which is the biodiversity key form. Therefore, to understand the relationship between changes in biodiversity and changes in ecosystem services and ecosystem functions, Multidimensional assessment should be applied. Technically, Biodiversity is everywhere, on Earth's surface and in every drop of water bodies. Biodiversity directly support ecosystem activities that help regulating, provisioning, and cultural services, which is so important for humans. However, until now a little studies connect changes in biodiversity with changes in ecosystem functioning to changes in human well-being. There is a need for further work to show the links between human well-being, regulating and supporting services, and biodiversity (millenniumecosystemas, 2003).

3.2.1. Protected Area Management

Protected area management involve a wide range of challenges whether it is related to the design of the reserve itself, specific ecosystems, or local population. Each protected area need a case-specific set of guidelines as a result to the many unpredictable elements in ecology matters (Hermoso, 2016). When planning the protection regions, it is so important to take in the consecration the human need in this region. While governments used to formed decisions about protected areas and then inform local people, now a days the attention is shifting towards greater discussions with stakeholders and combined decisions about how such areas should be set aside and managed. (Dudley, 2008)

3.2.2. Wildlife Management

Wildlife management is the art and science of managing the wildlife -both plants and animals-, which share planet with us. Preserving the suitable balance and the dynamics that go with it demand human attention. Wildlife habitats of all kinds are included in this maintaining and managing process. The objective is descendants to have the chance to experience the same animal and plant diversity that we now enjoy (Bsa, 2010).

3.2.3. Native, Nonnative and Invasive Species Management

Most of the public are mainly unable to distinguish between native and non-native species. They simply do not know which are which. Three quarters of the public were familiar with the term native species and two thirds had well known the term non-native species. Furthermore, most of them had a sensible estimation of what non-native means species that do not naturally exist in their area but which produced in other countries. The term invasive species was less known and considered a less appropriate term. there was a misunderstanding that the difference between native and non-native is based on how long settled a species is rather than how it became established in the first place and this needs to be reinforced through any communication. So It is so important to aware the community about the different between Native, Nonnative and invasive species, which will help to effectively manage all these three types in order to maintain the ecosystem biodiversity (Creative research, 2009).

4. Data Required for Watershed Management by Using GIS

4.1. GIS for Water Quantity Management and Required Data

With GIS techniques, it is possible to calculate how much water is available and where it should be directed, which is the main concern of the water quantity management. Dashboards can be located to observe basin levels in real time. Spatial analysis technique provides a fully visualization into the use, if it is agricultural, commercial, or residential, thus, community outreach can be done where required. Hydrologic model is another technique, which is considered as an advance GIS function. Figures of the supply-demand can be formed by running hydrologic models, which will help to manage water quantity for any watershed. (Esri, 2017)

Whether we are dealing with surface and ground water or trying to control floods and droughts, to manage water quantity by using GIS different kind of data are required. Some data are related to the watershed morphology (include depth, shoreline, area, residence time). Streamflow data are required too (include mean monthly streamflow, minimum streamflow, critical low streamflow and recurrence intervals, peak monthly streamflow, base flow). Other data, which

relate to the area and natural resources within the watershed are also required (include geology, climate, land cover, land use, existing water demand, quantity of runoff whether it's urban or agricultural).

4.2. GIS for Water Quality Management and Required Data

With GIS techniques, it is possible to stop pollution in their paths, which is the main target of the water quantity management. Live sensor data can be used to track water quality in real time. Response agencies can also provide the required data. Network technique helps to track the quality of the water and define the contaminants source, whether it is a point or non-point source. At the same time, public can be educated with live web maps that show where to take care, whom affects by the contamination, and how to reduce pollution. Water quality model is another technique, which is considered as an advance GIS function. These models provide a clear vision about the watershed conditions and help to manage the quality of the water (Esri, 2017).

The first and most important step to manage the quality of the water within the watershed is to define the source of the pollution, which may be point or nonpoint source. For the non-point source pollution management, GIS requires the quality and quantity of urban runoff and also quality and quantity of agricultural runoff. For the point pollution source, receiving water quality (include average and maximum concentrations and/or loadings of key parameters) are required. Other kinds of data (include land cover / land use, plant and animal communities' ecology, social and economic systems; urban centers, and Lake morphology) are also essential for water quality management.

4.3. GIS for Land Management and Required Data

With GIS techniques, it is possible to get better understanding about how existing and proposed land uses affect natural resources and how these resources control land use planning, which is the main target of land management. GIS functions can be used to map how climate change, human behavior, and water quality and quantity affects our natural land systems. Intuitive applications carry results to policy makers and public, so everyone can find where resources need protection. Map-based applications make it easy to set boundaries and find the best developments for the future. When watershed story display on a map, logical decisions can be made (Esri, 2017).

Every watershed has its specific kind of land, it may be as a wetland, riparian area, or any and land use practices. The data which will be required to manage any kind of land within the watershed boudoirs should be related to this land and the water passing through this land and also all the plant and animal communities within this land. Generally, the data, which is required to manage watershed land, are including geology, land cover / land use, existing water demand, valued watershed features, plant and animal communities' ecology, impaired uses and water use conflicts, social and economic systems; urban centers, receiving water quality and quantity, and lake morphology (depth, shoreline, area, residence time).

4.4. GIS for Biodiversity Management and Required Data

With GIS techniques, it is possible to get better understanding about how biodiversity affected by the existing and proposed natural resources and how these resources control the sustainability of biodiversity , which is the main target of biodiversity management. GIS functions can be used to map how human behavior, climate change, and water quality and quantity affects natural species weather its animals or plants systems. Intuitive applications carry results to policy makers and public, so everyone can find what species are under threaten and need protection. Map-based applications make it easy to set boundaries and find the best developments for the future. When watershed story display on a map, logical decisions can be made (Esri, 2017).

Managing biodiversity within any watershed is a challenged process since there will be need for a lot of accurate and in time data about the plants and animals species. Mainly, the required data are including plant and animal communities' ecology, land cover / land use, valued watershed features, receiving water quality and quantity, and lake morphology (depth, shoreline, area, residence time).

5. Conclusion

Watershed management has expand from the approximately straightforward task of water distribution to more multidisciplinary, complicated watershed management challenge. When people urbanization settled and created increasing population centers, the main challenge was a supply problem, delivering water to these places. As populations increased, however, water demand increased and challenges relating to water quantity and reliability were appeared. Water quality stand out as the next problem, because of population's growth and industries progress. Again, the expansion of the populations and the development industries was the main reason that lead to the third challenge, which is related to degradation of the land within the watershed boundaries. Biodiversity regression within the watershed was the fourth challenge, which also occur because of the human growth and more industrial projects, which directly lead to loss many spices.

Its ability to analyze, manage, and integrate large volumes of data, especially over very large areas is the key advantage that make GIS a powerful toll for all these challenges within the watershed management. The first step for an effective watershed management will be the comprehensive understanding for all these challenges and their components. For example for the water quality management, there are three types of pollution sources: non- point source pollution, point source pollution, and source water protection. So, after define our project, the next step will be starting to list all the kind of data, which is required to manage this watershed by using geographic information system software.

References

Aher, P. D., Adinarayana, J., Gorantiwar, S. D., & Sawant, S. A. (2014). Information System for Integrated Watershed Management UsingRemote Sensing and GIS. In Remote Sensing Applications in Environmental Research (pp. 17-34). Springer International Publishing.

Battle river, (2017). Priorities for watershed management. https://water.usgs.gov/edu/earthhowmuch.html. [Accessed 13 May 2017].

Boy scouts of America, 2010, fish and wildlife management.

Carver, M. (2014). Surface Water Quantity Management Framework for the Lower Athabasca River (GoA and DFO)-Technical Review. Aqua Environmental Associates, Nelson BC

Creative research. (2009). Wildlife Management and Invasive Non-Native Species, Report of Research Findings among the General Public, Anglers and the Horticultural Retail Trade (Volume 1).

Department of land & water conservation, 1997, the nsw state groundwater policy framework document.

Dietz, R. W. (2000). The use of GIS for integrated watershed analysis: integration of environmental models with GIS in the Upper Roanoke River Watershed, Master thesis, Virginia Polytechnic Institute and State University, USA.

Dudley, N. (Ed.). (2008). Guidelines for applying protected area management categories. IUCN.

Enemark, S. (2005). Understanding the land management paradigm. In Symposium on Innovative Technology for Land Administration: FIG Commission 7 (pp. 17-27).

Esri, (2017), Water resources: Balance supply and demand. http://www.esri.com/industries/water-resources/water-supply, [Accessed 22 June 2017].

Esri, (2017), Water resources: Improve conservation. http://www.esri.com/industries/water-resources/watershed-protection, [Accessed 22 June 2017].

Esri, (2017), Water resources: Preserve the water supply. http://www.esri.com/industries/water-resources/water-quality, [Accessed 22 June 2017].

Gabathuler, E., Hauert, C., & Giger, M. (2009). Benefits of sustainable land management.

Gunya, K. (2009). Participatory watershed management to decrease land degradation and sediment transport in Kagera and Nyando catchments of Lake Victoria basin, Master thesis, Linköping University, Department of Thematic Studies, Sweden.

Habtamu, T. (2011). Assessment of Sustainable Watershed Management Approach Case Study Lenche Dima, Tsegu rEyesus and Dijjil Watershed. A Project Paper Presented to the Faculty of the Graduate School of Cornell University in Partial Fulfillment of the Requirements for the Degree of Master of Professional Studies.

Hermoso, V., Abell, R., Linke, S., & Boon, P. (2016). The role of protected areas for freshwater biodiversity conservation: challenges and opportunities in a rapidly changing world. Aquatic Conservation: Marine and Freshwater Ecosystems, 26(S1), 3-11.

ISPN, 2013, land use and land management practices in environmental perspective.

Jining, C., & Yi, Q. (2009). Point Sources of Pollution: Local Effects and Control. Point Sources of Pollution: Local Effects and their Control-Volume II.

Johnson, D. L., Ambrose, S. H., Bassett, T. J., Bowen, M. L., Crummey, D. E., Isaacson, J. S., & Winter-Nelson, A. E. (1997). Meanings of environmental terms. Journal of environmental quality, 26(3), 581-589.

LENNTECH, (2017). How much water is there on earth?. https://www.lenntech.com/water-quantity-faq.htm. [Accessed 22 June 2017].

MILLENNIUMECOSYSTEMAS, S. (2003). Ecosystems and human well-being.

Mitsch, W. J., & Gosselink, J. G. (2007). Wetlands. Hoboken. ed: John Wiley & Sons, Inc.

NADC, (2017), Water quantity, http://www.nacdnet.org/about-nacd/what-we-do/water/water-quantity/, [Accessed 25 June 2017].

National Research Council. (2002). Riparian areas: functions and strategies for management. National Academies Press.

Reimold, R. J. (1998). Watershed management: practice, policies and coordination. McGraw-Hill Book Company Europe.

Republic of turkey ministry of forestry and water affairs general directorate of water management, 2012, flood and drought management department.

Saktaywin, W. (2009). Water Quality Management.

Seesomonn, K. (2010). Participatory Watershed M.anagement Process: A Case Study of Huai Mae Di Noi WAtershed. Ban Rai District, Uthai Thani Province, doctoral thesis, Kasetsart University, Thailand

Tceq, (2017), Management Program for Nonpoint Source Water Pollution. https://www.tceq.texas.gov/waterquality/nonpoint-source/mgmt-plan, [Accessed 22 June 2017].

USGS, (2017). What is a watershed? https://water.usgs.gov/edu/watershed.html. [Accessed 12 May 2017].

U.S. Environmental Protection Agency (EPA). (2017). Polluted Runoff: Source Water Protection Basics. https://www.epa.gov/sourcewaterprotection/source-water-protection-basics

U.S. Environmental Protection Agency (EPA). (2017). what are water quality standards? https://www.epa.gov/standards-water-body-health

Determination of Sand/Dune Source in Middle East Region and Evaluation of the Impact on Agricultural Lands in Euphrates-Tigris River Basin (Syria-Iraq)

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Abstract

This study was carried out in order to determine the dust resources in the Middle East geography, especially in Iraq and Syria, to determine dust-related threats and water assets, and to evaluate the possible effects of dust resources on agricultural areas of both countries. Using the Collect Earth methodology, which is a software based on remote sensing and geographical information systems by FAO, in the report prepared for the monitoring of the vegetation between 2001 and 2016, it is concluded that the tendency of land decay/desertification for the Middle East region where 15 countries including Syria and Iraq are located, has increased. Within the borders of Syria and Iraq, greening/healing tendency areas were determined as 388385.00 ha. and land degradation/desertification tendency areas as 396243.00 ha. Using the same dataset and methodology, a map of risk level classes of dust resources areas for the entire Middle East region was created and it was confirmed that 63.6% of the total area of Iraq, which constitutes the focal point of the study, and 53.7% of the total area of Syria were in the third degree dust resources area. In addition, when the distribution of water resources areas of Iraq and Syria according to risk level classes are examined, it is seen that the largest water resources areas of Iraq are in the third-degree dust resources region with 71.3% and Syria's the largest water resources area are in the fourth and fifth degree dust resources region with respectively 27.4% and 25.9%. By interpreting the results of the classification with regard to the Middle East, especially sand/dune areas, agricultural lands and water resources, the evaluations are made especially on the scale of Iraq and Syria neighboring on Turkey.

Keywords

Middle East, Collect Earth, Sand/Dune Source, Euphrates-Tigris River

1. Introduction

Sand and dust storms (SDS); uncontrolled, strong or turbulent winds occur when they meet loose and dry soil surfaces. These conditions are common in arid or semi-arid regions. SDS has increasingly become a serious problem because of their harmful effects on the human health, farmland, infrastructure and transportation systems. By determining a sand or dust resource it is important to know how active it is and to what extent it causes wind erosion. Land degradation and unsustainable land use can increase wind erosion, especially in semi-arid regions. Even if this does not lead to SDS directly it can affect agricultural productivity adversely. In the Northern Hemisphere including Middle East region, there is a dust zone. The negative local effects in the regions where the dust sources are located are quite large (Gemma et al. 2016).

The desert dust resources in the Middle East cause significant problems in the agricultural areas, especially in the countries where they are located and in close neighbors because they cause erosion, especially air pollution (Sivakumar 2005). Soil and vegetation destruction caused by wind-erosion along with Middle East-based dust sources poses a major problem in the context of land management (Stefanski 2007). The Middle East region hosts large dust resources such as Syria-Iraq deserts and Arabia deserts. In Iraq and Syria, where the Euphrates and Tigris rivers pass through and the agricultural activities are conducted in the restricted area, mainly the inefficiency of agricultural areas, losses of livestock farming, soil fertility, transportation, and economic and environmental losses are observed due to the wind erosion caused by dust sources (Sissakian et al. 2013).

In this context, that soil is irrigated and merging feature of soil aggregates is provided is among the important protection measures against the problems caused by sand and dust storms. The importance of the water resources in the region, especially the Tigris and Euphrates Rivers, is gaining more importance. For Syria and Iraq in the Middle East, the importance of the hydropolitics of the Euphrates and Tigris water resources is also increasing. The formation of water resources with strategic importance in a limited dimension necessitates the economic and efficient use of water (Dursun 2006; Özdemir et al. 2008). In terms of offering a solution, it is very important that the problems originating from ecology or politics in the region are explained through the scientific facts.

This study was carried out in order to determine the dust resources in the Middle East geography, especially in Iraq and Syria, to determine dust-related threats and water bodies, and to evaluate the possible effects of dust sources on agricultural areas of both countries. For this purpose, classification of dust sources has been done through Collect Earth dataset which was used for the first time by FAO within the scope of Global Forestry Inventory and Drylands Assessment Project. The results of the classification with regard to the Middle East, especially sand/dune areas, agricultural land and water resources have been assessed and the evaluations are made especially on the scale of Iraq and Syria neighboring on Turkey.

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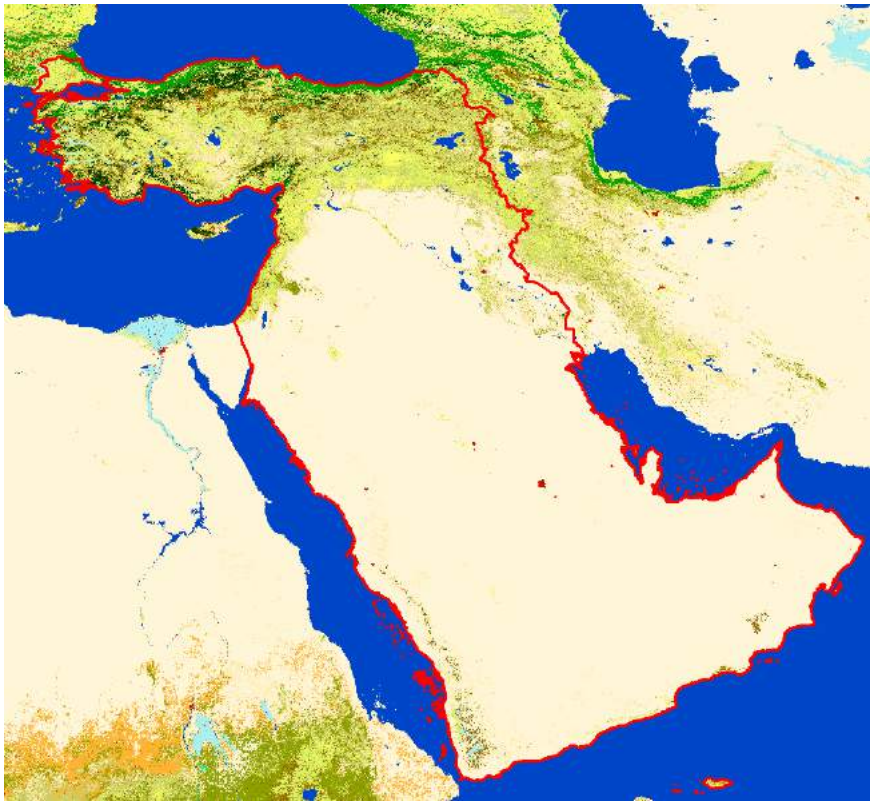
2. Material and Method

Middle East region has been chosen as the study area. In the world report of The European Space Agency's (ESA) Global Land Cover Map 2009, the map of Middle East land classification consisting of Turkey, Iraq, Syria, Jordan, Israel, Palestine, Saudi Arabia, United Arab Emirates, Yemen, Oman, Lebanon, Bahrain, Kuwait and Qatar is given in Figure 1.



Value	GlobCover global legend
11	Post-flooding or irrigated croplands
14	Rainfed croplands
20	Mosaic Cropland (50-70%) / Vegetation (grassland, shrubland, forest) (20-50%)
30	Mosaic Vegetation (grassland, shrubland, forest) (50-70%) / Cropland (20-50%)
40	Closed to open (>15%) broadleaved evergreen and/or semi-deciduous forest (>5m)
50	Closed (>40%) broadleaved deciduous forest (>5m)
60	Open (15-40%) broadleaved deciduous forest (>5m)
70	Closed (>40%) needleleaved evergreen forest (>5m)
90	Open (15-40%) needleleaved deciduous or evergreen forest (>5m)
100	Closed to open (>15%) mixed broadleaved and needleleaved forest (>5m)
110	Mosaic Forest/Shrubland (50-70%) / Grassland (20-50%)
120	Mosaic Grassland (50-70%) / Forest/Shrubland (20-50%)
130	Closed to open (>15%) shrubland (<5m)
140	Closed to open (>15%) grassland
150	Sparse (>15%) vegetation (woody vegetation, shrubs, grassland)
160	Closed (>40%) broadleaved forest regularly flooded - Fresh water
170	Closed (>40%) broadleaved semi-deciduous and/or evergreen forest regularly flooded - Saline water
180	Closed to open (>15%) vegetation (grassland, shrubland, woody vegetation) on regularly flooded or waterlogged soil - Fresh, brackish or saline water
190	Artificial surfaces and associated areas (urban areas >50%)
200	Bare areas
210	Water bodies
220	Permanent snow and ice

Figure 1. European Space Agency (ESA) 2009 world report Middle East land use classes.

In the ESA land use classes, 11, 14, 20, 30 coded fields illustrate the classes belonging to the agricultural category, and 200 coded fields to bare areas and 210 coded fields to water resources. The data of water and agricultural areas in the Middle East have obtained from the ESA data. Within the context of the "Global Forestry Inventory and Drylands

Assessment Project" of the Food and Agriculture Organization (FAO), the status of arid areas was determined using Collect Earth software, by evaluating primarily forest areas, agricultural areas, shrub areas, pasturelands and other areas. For this purpose, Open Foris Collect Earth software was used as the methodology. Collect earth is multi-purpose land monitoring. It is a data collection tool built on Java technology for remote sensing and GIS. Google Earth is used as the data entry interface. It uses graphical and classification results from high-resolution satellite image data (Google Earth, Bing Maps, Yandex etc.) and medium resolution satellite image data sets (Landsat 7 and 8 datasets , Modis datasets from Google Earth Engine) in general (Open Foris 2016). All data obtained are analyzed with SAIKU software (Figure 2). Its usage areas are support of multi-phase national forestry inventory, evaluations of LULUCF, monitoring of agricultural and urban areas, collecting socio-economic data, quantifying deforestation, reforestation and desertification.

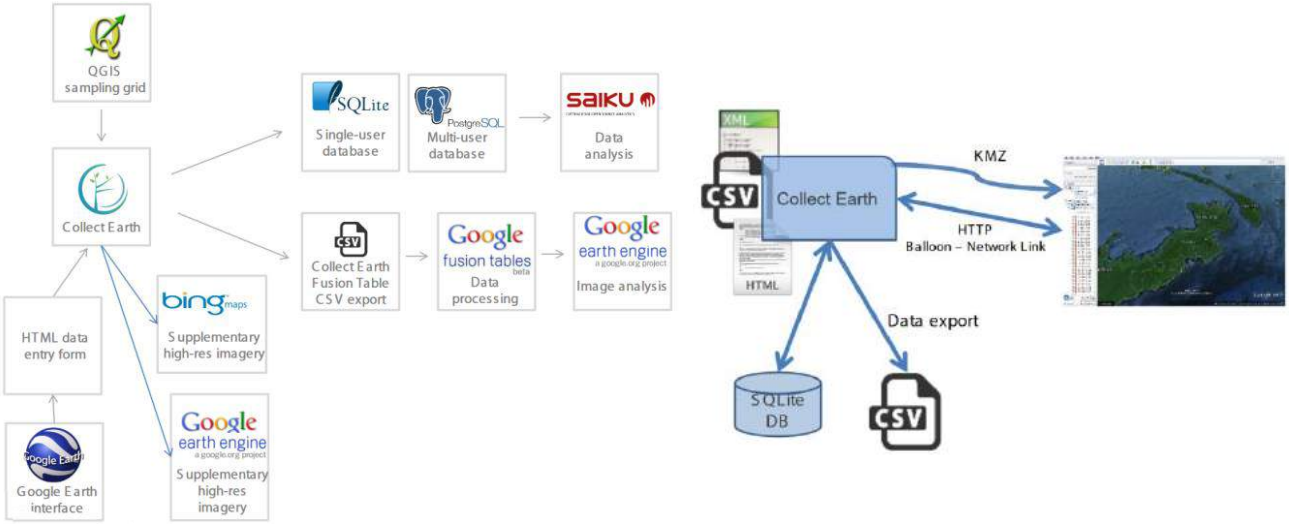


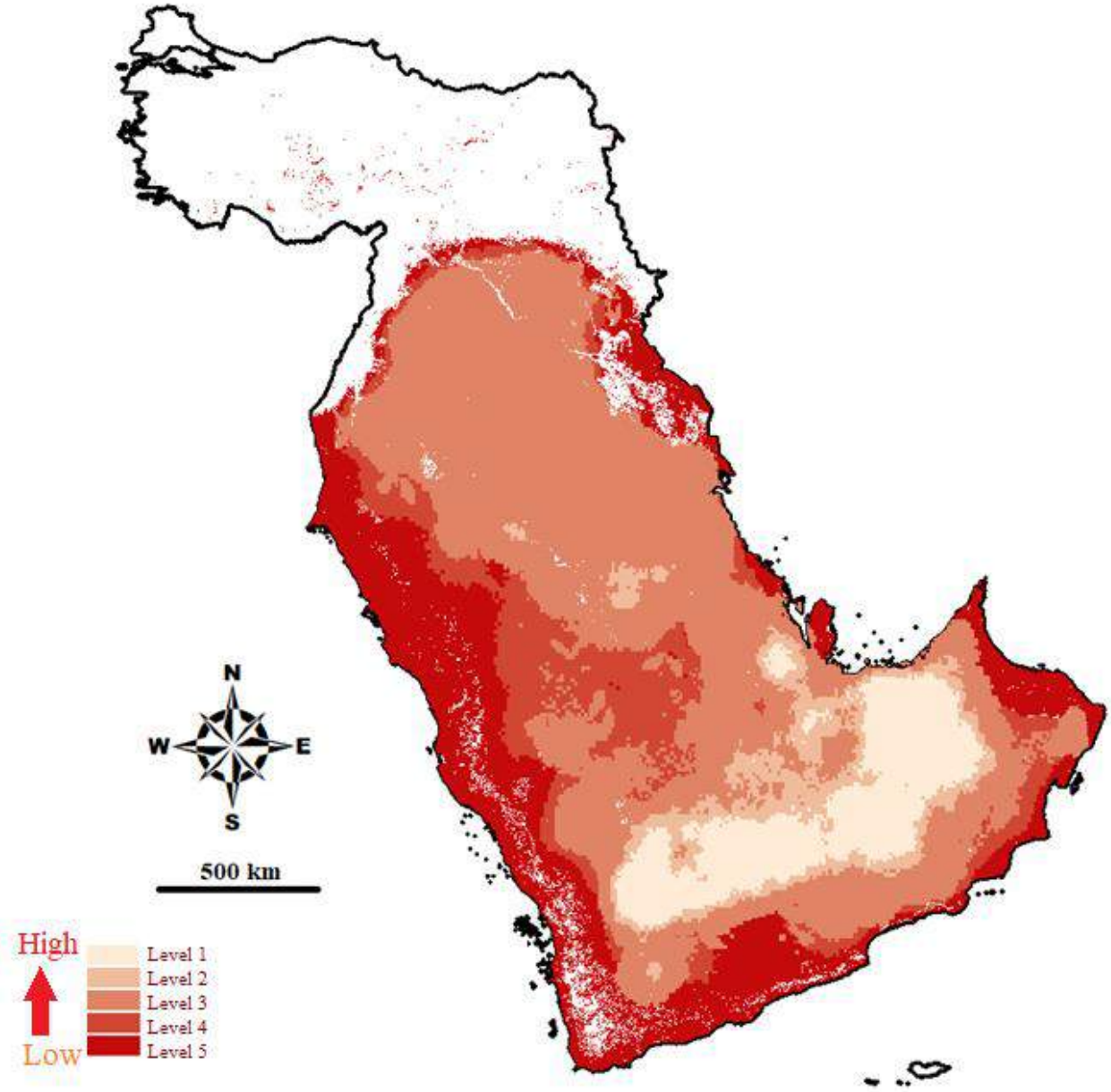
Figure 2. Open Foris Collect Earth.

Using the Collect Earth methodology, approximately 15000 plot areas (0.5 ha) were evaluated in the study done in Antalya / Turkey and a database related to land cover/use classification, greening/desertification was created. In this dataset, there are data on dust sources in both classes called 'sand' and 'dune' as the land class. In general, the 'sand' and 'dune' land classes generally correspond to the 200 coded 'bare soil' class of 2009 ESA data. Using the ArcMap 10.1 software on the Collect Earth dataset through both land classes dataset, the point density map of the fields belonging to both classes, predominantly to the dune class, was created and the dust resource regions were classified according to the density-importance levels.

3. Results and Discussion

Using the Collect Earth methodology, the sand/dune resource regions for the Middle East are classified at five levels of significance according to point density methodology (Figure 3). Areas of first-degree (level 1) dust resources are classified as having the highest risk level in terms of dust transportation, while those of fifth-degree (level 5) dust resources are classified as least in terms of risk level. In the Middle East, the largest area of dust resources regions is 1607398.00 km^2 and is located at the level 3 dust resources regions. This area is followed by fifth-degree dust resources areas with 765707.00 km^2 (Table 1). When the area sizes of the classified dust resources regions are examined in terms of countries, within five classes, Saudi Arabia has the largest dust resource regions in each risk level group (Table 2). Syria and Iraq contain all other dust resources regions except the first (level 1) and second-degree (level 2) dust resources.

The third-degree (level 3) dust resources areas cover 64% of Iraq (283185.00 km^2). The fourth-degree (level 4) dust resources areas cover 2.7% of Iraq (12160.00 km^2) and the fifth- degree (level 5) dust resources areas, 15% of Iraq (68831.00 km^2). Approximately 82% of the Iraqi country's land is covered by dust resources regions. In Syria, 53.7% (101151.00 km^2) are third-degree dust resources regions, 9.8% (18564.00 km^2) are fourth-degree dust resources regions, and 8.9% (16828.00 km^2) are fifth-degree dust resources regions. Approximately 72.4% of country's land in Syria is covered by dust resources region.



** Level 5degree dust resources areas were created by including the 200 coded 'bare soil' class of 2009 ESA land use classes map*

Figure 3. Sand/dune resource regions for the Middle East

Table 1. Dust resources areas

Risk levels of dust resources areas	*Area (km^2)*
Level 1	341865.00
Level 2	230020.00
Level 3	1607398.00
Level 4	390889.00
Level 5	765707.00
TOTAL	3335879.00

Table 2. Dust resources areas according to countries

Risk levels of dust resources areas	***Countries***	***Area (km²)***
Level 1	Oman	22673.00
	Saudi Arabia	254000.00
	United Arab Emirates	34931.00
	Yemen	30261.00
Level 2	Oman	24655.00
	Saudi Arabia	164947.00
	United Arab Emirates	15510.00
	Yemen	24908.00
Level 3	Bahrain	483.00
	Iraq	283185.00 (63.6%)*
	Israel	1295.00
	Jordan	65419.00
	Kuwait	15950.00
	Oman	145111.00
	Palestine	46.00
	Qatar	1886.00
	Saudi Arabia	832815.00
	Syria	101151.00 (53.7%)*
	United Arab Emirates	22787.00
	Yemen	137271.00
Level 4	Iraq	12160.00 (2.7%)*
	Israel	1214.00
	Jordan	9915.00
	Kuwait	488.00
	Lebanon	32.00
	Oman	44403.00
	Palestine	430.00
	Qatar	1.00
	Saudi Arabia	280990.00
	Syria	18564.00 (9.8%)*
	Yemen	22691.00
Level 5	Bahrain	51.00
	Iraq	68831.00 (15.0%)*
	Israel	10016.00
	Jordan	11347.00
	Kuwait	27.00
	Lebanon	915.00
	Oman	78507.00
	Palestine	1638.00
	Qatar	9487.00
	Saudi Arabia	359153.00
	Syria	16828.00 (8.9%)*
	Turkey	6443.00
	United Arab Emirates	6074.00
	Yemen	196390.00
TOTAL		3335879.00
**** shows the percentages by country total area***		

According to the ESA Global Land Cover Map 2009 world report (200 coded class), the vast majority of the area is covered with sand/dune areas of 3335879.00 km^2 without vegetation. This figure corresponds to 76.47% of the entire Middle East. On the other hand, surface water sources (210 coded class) for the countries of the Middle East are 19767 km^2 . This corresponds to approximately 0.5% of the total area. Iraq's total surface water resources is 5435 km^2, that of Syria is the 1303 km^2. When the distribution of water assets according to the dust resources regions of the Middle East countries is analyzed, it is seen that Iraq's surface water assets area of 3872.90 km ^{2} is in the third-degree dust resources regions. Within the same region, Syria has only 74.40 km^2 of water asset. Within the fourth degree dust resources regions, Iraq has 109.60 km^2, Syria has 356.80 km^2 of water asset and within the fifth degree dust resources regions Iraq has 247.80 km^2, Syria has 338.0 km^2 of water asset (Table 3).

When Iraq and Syria are evaluated in terms of water resources, 71.3% (3872.90 km^2) of Iraq's total 5435.00 km^2 of water resources area is located in the third-degree dust resources area. This situation poses a serious threat to the water resources for the protection of the agricultural areas in this region when considering that the existing water resources of Iraq are fed with the Euphrates and Tigris. In Syria, the rate of water resources in the third-grade dust resources region is 6% (78.40 km^2), the rate of water resources in the fourth-grade dust resources region is 27.4% (356.80 km^2) and the rate of water resources in the fifth-grade dust resources region is 25.9% (338.00 km^2). The same threat applies to Syria, but the risk level is lower than Iraq.

Table 3. Water asset areas according to the countries and risk levels of dust resources areas

Risk levels of dust resources areas	***Countries***	***Water asset areas (km^2)***
Level 2	Saudi Arabia	0.5
	United Arab Emirates	0.1
Level 3	Bahrain	0.5
	Iraq	3872.9 (71.3%)*
	Israel	136.0
	Jordan	127.9
	Kuwait	2.5
	Saudi Arabia	9.5
	Syria	78.4 (6%)*
	United Arab Emirates	56.1
	Yemen	4.7
Level 4	Iraq	109.6 (2%)*
	Israel	129.7
	Jordan	351.7
	Palestine	197.9
	Saudi Arabia	1.7
	Syria	356.8 (27.4%)*
Level 5	Iraq	247.8 (4.6%)*
	Israel	0.2
	Jordan	2.0
	Oman	1.5
	Palestine	1.7
	Qatar	0.1
	Saudi Arabia	10.4
	Syria	338.0 (25.9%)*
	Turkey	11.1
	United Arab Emirates	0.3
	Yemen	0.5

** shows the percentages by country total water asset area*

According to the ESA Global Land Cover Map 2009 world report for the Middle East region (class 11;14; 20 and 30), the total area of agricultural land is 594699.00 km^2. 459482.00 km^2, 48680 km^2 and 41975 km^2 of the agricultural land is located respectively in Turkey, Iraq and Syria. According to the dust resources regions, Iraq and Syria are mostly located in the third-degree dust resources region. The ratio of agricultural land within the level 3,4 and 5 dust resources regions which are most affected by the dust resources of Syria and Iraq to the total agricultural land is 25.90% (10873.00 km^2) in Syria and 10.50% (5110.00 km^2) in Iraq (Figure 4).

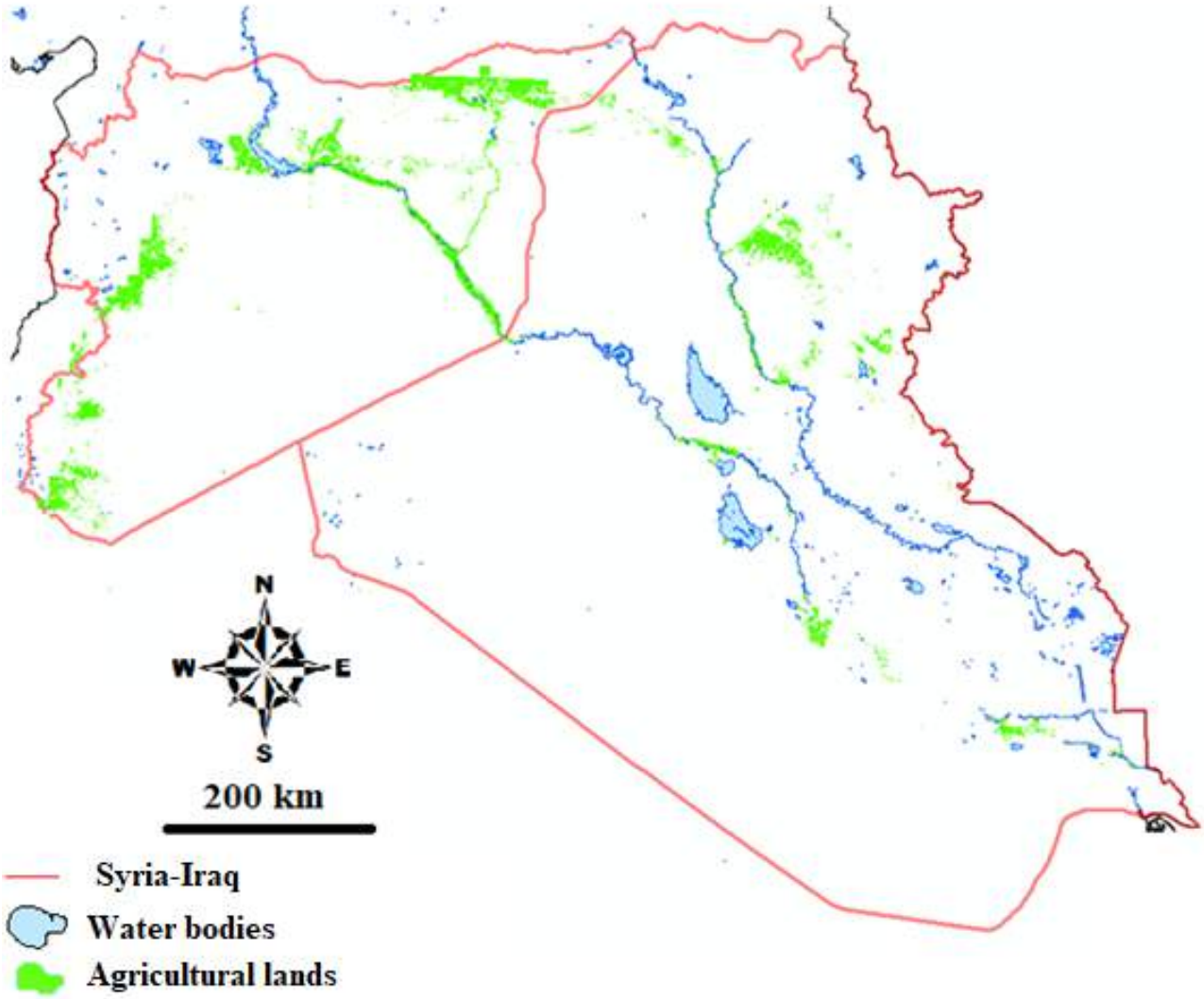


Figure 4. Agricultural lands within the dust resources regions of Syria and Iraq

Within General Directorate of Combating Desertification and Erosion in T.C. Ministry of Forestry and Water Affairs, a study was conducted for the detection of desertification-greening trends areas in the buffer zone of 111386.80 km^2 in Euphrates and Tigris rivers (10 km wide) within the borders of Syria and Iraq with the help of 8152 plot with a size of 0.5 ha by using Collect Earth methodology. As a result of the work carried out in order to monitor and evaluate the vegetation areas, mainly agricultural areas, 193749 ha greening and 73149 ha desertification area were detected between 2001-2016 years (Figure 5). A significant increase in the amount of greening, that is vegetation, in the agricultural areas along the Euphrates and Dicle rivers is the evidence of the protection of existing vegetation because the agricultural areas, vast majority of which is located in the third-degree sand/dune resources regions can be irrigated despite the problems of available dust resources and this provides soil aggregates to merge.

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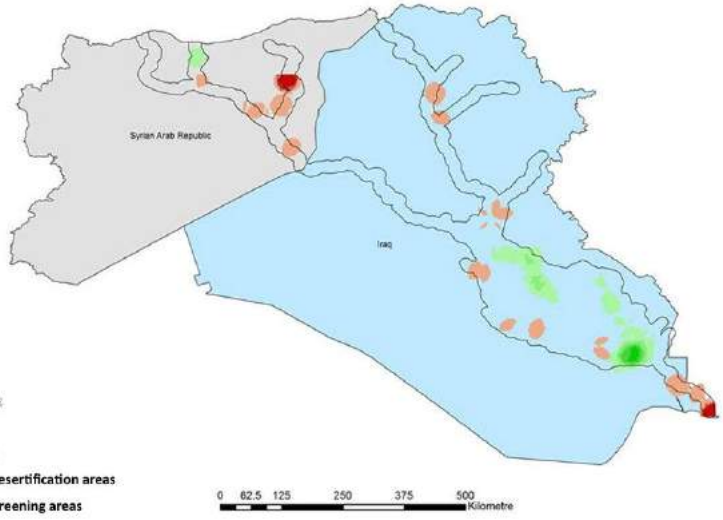

Desertification/Land Degradation_Greening Trends	*Area* (km²)	%
Greening	1937.49	1.74
Desertification/Land degredation	731.49	0.66

Figure 5. Multi-purpose land monitoring project in Euphrates and Tigris rivers

4. Conclusions

As a result of the study done;

- 76.47% of the entire Middle East (4362429 km^2) is dust resources consisting of sand and desert dune land classes. This high rate threatens vegetation in other land use classes, especially in the Middle East agricultural areas. Considering the current conditions of Iraq and Syria and the changes in land use, the primary factor that causes agricultural areas to become ineffective by exposing them to dust transportation by the influence of wind is the dust resources in the region.

- Using the 'sand/dune' land classes on the basis of the dataset created in the context of FAO's "Global Forestry Inventory and Drylands Assessment Project", a map of risk level classes for the entire Middle East region was created. In the southern part of the Middle East, level 1 and 2 dust resources regions risk classes are located, while the largest dust sources areas in the region are at the level 3 risk class. The countries of Iraq and Syria, which constitute the focal point of the research, are located in the region of the level 3 dust resources mostly. 63.6% of the total area in Iraq, and 53.7% of the total area in Syria constitute level 3 dust resource regions

- 71.3% of the water areas in Iraq, mostly formed by Euphrates and Tigris, are located in the level 3 risky dust resources region. For Syria, these rates are 6% for water areas in the level 3 risky dust resources regions and 27.4% and 25.9% for those in the level 4 and 5 risky dust resources regions, respectively. This requires that the country be sensitive in planning related to water assets and water use.

- 25.90% of Syria, 10.50% of Iraq is located in the level 3,4 and 5 risky dust resources region. The rest of the agricultural land is threatened by current dust resources and dominant wind directions. It has been observed that all of the irrigable agricultural lands from the Euphrates and Tigris rivers can be preserved by the use of the existing water and vegetation growth has been observed in irrigable agricultural lands during the last 16 years.

Acknowledgements

We thank the 20 operators who participated in the Global Drylands Assessment in Antalya/Turkey via General Directorate of Combating Desertification and Erosion; FAO staff who supported it; Danilo Mollicone: Forestry Officer and Project Lead Technical Officer, Forestry Department; Çağlar Başsüllü: FAO's Subregional Office for Central Asia

References

Bontemps S., Defourny P., Bogaert E.V., Arino O., Kalogirou V., Perez J.R., (2009), Products Description and Validation Report, http://due.esrin.esa.int/files/GLOBCOVER2009_Validation_Report_2.2.pdf, [Accessed 25 September 2017].

Dursun A., (2006), Sınır aşan Sular Fırat ve Dicle Nehirlerinin, Türkiye , Suriye ve Irak İlişkileri Üzerine Etkileri, Yüksek Lisans Tezi, Süleyman Demirel Üniversitesi, Isparta, Turkey.

Gemma S., Terradellas E., Baklanov A., Kang U., Sprigg W., Nickovic S., Boloorani A.D., Al-Dousari A.B.S., Benedetti A., Sealy A., Tong D., Zhang X., Shumake-Guillemot J., Zhang K., Knippertz P., Mohammed A.A.A., Al-Dabbas M., Cheng L., Otani S., Wang F., Zhang C., Ryoo S.B., Joowan, C., (2016), *Global assessment of sand and dust storms*, Published by the United Nations Environment Programme (UNEP) Nairobi, Kenya, 139 ss.

Open Foris, (2015) Free Open-Source Solutions for Environmental Monitoring,,http://wwwopenforisorg/ [Accessed 11 july 2017].

Özdemir Y., Öziş Ü., Baran T., Fıstıkoğlu O., Demirci N., (2008) *Sınır-Aşan Fırat Dicle Havzasının Su Potansiyeli ve Yararlanılması*, TMMOB Su Politikaları Kongresi, Ankara, Turkey, ss. 506-516.

Sissakian V.K., Nadhir A., Sven K., (2013), *Sand and dust storm events in Iraq*, Natural Science, doi: http://dx.doi.org/10.4236/ns.2013.510133

Sivakumar, M.V.K., (2005), *Impacts of sand storms/dust storms on agriculture*, Natural disasters and Extreme Events in Agriculture: Impacts and Mitigation (Mannava V.K., Sivakumar R.P., Motha H.P.D. Ed,) Springer-Verlag Berlin Heidelberg Press, Netherland, ss.159-177.

Stefanski R., (2007), *Impacts of sand and dust storms on agriculture and potential agricultural applications of a SDSWS*, WMO/GEO SDSWS Meeting – Barcelona, Spain.

Analysis of Flood Disaster by GIS and AHP Method: Trabzon-Beşikdüzü

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Abstract

When streams exceed their capacity, they overflow and cause floods which are destructive to their surrounding areas. Floods are natural disasters that have adverse economic and social effects on communities. Such negative effects are unarguably exacerbated by residential or commercial development in high-risk flood zones. Therefore, it is imperative to mitigate the harm caused by floods to human health, envionment, infrastructure and investements. Identifying the structures that are prone to being flooded and implementing precautionary measures would minimize the losses (Sargın, 2013).

In this study, we utilized Geographic Information System (GIS) to analyze floods. In the project, terrestrial data and GIS data were used in computer environment. Analytical Hierarchy Process (AHP) method is used in this study that aims to use decision support mechanisms more effectively and healthily in the monitoring and management of flood disasters.

We entered all collected data into the HEC-RAS software and perfomed flood analysis of Besikduzu, Trabzon. Based on the results of our analysis, we made recommendations with respect to the magnitude and significance of the observed changes.

Keywords
Flood, Besikduzu, AHP, GIS

1.Introduction

Different computer models are developed to understand the flood and to demonstrate its effects. It is possible to collect the main constituent of these models in four parts. These are hydrological models, hydraulic models, flood mapping and produce of flood maps for use in the model.

In this study, we aim to produce flood hazard maps for Takazli Creek using GIS and hydraulics software. We inspected the general phsical properties of the primary study areas'a basin. In light of our findings, we proceeded to develop the hydrologic and hydraulic models.

2.Study Area

Town of Besikduzu is 45 kilometers west of Trabzon. The central population 21,870 (Figure 1).

The district center is flat and at sea level. Its interior has a rather rugged and prone terrain. Its surface area is 121 km2.

The town has a typical Black Sea climate with cool summers and mild winters. It rains all four seasons. The average temperature is 22 C in the warmest month and 6 C in the coldest. Humidity is around %60-%70.

There are 5 creeks in town that are capable of causing floods. These are: Takazli, Nefsisarli, Hudela, Cavuslu and Tumen Creeks (Figure 2). We picked Takazli Creek as the basin area.

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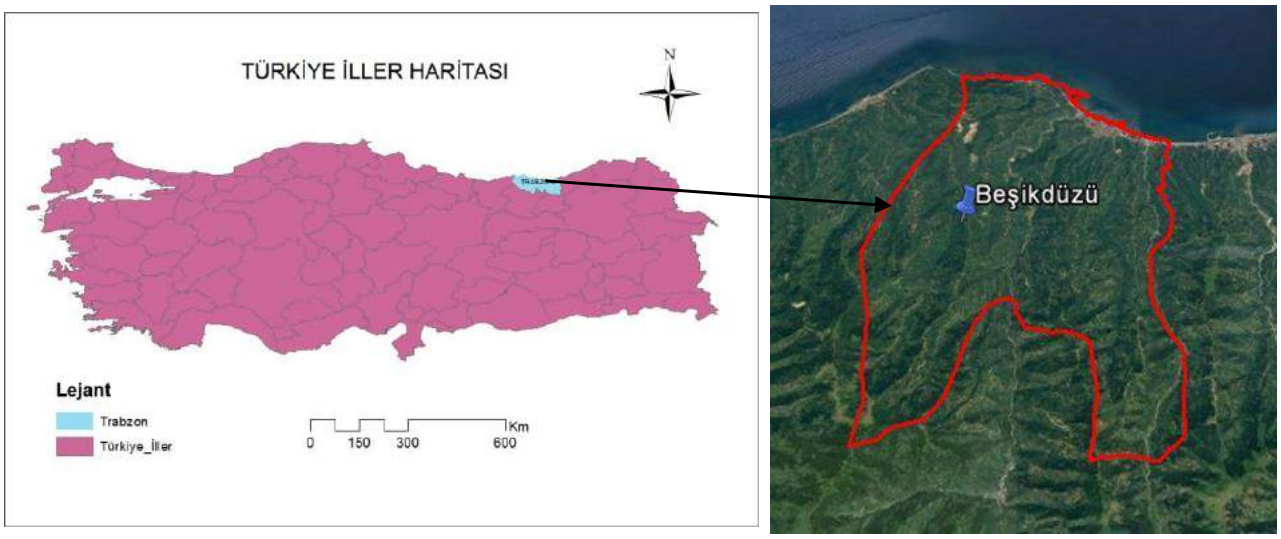


Figure 1:Study Area

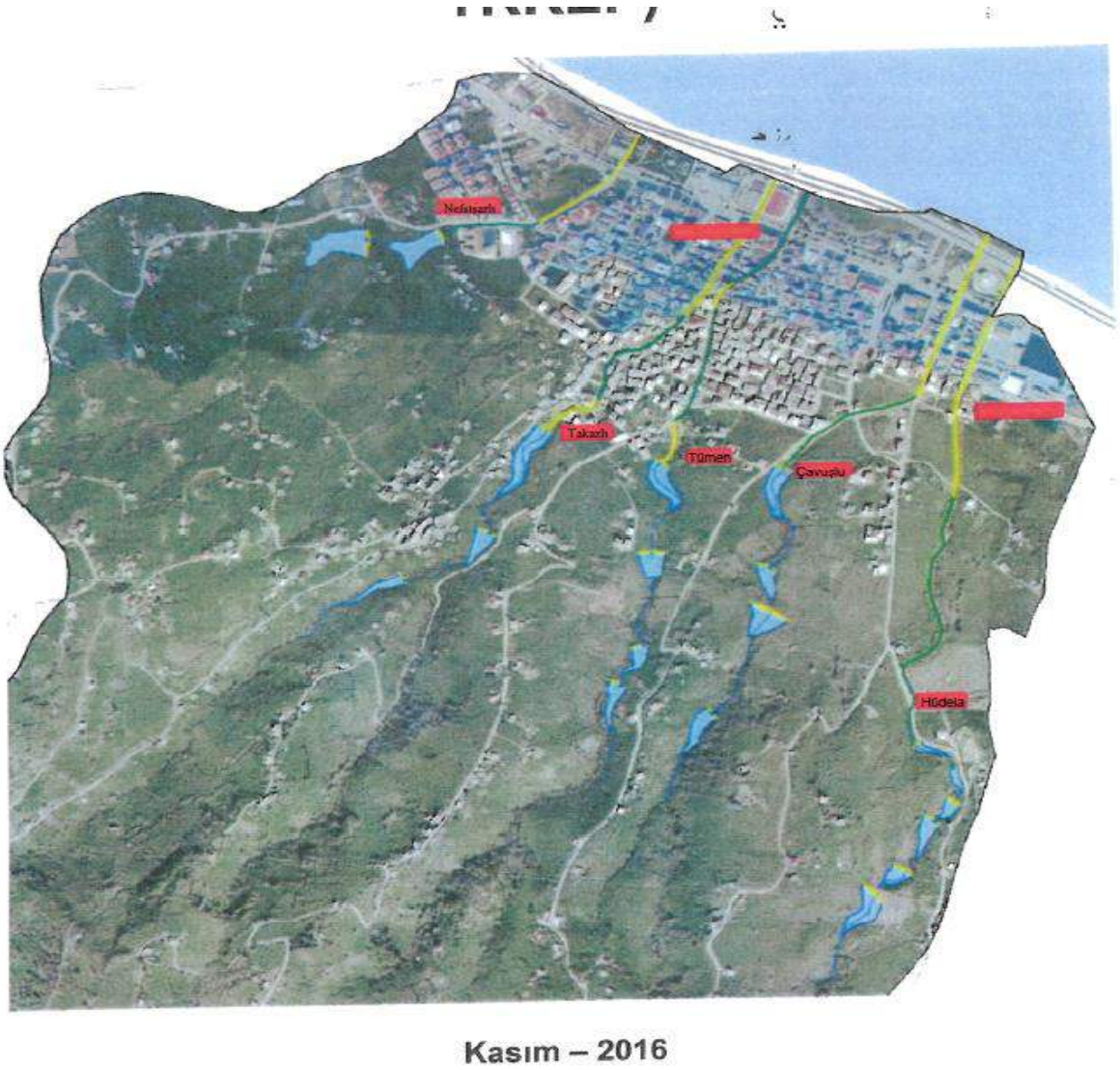


Figure 2: Beşikdüzü creeks

3.Tools and Procedures

Figure 3 outlines the phases of this project.

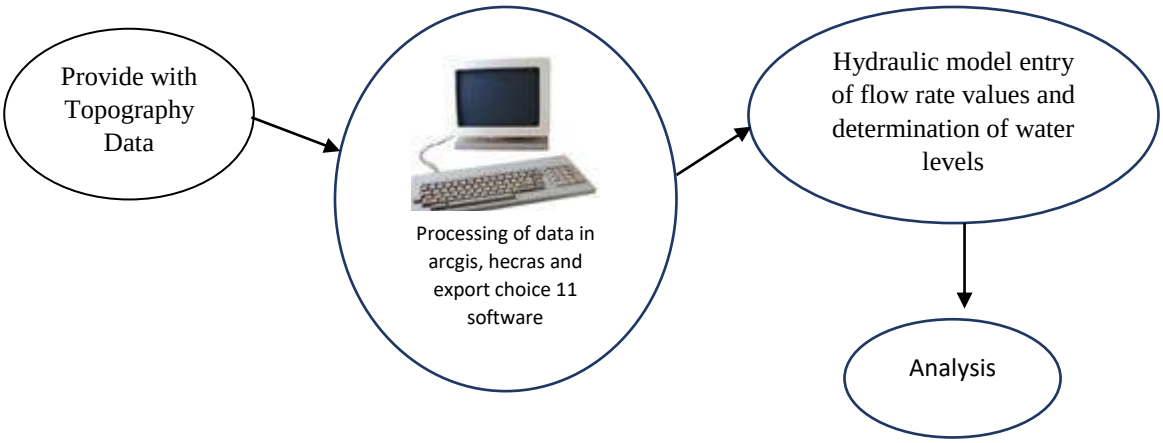


Figure 3:Work phases

3.1 Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is the most frequently used method of multiple-criteria decision analysis. The objective of MCDA methods is to keep decision making under control and arrive at the resulting decision as easily and quickly as possible in the presence of large number of alternatives and criteria (Öztürk, 2009).

Figure 4: AHP tree diagram

The primary objective and the subsequent criteria and alternatives are displayed based on the principles of AHP. For Besikduzu, Tarbzon, the flood hazard risk map (Figure 4) and the factors that contributed to the floods are shown in a hierarchical tree sturcture generated via AHP (Figure 5).

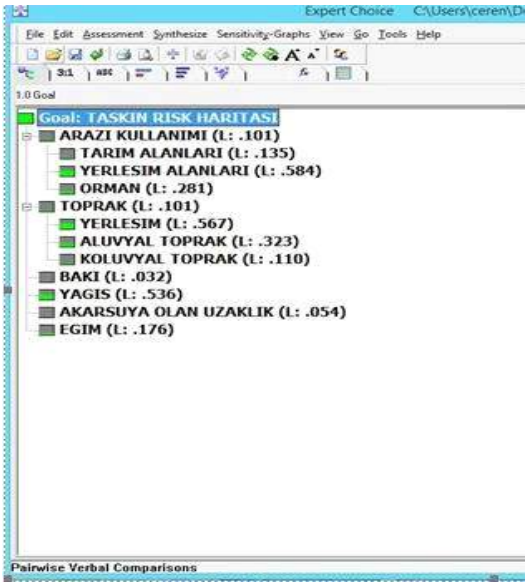
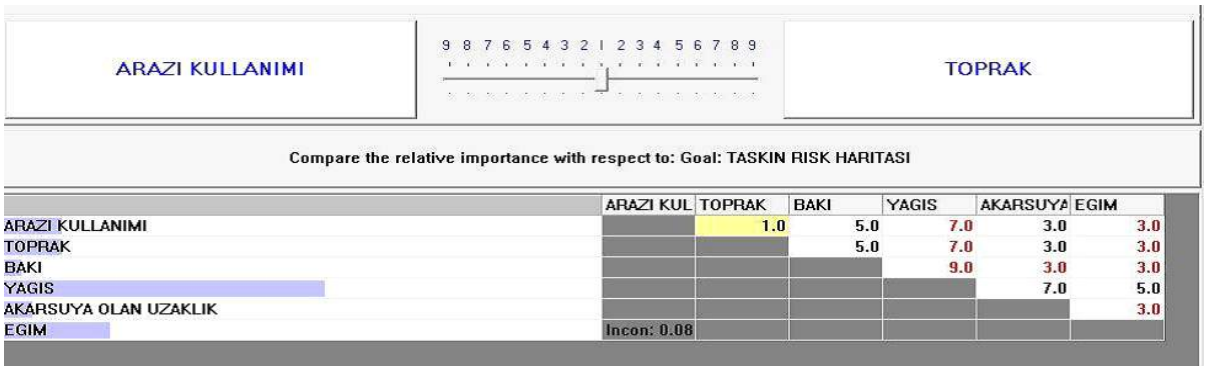


Figure 5: Flood map hierarchical structure generated via AHP.

In AHP, decision making is broken down into its components which are organized in a hierarchical structure. Pairwise comparisons are made in order to calculate scores based on degrees of priority (Figure 6). A basic scale with scores ranging from 1 to 9 was adopted for pairwise comparisons. The first step in AHP is to identify the primary objective. In order to identify all criteria that influnce the decision-making process, we consulted subject matter experts.

According to the AHP results, the area under study is determined to be hazardous, while potential floods can be brought on particularly by rain and sloping land (Figure 7).



	ARAZI KUL	TOPRAK	BAKI	YAGIS	AKARSUYA	EGIM
ARAZI KULLANIMI		1.0	5.0	7.0	3.0	3.0
TOPRAK			5.0	7.0	3.0	3.0
BAKI				9.0	3.0	3.0
YAGIS					7.0	5.0
AKARSUYA OLAN UZAKLIK						3.0
EGIM	Incon: 0.08					

Figure 6: Binary comparison example

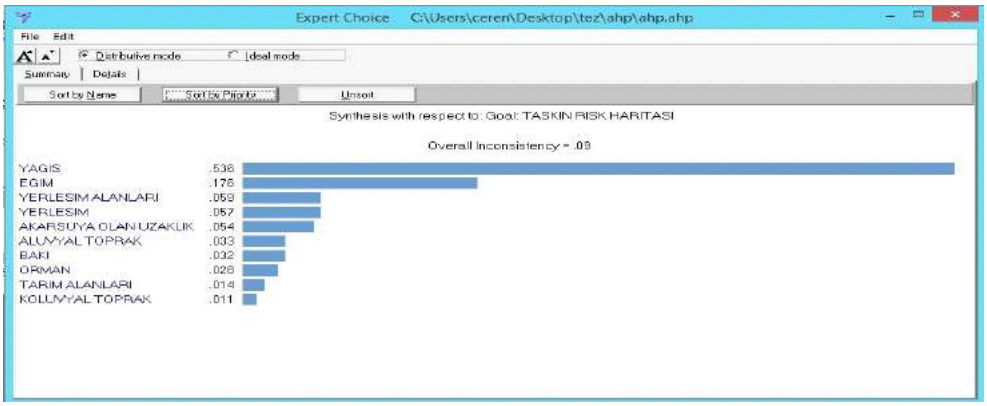


Figure 7: AHP end result

3.2 Takazli Creek Hydraulic Model Study

Existing numeric maps were used in modeling the residential areas. In order to move Geographic data into the HEC-RAS software, a numeric height model of the region is needed. 3D model of the terrain is generated using ArcGIS(Figure 8).

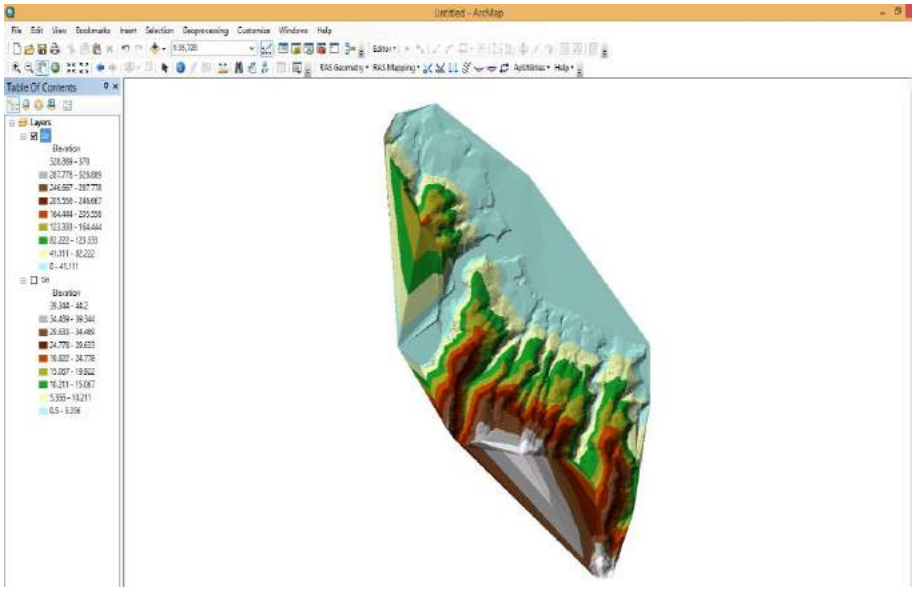


Figure 8: Beşikdüzü TIN model.

3.2.1 Takazlı Creek

Precipitation area: 2.70 km^2
Main arm length: 5.50 km
Manning's roughness coefficient of the creekbed was taken as n=0.021

Using a HEC-RAS model (Table 1), water surface levels were calculated for different flow rates and water surface profiles were generated (Figure 9).

Table 1: Flood return periods and discharges

Return Period in Years	Flood Discharge
2	4.3
5	6.6
10	8.5
25	11.9
50	15.4
100	19.3
500	26.7

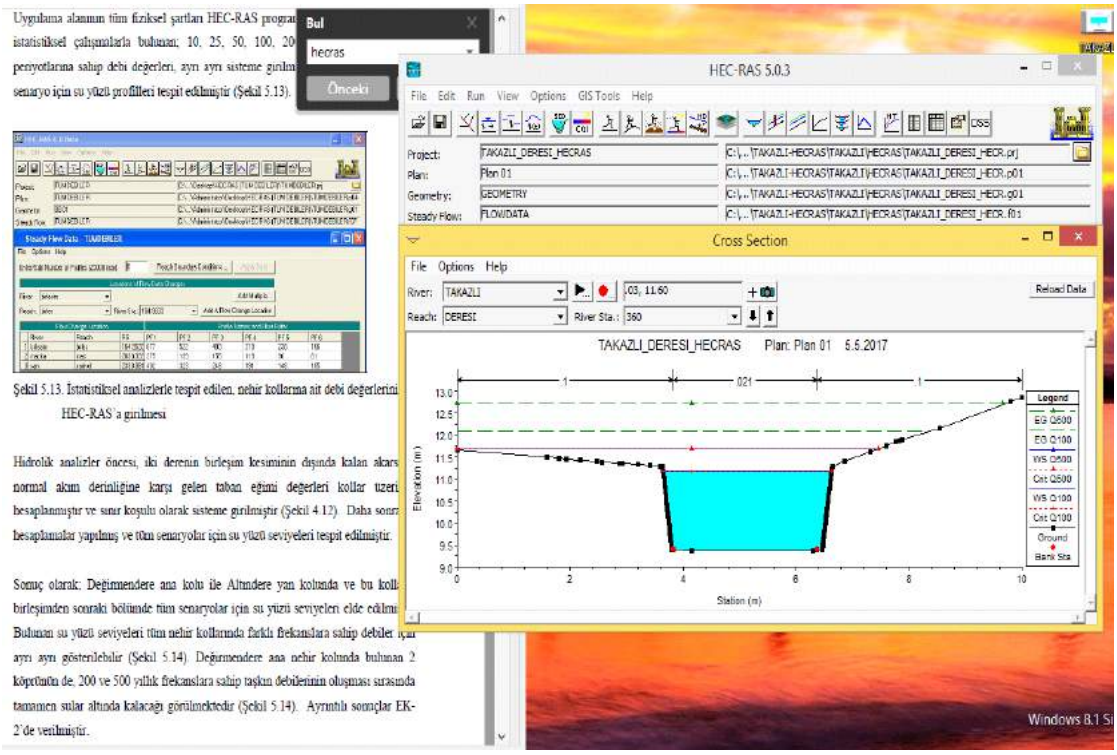


Figure 9: Entering the channel discharge values, which are determined by statistical analysis, into HEC-RAS.

As a result, 100- and 500- year water surface levels were obtained for Takazli Creek's mainstream(Figure 10).

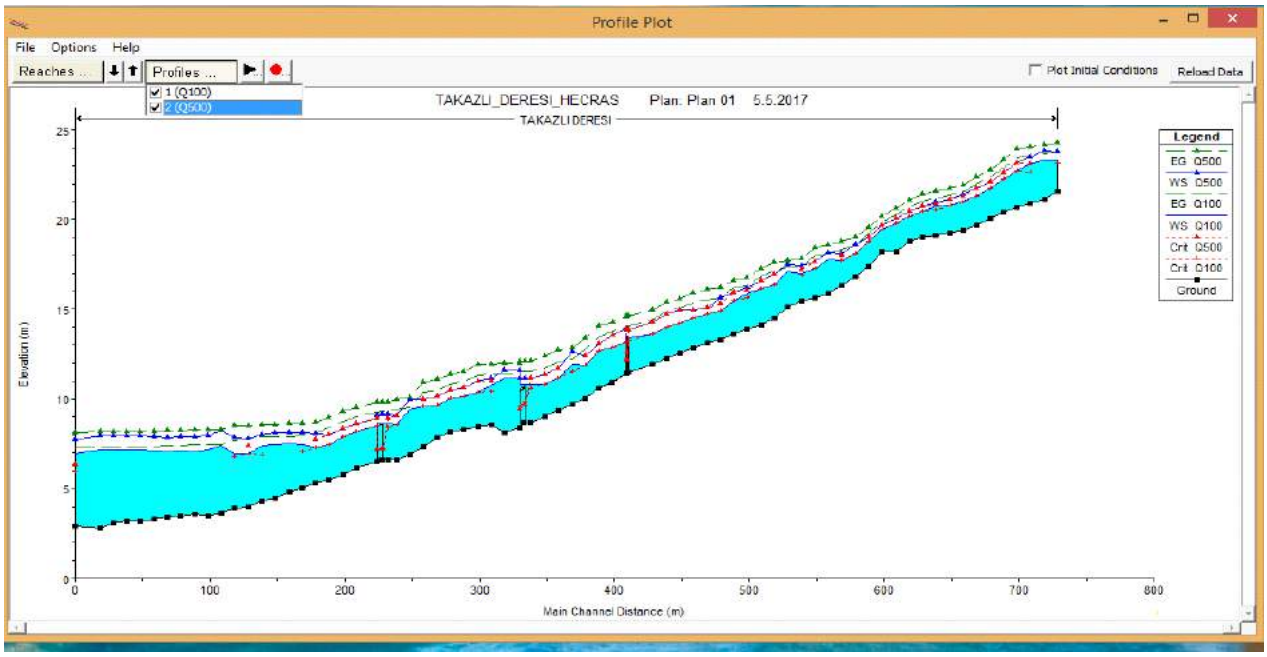


Figure 10: Takazli Creek water surface profiles for discharges with 100- and 500- year repeat periods.

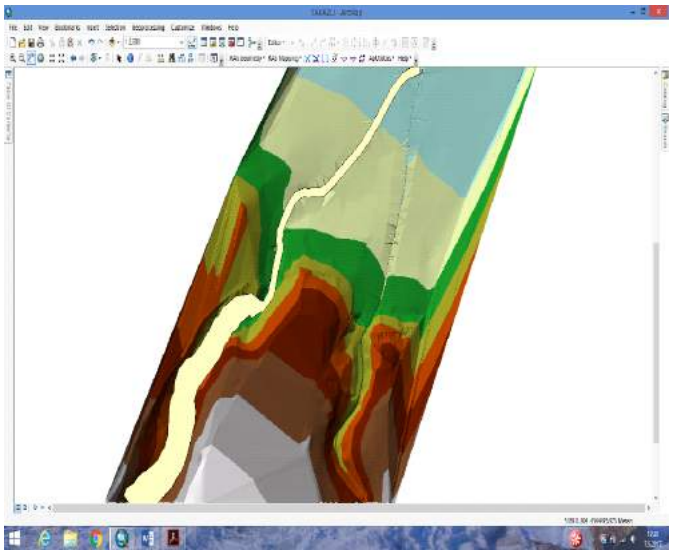
All topographic data was entered into HEC-RAS, which is capable of performing hydraulic analysis, using the HEC-GeoRAS extension for ArcGIS. Discharge values calculated via statistical methods for different repeat periods (100- and 500- year) were plugged into the hydraulic model, and water levels were calculated. The results were moved to ArcGIS via HEC-GeoRAS where flood analysis was carried out. In light of the findings, recommendations were made regarding the magnitude and significance of the observed changes.

Results

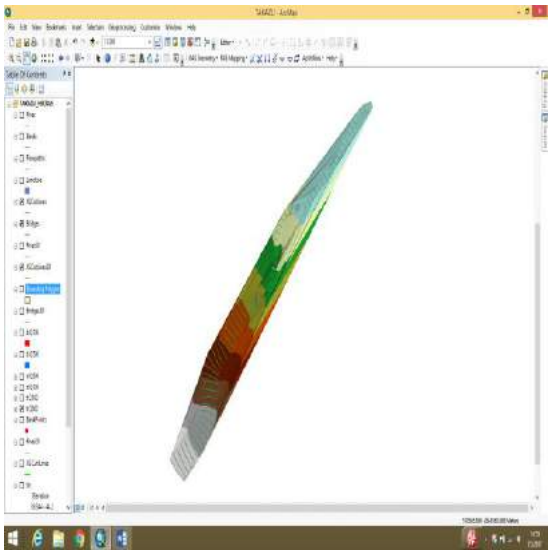
The results of the study show that future floods that reach the expected maximum water level would cause major structural damage in Besikduzu town center due to the pesence of development alongside the creek and the narrowing of the creekbed by the existing bridges. Hazard studies of floods, which are capable of causing significant casualties, should not be overlooked. Flood hazard analysis should be carried out and precautionary actions should be taken based on the identified risks. GIS methods allow performing flood hazard analysis quickly, and provide effective results by considering multiple factors.

As a result of the hydrodynamic modeling studies made within the scope of the report, from the mansard the grilles 2D model had negative effects on the water profil, have been determined to cause floods (Figure 11). Using AHP, criteria that cause floods in Besikduzu, Trabzon were identified. Rain was determined to be the most significant criterion. Besikduzu town municipality carried out a study on flood prevention. As a result, channel preservation perimeters were established and the zoning plan was amended accordingly.

Figure 11: Q500 Flood propagation map



Bounding polygon



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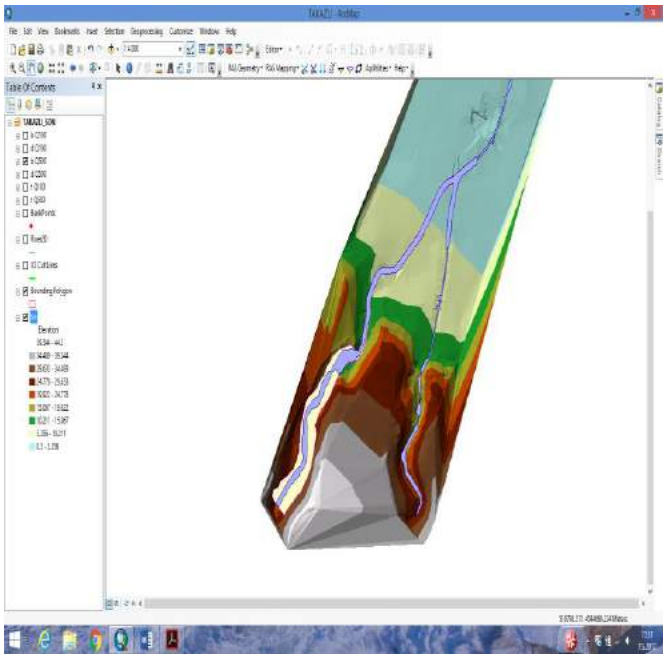

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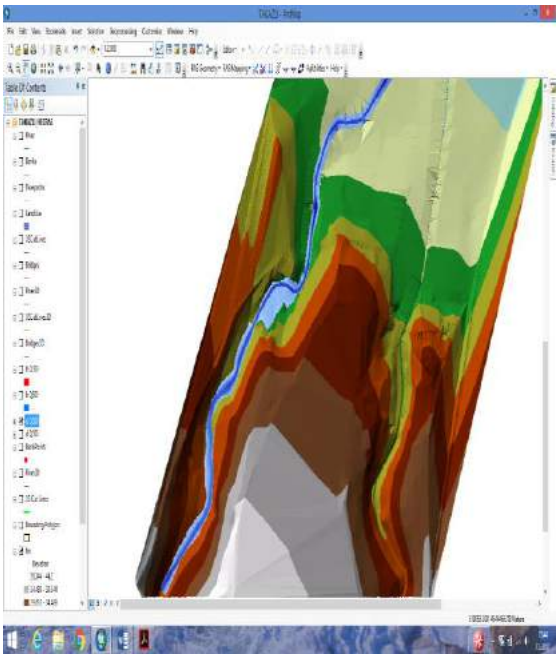

dQ500

Katman adı	Türü	Açıklama
Bounding polygon	Vektör	"kesit" katmanı sınırları
t Q500	Raster	"kesit" katmanı sınırları içerisinde deniz seviyesinden itibaren oluşacak su yüzeyi
b Q500	Vektör	Nihai taşkın alanı
d Q500	Raster	Nihai taşkın alanında oluşacak su kalınlığı

Acknowledgements

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References

ÇÖLKESEN.İ,(2009), Uzaktan Algılamada İleri Sınıflandırma Tekniklerinin Karşılaştırılması ve Analizi, Gebze Yüksek Teknoloji Enstitüsü Mühendislik ve Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi,Gebze.

OĞUZ,K. OĞUZ,E. COŞKUN,M.(2016), Coğrafi Bilgi Sistemleri ile Taşkın Risk Alanlarının Belirlenmesi Artvin İli Örneği: 4.Ulusal Taşkın Sempozyumu 21-24 Kasım 2016, Rize.

Orman ve Su İşleri Bakanlığı, 2016. Beşikdüzü İlçe Merkezi Dereleri Taşkın ve Rüsubat Kontrolü Eylem Planı. Beşikdüzü Belediyesi, Trabzon.

Öztürk, D., (2009). " Cbs Tabanlı Çok Ölçütlü Karar Analizi Yöntemleri İle Sel ve Taşkın Duyarlılığının Belirlenmesi: Güney Marmara Havzası Örneği", Doktora Tezi, Y.T.Ü. Fen Bilimleri Enstitüsü, İstanbul.

ÖZALP,D. (2009),Dere Taşkın Risk Haritalarının CBS Kullanılarak Oluşturulması ve CBS ile Taşkın Risk Analizi, İstanbul Teknik Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, İstanbul.

Sargın, A. H., (2013). Coğrafi Bilgi Sistemleri ile Taşkın Riski Ön Değerlendirmesi, T.C. Orman ve Su İşleri Bakanlığı Devlet Su İşleri Genel Müdürlüğü Teknoloji Dairesi Başkanlığı.

URL http://www.dsi.gov.tr/docs/yayinlarimiz/cbs-ile-taşkın-riski-ön-değerlendirmesi.pdf, [Accessed 08 June 2017].

ŞAHİN,E. (2012), CBS Tabanlı Çok Kriterli Karar Verme Analizi Yöntemi Kullanılarak Heyelan Duyarlılık Haritasının Üretilmesi: Trabzon İli Örneği, Gebze Yüksek Teknoloji Enstitüsü Mühendislik ve Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, Gebze.

ÜYÜKLÜOĞLU,M. ÜNAL,B. TURAN,B. (2015), HEC-RAS Paket Programı İle Manavgat İlçesi Ilıca Deresi Taşkın Bölgesinin Modellenmesi: 4. Su Yapıları Sempozyumu 19-21 Kasım 2015, Antalya.

Netcad Interoperability Platform

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Abstract

With the Netcad interoperability platform, it is aimed to increase the accuracy and quality of data by preventing duplication of data, to reduce application development costs, to increase the user experience and to use it effectively in a timely manner.

There are different software companies and different infrastructure technologies in public institutions. Although different systems produce different results by storing different data, common points have always been to serve the institution.

Netcad allows to analyze on map by digitizing verbal data integrated with different systems. At the same time, Netcad also provides third party corporate map baselines to identify the geographical locations of verbal data, to access the addresses, plans, etc. produced by Netcad.

One goal of the NetCAD interoperability platform is to be integrated with systems that have different technologies and infrastructures. The most effective way to integrate with systems that have different operating systems, hardware and software technologies is to use web service technologies. Data produced by Netcad is provided by Netcad Netgis services and OGC standards. Proxy service is used to communicate with web services of third party companies.

With Netcad interoperability platform, Netcad map can be displayed in the user interface of third party software producing verbal data, verbal (debt, declaration, accrual) data generated by third party software on Netcad map can be listed and thematic analyzes can be done. In this way, data with different qualities and technologies from a single point can be quickly accessed, controlled, easily integrated into new systems when needed.

Keywords

Netcad, GIS, MIS, Entegrasyon, Web Servis, Map, Netcad VGA, Netgis

1. Introduction

With Netcad VGA, precise and special data such as Address, Cadastre, Plan, Infrastructure are produced with all kinds of spatial quality controls. Produced spatial data and various analyzes, queries, thematic reports are published on desktop, mobile phone and web platforms.

Netcad Netgis web services deliver these services to OGC standards when third-party software vendors with different areas of expertise need the data produced by Netcad VGA such as address, cadastre, plan. Third-party software companies that implement the data that is served to their system are saved at no extra cost, get the right data, and do not repeat the process.

The software company uses the Netcad Netgis Map Client with a common dataset when it wants to display the corresponding location on the map of the verbal data. After third-party software companies use Netcad Netgis Map Client to view the geographical location of their verbal data, Netcad Netgis Map Client can accelerate processes and improve the quality of verbal data by using a variety of capabilities including 360 street view, building photos, thematic, spatial analysis.

With Netcad Netgis web services, the data is kept in OGC standards and development costs are kept at optimum level. With the know-how acquired by third-party software companies, development, documentation and training costs are eliminated in different projects.

Verbal and visual data not produced by Netcad Netcad is implemented through corporate products while the opposite of current model is implemented. Using Netcad corporations products, editing tools such as archives, document tracking, etc., which are managed by third party companies belonging to spatial objects such as parcels, buildings, independent building unists, are displayed.

In cases where only verbal data such as MIS should be displayed, Netcad is listed in corporate products by connecting to web services provided by MIS companies and obtaining verbal data such as debt / declaration.

1.1. Model

Within Netcad interoperability platform, common data sets are used to communicate different systems. UAVT (National Address Database), MAKS (Spatial Address Recording System) codes for address information, Ada, Parcel, Tapu neighborhood names are used for cadastral data.

Because UAVT and MAKS codes are generated from a common center, the use of UAVT or MAKS code during data exchange of different systems will always lead to the correct result. Since the same Ada / Parcel values are repeated within the administrative boundaries, when the name of the Tapu Neighborhood is also used, the matching rate of the data is increasing.

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1.2. Method

For communicating two different systems, it is necessary to determine how to transfer the data from the source to the target after the common data set is determined. The end user profile, available resources and current technologies need to be well analyzed before determining how often the data will be transmitted or received and which technologies will be used.

Web technology is used if the end user is not in a stable environment and always needs to reach the current database. The current data is transmitted via web services. Current web service technologies such as rest api, soap are used to reduce development costs. Netcad Netgis services serve data using soap technology. Service input and output are in OGC standards.

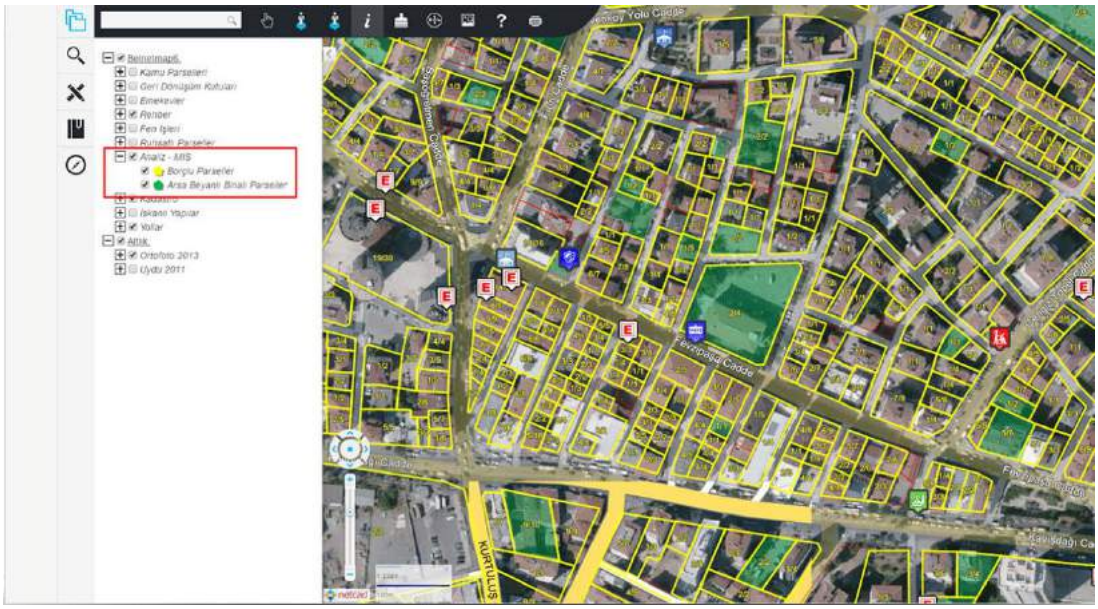

Image 1: MIS Tematik Harita

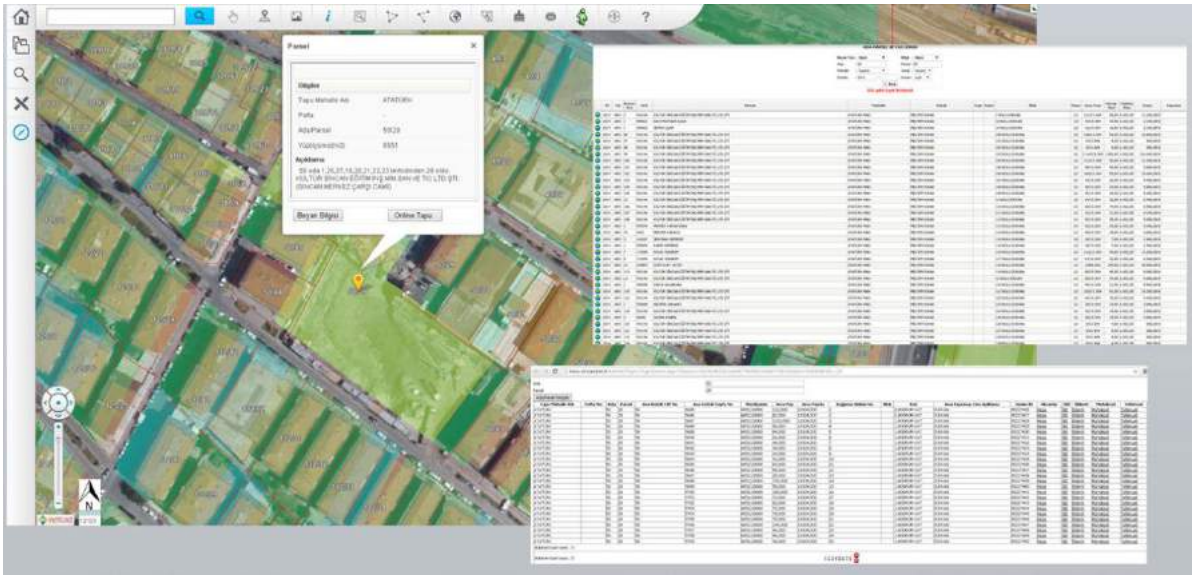

Image 2: MIS Bilgileri

1.3. Netcad Interoperability Platform Services

Netcad Interoperability Platform services are the basis for the address/property data of the institution. The criteria in the address services are UAVT codes. Since the parcel structure contains the most up to date parcel log, MIS is the only source for parcel related jobs.

1. Neighborhood Query: brings up the current Neighborhood list,
    a. MIS software accesses current neighborhood data.
    b. Old records can be queried.

2. Road Query: Bring up the Current Road list,
    a. MIS software accesses the current road data.
    b. Old road names can be queried together with their current state.
    c. The roads in the neighborhood can be queried.
3. Building Door Number Query: It brings up the current door list.
    a. MIS software accesses the current door list, Neighborhood, Road criteria can be used.
    b. Old records can be queried.

4. Parcel query: The current parcel list can be accessed.
    a. MIS software accesses current parcel list.
    b. Changes in the parcels (Sorting, Merge) are monitored.

5. Independent Building Unit Query: The current independent unit list can be accessed.
    a. MIS software accesses the current independent building unit list,
    b. Neighborhood, road, building door number criteria can be used,
    c. Neighborhood, Parcel, Structure and Road information associated the doors can be listed.
    d. Old records can be queried.

6. Map Query: The web-assisted map of address data can be retrieved dynamically.
    a. BELNET WEB maps can be displayed dynamically on MIS software screens. Enlarge, shrink, query etc. map controls can be provided. Recent address maps can be displayed on satellite images.

7. NetGIS SDK: NetGIS SDK is a tool that enables MIS software to add itself directly to its own work screens, and then define all the map control features such as enlarge, shrink, shift, get information, measure operations.

8. NetGIS CVS: The NetGIS CVS (Geographic Data Service) mechanism allows collecting data for the six services mentioned in the above 1-5. It is a tool to provide aggregate data integration especially at project start-ups.

1.4. Advantages

- Prevent duplicate service, hardware and software purchases
- Provides geographical publishing, analysis and reporting of services
- Provides a fair distribution of missing, inaccessible services to the citizen
- Provides an increase in service quality from the moment it is established
- From the moment of its establishment, it provides visible increases in its corporate income.

1.5. Key Benefits

- Applications such as road constructions, green area regulations, cleaning works can be processed into map environment.
- It is possible to plan social assistance packages and follow them on a map basis.
- The work done by the zabita unit can be monitored on the system.
- The work done by the fire department can be monitored in the map environment.
- Unspecified properties can be monitored.
- Highest Money collectin neighborhoods, streets where the most debt is accrued can be reported, visualized on the map.
- Colored maps of neighborhoods can be created according to investment amounts.
- Illegal water consumption can be calculated and displayed on the map. Buildings which are borrowed from water bill can be colored on the map,
- Trouble situations and completed work can be processed into map environment.
- Parcels / buildings that do not have a license can be colored.
- Property information system can be established.

Example:

Netcad Netgis service's entry into OCG standards,

```
<GetInfoEx version="2.0">
      <GetInfo>
            <SRID/>
            <!--Hedef Projeksiyonu (SRID) -->
            <Proj/>
            <!-- Hedef Projeksiyonu (WKT) -->
            <Clockwise>False</Clockwise>
            <CountOnly/>
            <FAD>TABLE_NAME</FAD>
            <Filter xmlns:gml="http://www.opengis.net/gml">
                  <And>
                        <PropertyIsLessThan>
                              <PropertyName>AREA</PropertyName>
                              <Literal>100000</Literal>
                        </PropertyIsLessThan>
                        <PropertyIsBetween>
                              <PropertyName>TOTALPOPULATION</PropertyName>
                              <LowerBoundary>
                                    <Literal>2000</Literal>
                              </LowerBoundary>
                              <UpperBoundary>
                                    <Literal>6000</Literal>
                              </UpperBoundary>
                        </PropertyIsBetween>
                  </And>
            </Filter>
      </GetInfo>
</GetInfoEx>
```

References

http://portal.netcad.com.tr/display/HELP/KEOS.MISGIS_ILERI
http://portal.netcad.com.tr/display/NCDN/NETGIS+Server+Web+Servisleri
http://portal.netcad.com.tr/display/NCDN/NETGIS+SERVER+Harita+Istemcisi+API%27si

Turkish Topographic Vector Database (TOPOVT) Real Time Updating System

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Abstract

Turkish Topographic Vector Database (TOPOVT) is a 3D vector database comprising 1:25.000 scale or higher resolution topographic features, contours representing the topography and geographic names. TOPOVT is the basic geographic data source for our country mapping and base for GIS applications. Feature collection stage of TOPOVT will soon be completed by covering whole Turkey. The updating works have already begun and will go on with an acceleration in 2018. Real time or near real time updating of continuously changing geographic features in our country as far as possible and avoiding the duplicate geographic data production by governmental institutions are the main objectives of General Command of Mapping which is the biggest geographic data producer in basic scales in Turkey.

TOPOVT Real Time Updating System was designed to provide all governmental institutions and municipalities producing and using geographic information via internet to update and easily access to TOPOVT. Most of the TOPOVT features are acquired by governmental institutions and municipalities according to their needs. TOPOVT Real Time Updating System is realized to avoid duplicate geographic data production countrywide and reflect the changes in topography to TOPOVT in real time or near real time. The software component of the system consists of desktop and android (or tablets) applications. The desktop application will enable governmental institutions and municipalities to update TOPOVT in their service areas according to their job definition without needing another software thus providing the TOPOVT users to make use of the up-to-date data. Android (tablet) application will provide the field geographic data collectors to access TOPOVT directly and to update the data in real time or in near real time unless 3G internet is available.

By this system, all the governmental institutions needing topographic database for their applications will easily reach TOPOVT, make use of the data in their field works and present the data they produced to country use. Also, by avoiding the duplicate geographic data production, national sources will be utilized economically and effectively.

Keywords

TOPOVT, Real Time Updating, Topographic Feature, Vector Database

1. Introduction

General Command of Mapping is responsible for the production of maps for defense and development purposes and provide geographic data to governmental institutions according to the regulations. In order to realize this responsibility effectively, Turkish Topographic Vector Database (TOPOVT) was established with a model representing the real world continuously with vector data without file base. TOPOVT is the topographic vector database in which the 1:25.000 scale topographic data produced by General Command of Mapping are stored and presented and also standard topographic printed maps are produced.

The vector data in TOPOVT is acquired mainly from stereo aerial photos by digital photogrammetric workstations and then completed in the field by checking the compiled data, correcting the mistakes and collecting the attributes of the features and also the geographic names. After field completion the data are post-processed, topologic rules are controlled and then uploaded to TOPOVT (Yüksel et al. 2013)

At the design stage of TOPOVT, all collected features in classical map production are investigated for their integrity, collection rules and topologic relations. New topographic feature classes and subtypes are determined by making use of VMAP (Vector Map) data model. The attributes and attribute values of these features are also determined; UML (Unified Modelling Language) diagrams are designed showing the topographic features, attributes, lower bounds, attribute values and transformation tables (Canıberk et al. 2014).

2. Problem Definition

The data need for the applications in which the spatial analyses are carried out are not met by a single producer. These applications need attribute information together with spatial information. The variety of these attributes directly influence the results of the application. The countrywide database are needed for the fulfilment of the requirement to the spatial data and attributes produced by different institutions in order to execute the mentioned applications. The different institutions or sides have to cooperate effectively to share the data they collected for establishing and sustaining these databases.

Today, the spatial information is the base for every kind of planning work. For this reason, the most important factor in healthy decision making is the working on accurate and up-to-date geographic data in planning works. The applicability of the planning is related to the availability and up-to-dateness of the data (Önder, 2000).

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Different application fields, such as earth sciences, natural resource management, environmental protection, urban and regional planning, defense, transport, tourism, statistics and education need geographic data, because they require regional or countrywide analyses. Spatial data are generally related to resolution/scale and they have to be analyzed and presented with the resolution/scale that modelled phenomenon and processes were the best understood (Weibel and Dutton, 1999; Başaraner and Selçuk, 2004). In this context, TOPOVT is trying to fulfill the users' spatial data needs according to resolution, scale and up-to-dateness; it also assumes a role in effective use of national sources and avoiding duplicate productions.

Although it assumed that keeping the national spatial databases up-to-date is the responsibility of national mapping institutions, it is also the responsibility of the partners who need and produce spatial data. The updating process is mainly carried out by photogrammetric compilation and field works. Hanson and Wolff (2010) are defined these solutions as time consuming and expensive; thus failing to respond effectively to update requests. Müller and Heipke (2009) have achieved a 65.5% success rate in the method they developed for the semi-automated updating and control of large-scale databases using aerial photos at 10 cm resolution. However, it can be foreseen that it will be difficult to implement it on a country basis because the method they apply will lead to keeping the institutional database updated with only institutional capabilities.

Coumans (2016) is stated in her article that Ordnance Survey Ireland (OSi) was designed a topographic database that 1:1,000,000 cartographic products could be produced from 1:1,000 topographic database in an automated workflow. OSi geared to present real features to the users by combining the efforts to collect data in different scales. OSi has combined efforts to produce spatial data by avoiding duplicate works on different scales.

Moore (2013) pointed out that U.S. Geological Survey's (USGS) national 7.5-minute topographic map series was completed in 2000. He asserted that one sheet of map would cost more than $50,000 per map (in 2007 dollars) and would take 45 years to complete the series in traditional method. By using the available different resolution and different accuracy level GIS sources countrywide, USGS achieved three years updating cycle and cheaper production expenses than the original topographic maps by at least a factor of 100.

A newly emerging paradigm, namely volunteered GIS (VIG) is effecting the geographic information collection phenomenon. This kind of geographic information is derived from ordinary volunteered people, in a sense it is crowdsourced. VIG is executed via web applications or mobile phone applications. One of the most successful VGI application is OpenStreetMap (OSM). OSM produced data in some places are claimed to be more accurate and detailed than the officially produced maps of that place. By the help of the volunteers, the geographic information is collected or updated immediately in urgent circumstances (Fast and Rinner, 2014).

USGS also seeks volunteers to contribute The National Map (TNM). They call the volunteers as The National Map Corps (TNMCorps). In this project USGS urges from TNMCorps to update existing data and collect non existing data. Especially, the volunteers are requested to give the location of community buildings like schools, hospitals, fire stations etc. USGS informs its volunteers that TNM data collected by VIG yields accurate and up-to-date information to the citizens (USGS, 2013).

The tendency in geospatial data production is towards avoiding multi-production efforts on the same location as it is seen in the above mentioned production examples. While the countries are seeking the ways to reduce the geospatial data production expenses, they are also trying to save labor and time. As a result of these efforts, they manage to produce more up-to-date geospatial data on broader areas of interest. Consequently, General Command of Mapping, the national mapping agency of Turkey, initiated a project to unite all geospatial data production efforts so as to allow all governmental institutions to share and to contribute Turkey's geospatial data.

3. Real Time Updating System Design

It is also an important and ambitious work to live as long as the creation of the spatial databases (Cömert et al., 2009). The necessity of digital geographical information is in the tendency to increase continuously; by reviewing the digital geographical data produced, the data model used in production needs to be updated according to user needs and the design of geographic databases in accordance with this data model is required. TOPOVT is a structure that can respond to user needs in this context.

With the establishment of TOPOVT; the ability of geographic data production to adapt to the efficiency and technological developments in the map production system has increased. Geographical data users are provided with the necessary data infrastructure for online geographic data support. Although the definition of the rules for the analysis, design phases and the loading of the database is very important as of the near future, nowadays it is left to update the database. From this perspective, the real-time database update system will take an important step toward reaching institutional targets (Canıberk et al., 2015).

TOPOVT Real Time Updating System was designed to provide all governmental institutions and municipalities producing and using geographic information via internet to update and easily access to TOPOVT which is the basic data source of geographical map and topographic map production, which is the basis for GIS applications.

3.1. Web Platform Updating System

The real-time topographic database update system requires the selection of data to be published, the identification of users and groups, and authorization procedures. After this process, the users will be able to connect from different platforms and perform add-delete-update operations.

The system consists of data management and data transfer, topographic data entry and editing, layer drawing and attribute information entry, mapping, authorization and service integration layers. An example from the system interface is presented in Figure 1-2.

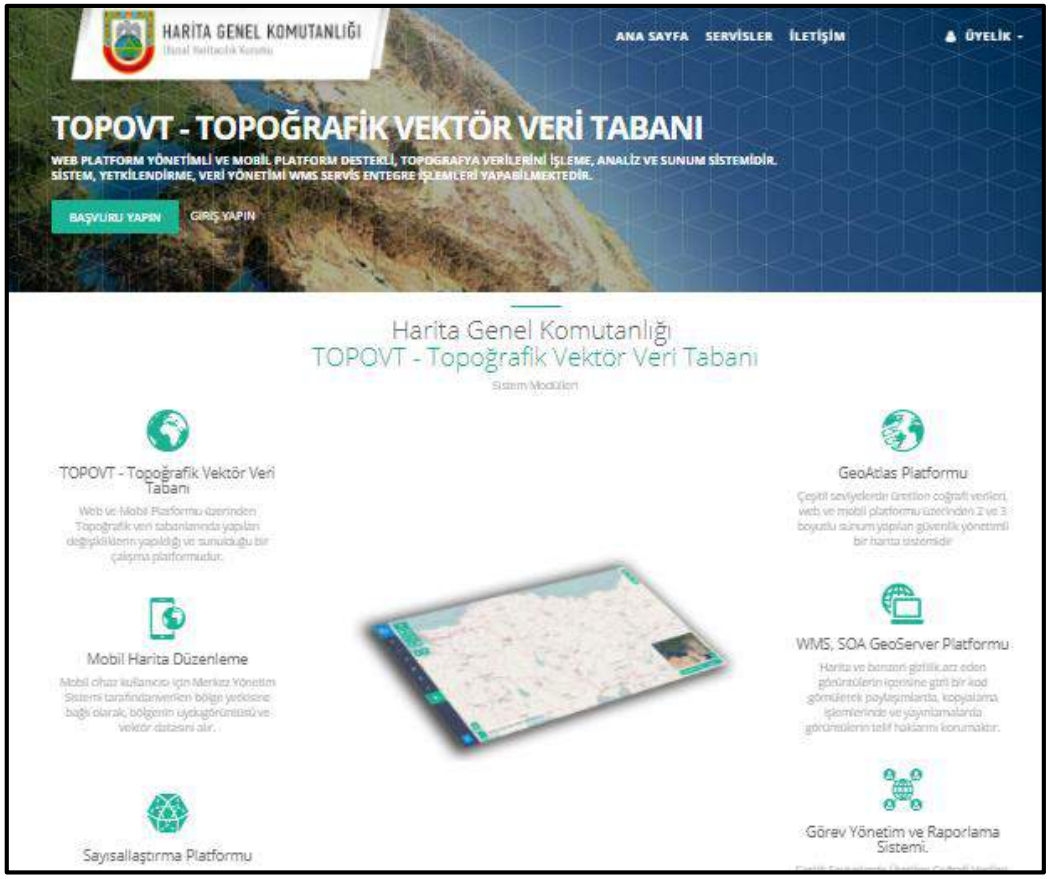
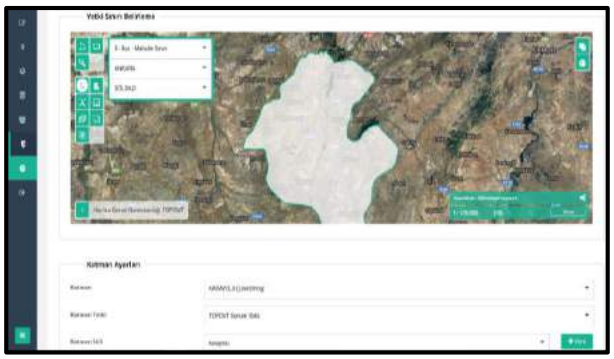


Figure1: Main screen display of the system

Figure 2: System user login screen

By accessing this web-based application through any browser; time management, tracking, and reporting can be done according to layer and attribute information, vector can be displayed with given symbols, digital elevation models and WMS services can be displayed. Figure 3 shows the region-based authorization and Figure 4 shows the images related to the attribute-based authorization.



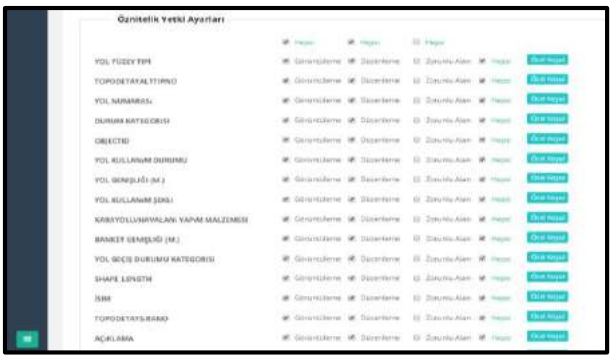


Figure 3: Zone-based authorization *Figure 4: Attribute-based authorization*

All map submissions can be managed via a single platform with internal and external services. Vector data can be viewed and managed from web platforms on map layers; can be reported by hundreds of users within the authorities granted at the same time from the databases. In addition, the change of history-based topography can be observed. In addition, services such as WMS, WFS, WCS can be added dynamically and can be presented based on authority (Figure 5).

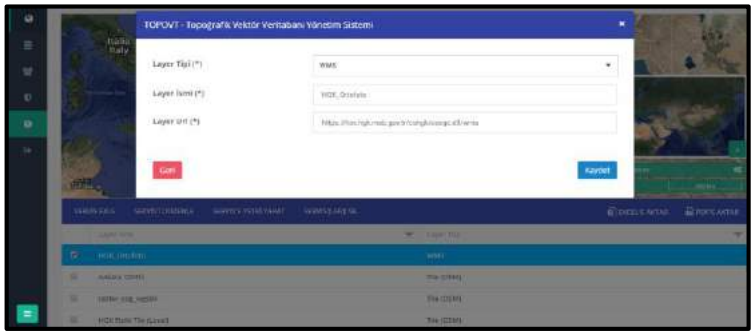


Figure 5: Service addition and authorization

System administrator provide public authorities and all other stakeholders to perform updating, addition, deletion and correction operations on the authorized area by performing authorization on the basis of layer, region, province, district, village, neighborhood and attribute and. The vector processing required to update TOPOVT from existing geographical data is executed fast, secure and data integrity ensured. To this end, tools that work in the internet interface and that can perform many basic geographic operations (cutting, cropping, merging, reshaping, etc.) are integrated into the system. Figure 6 shows the application of the system-integrated geographic editing tools.

Figure 6: Geo-editing tools application

3.2. Mobile (Android) Platform Updating System

A mobile platform update system is designed for users to access TOPOVT data with tablet computers in the field (Figure 7). The system is managed by Mobile Device Management System (MDM) and can be linked to the TOPOVT update infrastructure. The user access authority to the system is determined by MDM and can work integrated with the real time updating system. Tablets can be controlled remotely via the management console, messages can be sent to the tablet via the management console, such as resetting the system, turning GNSS on/off, locking the device. This ensures that both the tablet and the data in the tablet are safe. At the same time, the data downloaded to the disks of the tablets are protected by encryption algorithms, preventing unauthorized access to the data.

Figure 7: Tablet PC and external GNSS receiver

Software running on the Android platform can access TOPOVT data, just like the software running on the browser, and perform add-delete-update operations within the authorities. Users can work in real time as well as download the data at the same time as the internet connection and send them to TOPOVT at the end of their work and they will be able to work in near real time.

Users see only the mobile update software on their tablets and cannot access any other settings and cannot run any programs. Separately authorized users for each tablet are directed to the main screen in Figure 8 to log in to their tablets and the main application screen (Figure 9) is displayed with successful user input.

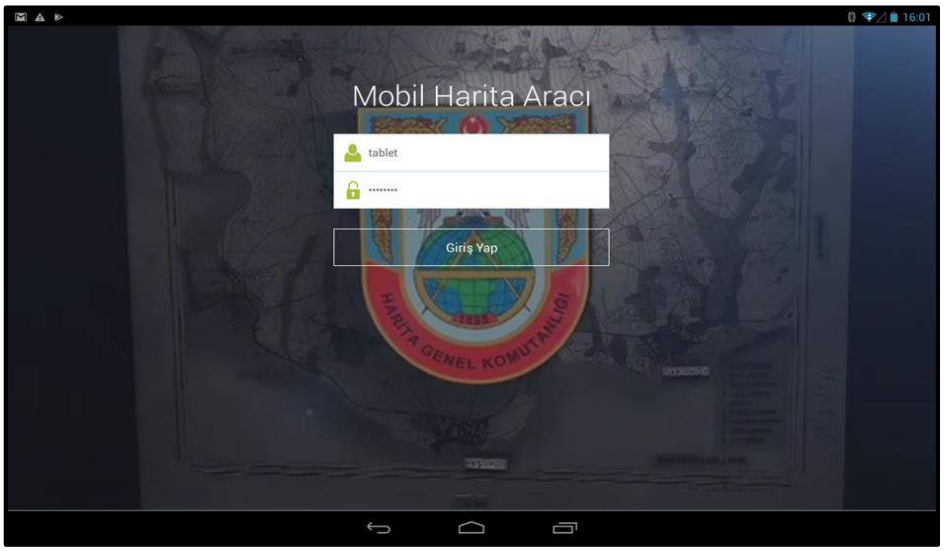


Figure 8: Mobile application user login Mobil

The main screen consists of four sections. These sections are; Settings Bar (1), Transaction Menu (2), Tools Menu (3), Map Module (4). All functions in these sections are active according to the user's authority.

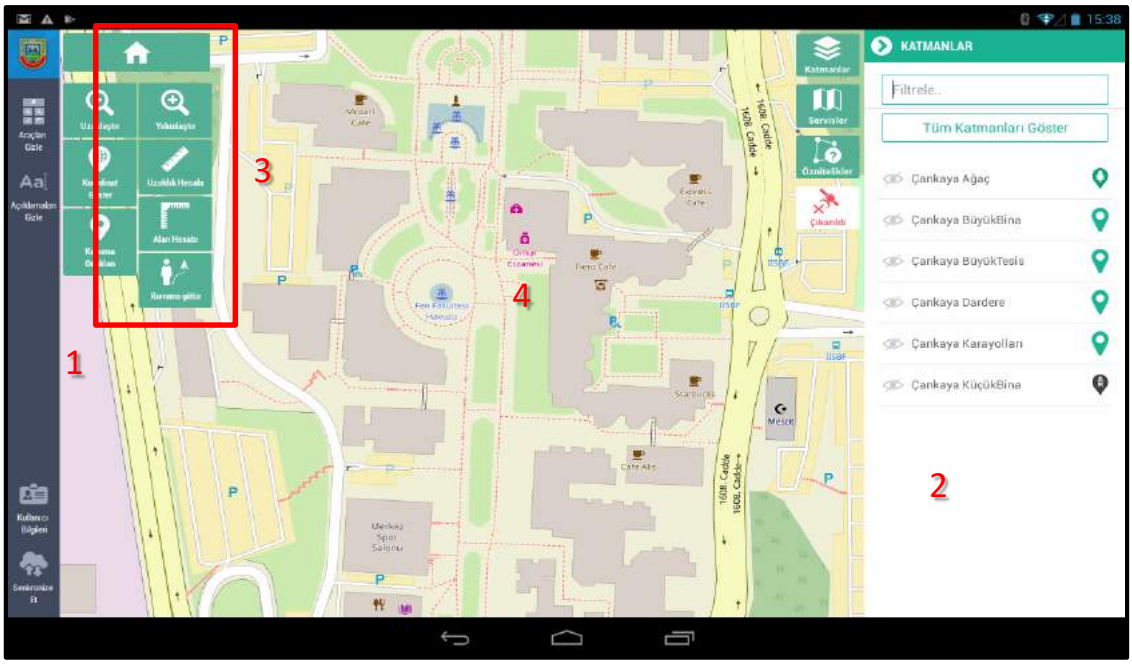


Figure 9: Mobile application main screen

Mobile application vector contains many tools for data editing. These tools allow the user to edit on the existing geometry on the selected layer. The user can use these tools within his/her authority. Editing tools become active after feature(s) are selected. Single feature editing when a geometry is selected, multiple feature editing tools when multiple geometries are selected. The system has merge, clip, intersect, union, snap from node to node, split functions which are the basic geographic information system functions that facilitate data collection in the user interface (Figure 10).

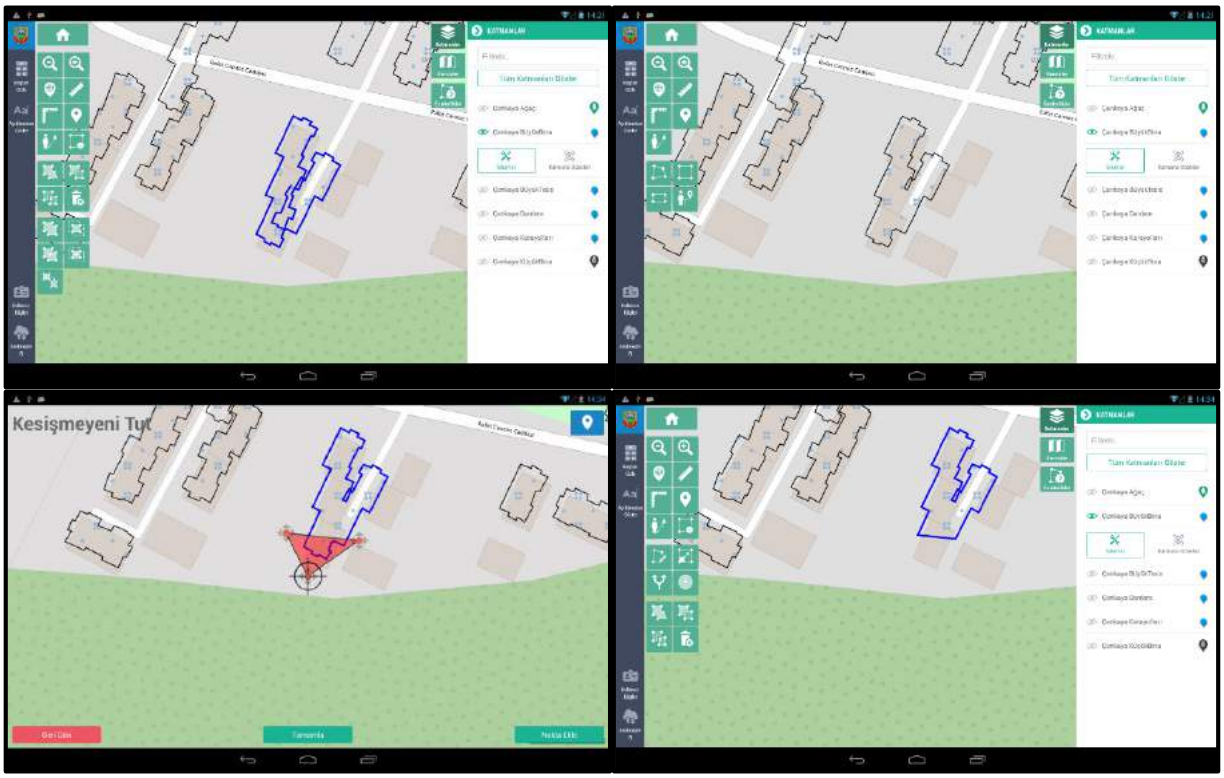


Figure 10: Geometry editing tools

An external GNSS receiver can be plugged into tablets from the micro usb port and thus ensures feature collection at ±3 m spatial accuracy. The tablet application can detect the installed GNSS receiver and work with the external receiver. After connecting the receiver, all the information (satellite number, geometry etc.) from the receiver can be displayed. A new point or vertex can be added with the GNSS receiver, and existing geometries can be arranged according to GNSS coordinates (Figure 11).

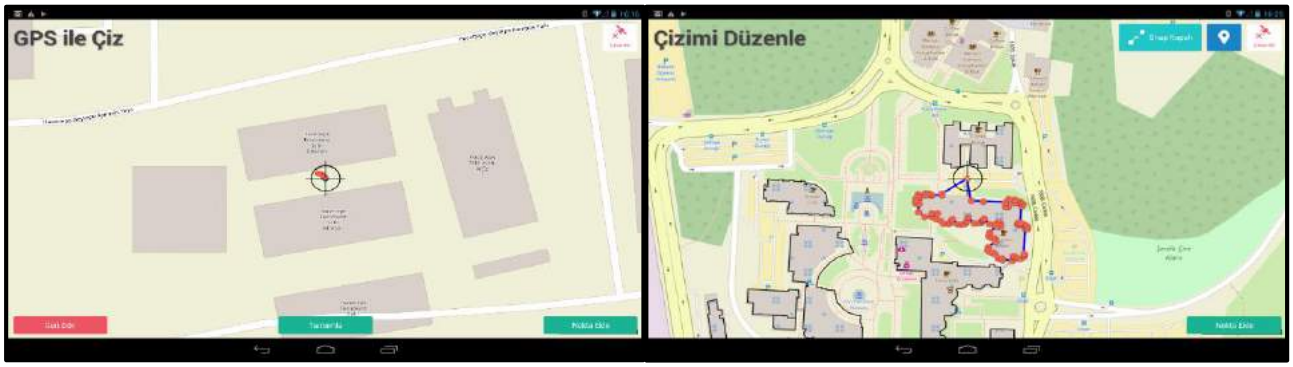


Figure11: Edit drawing and geometry with GNSS

4. Results and Discussion

TOPOVT is a database in which 1: 25.000 scale topographical data produced by the General Command of Mapping is held and presented, and at the same time standard topographic map production is performed which is one of the most important tasks of the institution.

Rapid development is observed in our country especially in urban areas. As a result of this development, when the newly created, changed or lost features are transferred to the database in short time intervals, the will of the users who need the up-to-date database will be met. For this reason, the establishment of a real-time updating system is important.

The developed system will provide public institutions and organizations and municipalities direct access to TOPOVT, and will facilitate data sharing among institutions. Thus, institutions will contribute to the updating of TOPOVT in line with their needs, and repetitive productions between institutions will cease to exist. With the real-time updating system, data can be updated at the same time by splitting large areas, integration of data produced or possessed by public institutions and organizations producing topographical data can be provided and all updates can be instantly controlled from a single center, TOPOVT.

With TOPOVT Real Time Updating System;

- The duplicate geographical data collections of institutions will be avoided,
- The geographical data will be kept up-to-date with labor and time saved from duplicate transactions,
- Emergency geographic data needs will be met shortly as there will be no bureaucratic procedures,
- Full and correct geographical data will be used and shared since missing and errors are reported and corrected by the related institution.

Thus, TOPOVT can be updated with the geographical data produced by the public institutions and organizations and the municipalities. In addition, data collection can be carried out between the institutions by collecting detailed geographical features similar to TOPOVT and making necessary changes in feature definitions and attributes to prevent duplication. Organizations will be able to contribute to the correctness and completeness of TOPVT by noting errors and omissions.

For further applications, some improvements can be made in the TOPOVT Real Time Updating System to allow VIG to Turkish citizens in order to contribute their observations to a TOPOVT condensed version by their mobile phones. The volunteers can especially be requested to give location and name of the community buildings so as to present up-to-date and accurate information to other citizens.

References

Başaraner M. and Selçuk M., (2004), *An Attempt to Automated Generalization of Buildings and Settlement Areas in Topographic Maps*, Proceedings of XXth ISPRS Congress, 12-23 July 2004, Istanbul, Turkey.

Canıberk M., Yüksel B., Saygılı A., Okul A., Yılmaz A., Çekin M., Çabuk S., (2015), *Gerçek Zamanlı Topoğrafik Vektör Veri Güncelleme Sistemi Tasarımı ve Uygulaması*, TUFUAB VIII. Teknik Sempozyumu, Konya

Canıberk M., Okul A., Saygılı A., Yüksel B., (2014) *Topoğrafik Verilerin Hazırlanması ve Sunumu*, Harita Dergisi, Sayı 151, 33-38 ISSN:1300-5790

Coumans F., (2016) *PART 1: Cartographic Orchestration: Ordnance Survey Ireland Shows New Perspectives*, GIM International, https://www.gim-international.com/content/article/ordnance-survey-ireland-shows-new-perspectives, Accessed on October 29, 2017.

Cömert Ç., Ulutaş D., Akıncı H., Kara G., (2009), *Ulusal Konumsal Veri Altyapılarının Gerçekleştirimi için Semantik Web Servisleri*, TMMOB Coğrafi Bilgi Sistemleri Kongresi.

Fast V. and Rinner C., (2014), *A Systems Perspective on Volunteered Geographic Information*, ISPRS Int. J. Geo-Inf. 2014, 3, 1278-1292; doi:10.3390/ijgi3041278.

Hanson E. and Wolff E., (2010), *Change Detection For Update Of Topographic Databases Through Multi-Level Region-Based Classification Of Vhr Optical And Sar Data*, GEOBIA 2010: Geograpich Object-Based Image Analysis, Ghent, Belgium

Moore L., (2013), *US Topo - US Topo — A New National Map Series*, https://www.directionsmag.com/article/2000, Accessed on October 29, 2017.

Müller S. and Heipke C., (2009), *Object-Based Verification and Update of a Large-scale Topographic Database*, IntArcPhRS (38), Part:1-4-7/WS, Hannover, 6.S, ISPRS Commission IV, WG IV/2

Önder M. (2000), *Coğrafi Bilgi Sistemlerinde ve Uzaktan Algılama*, Hacettepe Üniversitesi Matbaası, Ankara

USGS, (2013), *USGS Needs YOU! Help Our National Mapping Efforts By Adding Your Community's Landmarks and Buildings*, https://www2.usgs.gov/blogs/features/usgs_top_story/usgs-needs-you-help-our-national-mapping-efforts-by-adding-your-communitys-landmarks-and-buildings/ , Accessed on October 29, 2017.

Weibel R. and Dutton, G., (1998), *Constraints-based Automated Map Generalization*, In: Proceedings of 8th International Symposium on Spatial Data Handling (SDH'98), Vancouver, 214-224.

Yüksel B., Saygılı A., Okul A., (2013), *HGK 1:25.000 Ölçekli Topoğrafik Veritabanı*, TMMOB Harita ve Kadastro Mühendisleri Odası 14. Türkiye Harita Bilimsel ve Teknik Kurultayı, 14-17 Mayıs 2013, Ankara

Potential of Spatial Semantics for Developing Multi-Representation Spatial Databases

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Abstract

A multi-representation spatial database (MRSDB) integrates various spatial databases or datasets at different levels of detail (heterogeneous in terms of scale/resolution and/or theme) in order to create a more sophisticated environment for multi-purpose geographic data and map production as well as multi-level spatial analysis and visualization. Spatial semantics generally focus on understanding the meaning of spatial entities as well as their counterparts in the cognitive and digital world, and can facilitate the design of more sophisticated spatial databases and geographic information systems by eliminating the existing heterogeneity problem, enhancing the interoperability of distributed systems and developing intelligent interfaces for user interactions. In this context, semantic interoperability, ontologies, spatial semantic web and linked data are hot topics for researchers. This study focuses on potential use of the techniques and technologies in the field of (geo)spatial semantics for developing MRSDBs.

Keywords

Spatial Semantics, Multi-Representation Spatial Databases, Semantic Interoperability, Spatial Ontologies, Linked Spatial Data, Spatial Semantic Web

1. Introduction

Today, large amounts of spatial datasets exist that come from multiple sources. In these datasets, the same real-world object may have been defined in different forms, semantically, geometrically and/or graphically, since they are produced at different levels of detail for various applications (Friis-Christensen et al. 2005; Basaraner 2012). For instance, a building that is represented as a polygon feature or a map symbol on a large-scale map/dataset can be represented as a point feature on a smaller scale map/dataset. Linking these heterogeneous data and make them machine-understandable for automatic processing and reasoning has a great potential for generating new knowledge from linked data sources (Hahmann and Burghardt 2010). In this context, when used in conjunction with semantic Web technologies, the multi-representation spatial database (MRSDB) approach, which includes geographic and cartographic databases as well as topographic and thematic databases as the more specialized types, thus covering the concepts of semantic, geometric and graphical resolution, can be used for analysis and visualization at multiple levels of detail and, if necessary, for automatic transfer of updates to other levels of detail. Automatic updates between levels of detail is also important for ensuring consistency between datasets of different resolution (Wang and Meng 2009). This study focuses on potential use of the techniques and technologies in the field of (geo)spatial semantics for developing MRSDBs.

The paper organized as follows. Section 2 describes multi-representation spatial databases. Section 3 introduces semantic Web technologies within the context of geospatial world. Section 4 describes geographic (geo-) ontologies. Finally, section 5 presents discussion and concludes the paper.

2. Multi-Representation Spatial Databases (MRSDBs)

A MRSDB integrates various spatial databases or datasets at different levels of detail (heterogeneous in terms of scale/resolution and/or theme) in order to create a more sophisticated environment for multi-purpose geographic data and map production as well as multi-level spatial analysis and visualization. From a broader perspective, it can include interconnected topographic and thematic geographic and cartographic databases/datasets at different levels of detail. This kind of structuring makes it easy and cost effective to maintain these databases or datasets, consistently integrate data from variety of sources, and increase the efficiency of applications in various areas (Basaraner 2012). Various institutions have responsibility to establish and maintain their databases for specific requirements in terms of different level of detail, precision or resolution. Typically, there is a reference scale, probably the most detailed one that changes occur in that level of detail. Databases at coarser scales need to be updated according to the reference scale. This can lead to inconsistency problems among data if the linkage between reference and target scales is missing (Friis-Christensen et al. 2005). With a MRSDB, these inconsistency problems can be solved and effort for updating data can be reduced. However, MRSDB approaches have not become widespread yet and most approaches are tool-dependent (Annoni et al. 2008).

One of approaches proposed for creating a MRSDB is the VUEL approach. The author defines VUEL as “a unique combination of a visible element (geometry and graphic symbols) with a particular semantics”. Thus, VUEL (e.g. house) is not the semantic object itself, but something we can see on a representation (e.g. a striped blue polygon with house attributes) (Bedard and Bernier 2002). The other approach, the stamping technique, takes multi-representations from two

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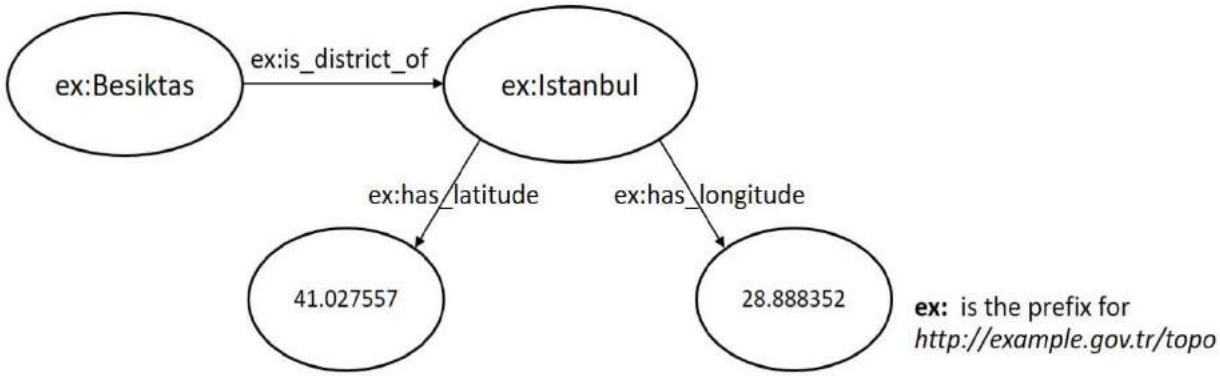
perspectives as point of view and resolution. It consists of a pair of stamps (point of view, resolution). These stamps characterize different representations of real-world objects (Vangenot et al. 2002). Benslimane et al. (2003) took the stamping technique one step further and merged the stamping technique with the description logic (DL) to create a DL-based ontology language for multi-representation.

3. Semantic Web Technologies

The semantic Web concept, which is frequently used with ontologies today, was first introduced in 2001 by Tim Berners-Lee, founder of the Internet (Berners-Lee et al. 2001). Semantic Web is defined as "an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation". In this context, the semantic Web, initially prepared for human consumption, aims to make the World Wide Web understandable not only for humans but also for machines (Lassila and Swick 1999). Semantic technologies (like ontology) that basically contain logic systems (First Order Logic, Description Logic etc.) emerge as a promising approach to allow reasoning from big data that have recently entered our lives (Sikos 2015).

The most basic technology for the semantic Web is the Resource Description Framework (RDF) concept (Beckett and McBride 2004). With RDF, data providers can deliver data with their meaning as an interoperable way to work with other semantic systems on the Web. RDFs become linked data when they are presented over the Web in the context of certain rules and associated with other data (Hahmann and Burghardt 2010). The RDF structure is presented as subject-predicate-object in the form of triples (Figure 1). For example, when saying "Besiktas is the district of Istanbul", "Besiktas" is the subject, "Istanbul" is the object, and "district" is the predicate expressing the relation between the subject and the object. By combining similar RDF definitions and associating RDFs with each other, dictionaries can be created at various levels and domains. The machines can infer meaningful information from the data defined in this way. For instance, in addition to the above example, if "Dolmabahce Palace is located in Besiktas" is defined by using semantic technologies, then the inference that "Dolmabahce Palace is located in Istanbul" can be done automatically by the machines. In the case that all data in the web, which is generally as documents designed for understanding of humans, can be understood by the machines, the semantic web can achieve its intended purpose. In this context, initiatives such as Linked Open Data Cloud, which aim to provide a relation between all the linked data in the Web, serve Berners-Lee's semantic Web vision (Hu and Janowicz 2016). The LinkedGeoData initiative, which transforms OpenStreetMap data to the RDF knowledge base within linked data rules and links this data to other knowledge bases such as DBpedia and Geo Names, contributes to the geospatial part of the semantic Web (Auer et al. 2009).



Subject	Predicate	Object
http://example.gov.tr/topo/Besiktas	http://example.gov.tr/topo/is_district_of	ex:Istanbul
http://example.gov.tr/topo/Istanbul	http://example.gov.tr/topo/has_latitude	41.027557
http://example.gov.tr/topo/Istanbul	http://example.gov.tr/topo/has_longitude	28.888352

Figure 1. The RDF structure in the form of triples

Based on RDF technology, Web Ontology Language (OWL), which formally proposed by the World Wide Web Consortium (W3C) in 2004, is frequently used in the current semantic Web environment (McGuinness and van Harmelen 2004). Roughly, it is a form of language that concepts such as classes, properties, and individuals are defined (Figure 2). OWL uses Description Logic and with OWL it is possible to define more advanced class relations than RDF. The SPARQL standard, which is also proposed by the W3C, is used to query and process the information contained in the semantic Web (Prud'hommeaux and Seaborne 2008). Since SPARQL does not directly support spatial queries,

GeoSPARQL standard, which has been developed as an extension to the SPARQL standard by the Open Geospatial Consortium (OGC), support spatial queries and operations (Perry and Herring 2012).

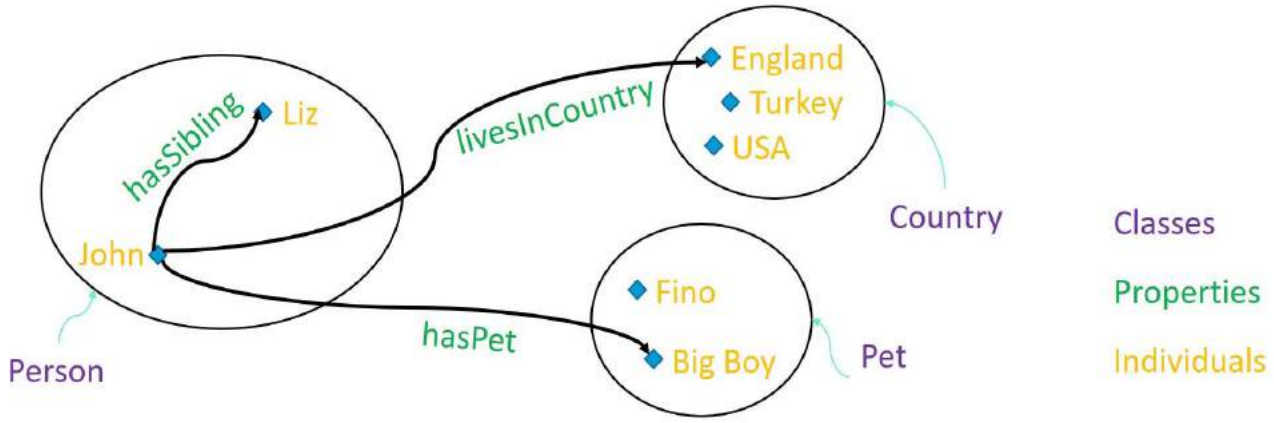


Figure 2. Classes, Properties and Individuals of OWL (reproduced from Horridge and Brandt 2013)

4. MRSDB and Semantic Web

In the geographic community, same real-world object can be represented in different forms according to different point of views. Multiplicity in definitions of the entities leads to semantic heterogeneity. Therefore, the integration of geographic information and the fusion of spatial data from multiple sources is still a challenge (Yi 2013). In this context, one of the most important step to ensure spatial semantic interoperability and the integration of data from various sources is to create ontology (Kieler 2008; Hu 2017). Simply, ontology is the conceptualization and modelling of classes, entities, and relations of a specific domain with the help of logic systems. The ontologies are generally divided into three groups; high-level (global) ontologies, domain ontologies and application ontologies. Hart and Dolbear (2013) have added micro-ontologies to this group which is at the bottom level. Recently, Ontology Design Pattern approach, which is special design steps for various applications, is also used as application ontologies (Carral et al. 2013; Hu 2017). Sinha et al. (2014) describe ontology design patterns as small ontologies which are capturing essential and reusable characteristics of a specific domain. In addition, they remark that domain experts and ontology engineers need to collaborate to reveal a design pattern. The ontology that provides the conceptualization of the application domain and the knowledge representation provides a potential and support for the integration of heterogeneous information coming from multiple sources and the matching of entities (Rodríguez and Egenhofer 2003; Stoter et al. 2006). In order to create an ontology, generally first step is to build a taxonomy. Since taxonomy can be considered as science of classification, it is an important part of the process of creating geo-ontologies. Consequently, National Mapping Agencies (NMAs) like United States Geological Survey (USGS) and Ordnance Survey (OS) have created taxonomies for their spatial data to create linked data applications based on ontologies (Varanka 2009). Development of geo-ontologies is substantial for sharing and integrating geographic data among different users. A geo-ontology has to consist not only semantic relations such as synonymy, similarity, mereonomy and hyponymy, but also spatial relations such as adjacency, spatial containment and connectedness (Fonseca and Camara, 2009).

Hahmann and Burghardt (2010) reveal similarities and differences between the linked data and MRSDBs. Both linked data and MRSDB contain different views of the same real-world object and both allow geometry-driven feature matching. Major difference between them occur in focus. While MRSDBs focus on different geometric and semantic abstraction level, linked data focus on different representation of same real-world object. The purpose of linked data is not often to produce high quality and effective maps like MRSDB, but access to various information in the Web.

Looking at the Infrastructure for spatial information in Europe (INSPIRE), it can be seen that one of its purposes is to solve the inconsistencies in multi-lingual and cross-border issues. Multilinguality is one of the most important factors that make data harmonization difficult (Annoni et al. 2008). One of the solutions is to keep geographical information through ontologies and to provide integration by matching ontologies. In the geographic domain, ontology matching is a process of integration heterogeneous geospatial data which considered semantically similar (Figure 3). Besides, ontology integration is a crucial issue for reuse and share information among different communities and to create knowledge base about a domain (Kavouras and Kokla 2007). For instance, land use classification systems from Austrian Realraumanalyse (left) and the European CORINE can be seen in Figure 4. Based on similarities between these two systems either automatic or manual ontology matching approaches can be a potential solution for integration geospatial data. Similarly, national geographic data infrastructures can be integrated by the use of semantic matching approaches independently from languages and borders (Ulutaş et al. 2016).

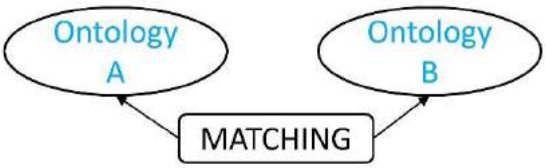


Figure 3. Ontology matching

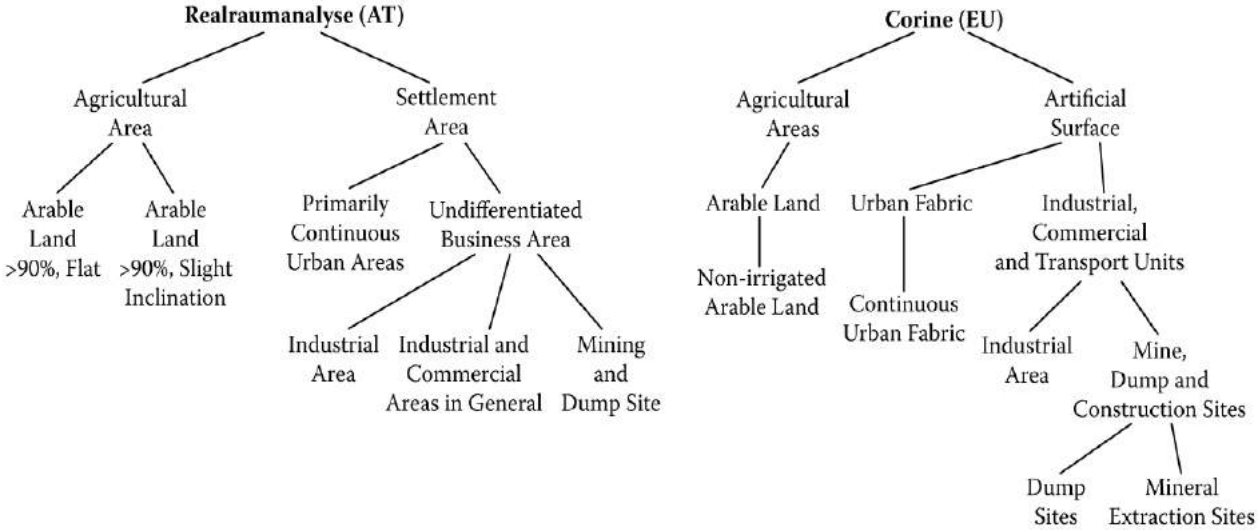


*Figure 4. Land use classification systems of the Austrian Realraumanalyse (left) and the European CORINE (*Annoni et al. 2008*)*

5. Conclusions

In this study, multi-representation databases and spatial semantic web technologies are examined and the approaches used for overcoming various heterogeneity problems (in terms of scale/resolution, theme or language) are presented. Multiple taxonomies for the same real-world objects can be defined by considering the application requirements and purpose to overcome the heterogeneity problems that originate from data sources and/or feature representations at different levels of detail. Taxonomies are the first step in creating ontologies, and ontologies are the basis of the semantic Web approach. With such an approach, a MRSDB can be created by means of multiple ontologies; feature representations at different levels of detail can be performed, the inconsistencies in the data between different levels of detail can be checked and corrected, the semantic integration of various spatial data can be ensured and new knowledge inferences can be made (Tanasescu 2007; Varanka 2009; Basaraner 2013; Ulutaş et al. 2016; Hu 2017). The study has shown that MRSDBs and ontologies can be used in conjunction with stamping technique or a new approach similar to this technique. Future work will focus on a MRSDB that will be built with geospatial semantic technologies.

References

Annoni A., Friis-Christensen A., Lucchi R., Lutz M., (2008), *Requirements and challenges for building a European spatial information infrastructure: INSPIRE*, In Creating Spatial Information Infrastructures: Towards the Spatial Semantic Web, (van Oosterom P., Zlatanova S. Eds.), CRC Press, Boca Raton, Florida, USA, pp. 1-18

Auer S., Lehmann J., Hellmann S., (2009), *Linkedgeodata: Adding a spatial dimension to the web of data*, 8th International Semantic Web Conference (ISWC 2009), Washington, DC, USA, pp. 731-746.

Basaraner M., (2012), *An investigation of semantic, geometric and graphic heterogeneities of building and facility objects in a multi-resolution spatial database*, Proceedings of 4th International Conference on Cartography and GIS, Albena, Bulgaria.

Basaraner M., (2013), *Taxonomies of building objects towards topographic and thematic geo-ontologies*, 26th International Cartographic Conference, Dresden, Germany.

Beckett D., McBride B., (2004), *RDF/XML syntax specification (revised)*, W3C Recommendation, W3C Consortium.

Bedard Y., Bernier E., (2002), *Supporting multiple representations with spatial databases views management and the concept of VUEL*, ISPRS/ICA Joint Workshop on Multi-Scale Representations of Spatial Data, Ottawa, USA, pp. 1–14.

Berners-Lee T., Hendler J., Lassila O., (2001), *The semantic Web*, Scientific American, 284(5), 28–37.

Benslimane D., Vangenot C., Roussey C., Arara A., (2003), *Multirepresentation in ontologies*, Proceedings of Advances in Databases and Information Systems: 7th East European Conference (ADBIS 2003), (Kalinichenko L., Manthey R., Thalheim B., Wloka U., Eds.), Heidelberg:Springer-Verlag, Dresden, Germany.

Carral D., Scheider S., Janowicz K., Vardeman C., Krisnadhi A. A., Hitzler P., (2013), *An ontology design pattern for cartographic map scaling*, 10th International Conference Proceedings, The Semantic Web: Semantics and Big Data (ESWC 2013), (Cimiano P., Corcho O., Presutti V., Hollink L., Rudolph S., Eds.), Heidelberg:Springer-Verlag, Montpellier, France.

Friis-Christensen A., Jensen C. S., Nytun J. P., Skogan D., (2005), *A conceptual schema language for the management of multiple representations of geographic entities*, Transactions in GIS, 9(3), 345–380.

Fonseca F. T., Câmara G., (2009), *Geo-Ontologies*, In The GIS Manual (Madden M., Ed.), ASPRS, Bethesda, Maryland, USA.

Hahmann S., Burghardt D., (2010), *Linked Data - A multiple representation database at Web scale?*, 13th Workshop of the ICA commission on Generalisation and Multiple Representation, Zürich, Switzerland.

Hart G., Dolbear C., (2013), Linked Data: A Geographic Perspective, CRC Press, Boca Raton, Florida, USA, pp. 183-224.

Horridge M., Brandt S., (2011), *A practical guide to building OWL ontologies using Protégé 4 and CO-ODE tools, edition 1.3*, University of Manchester.

Hu Y., (2017), *Geospatial semantics*, In Comprehensive Geographic Information Systems, (Huang B., Ed.), Elsevier, Oxford, UK, pp. 80-94.

Hu Y., Janowicz K., (2016), *Enriching top-down geo-ontologies using bottom-up knowledge mined from linked data*, In Advancing Geographic Information Science: The Past and Next Twenty Years, (Onsrud H., Kuhn W., Eds.), GSDI Association Press, Needham, Massachusetts, USA, pp. 183-198

Kavouras M., Kokla M., (2007), Theories of Geographic Concepts: Ontological Approaches to Semantic Integration, CRC Press, Boca Raton, Florida, USA, pp. 193–219

Kieler B., (2008), *Semantic data integration across different scales: automatic learning generalization rules*, International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 37, 685–690.

Lassila O., Swick R. R., (1999), *Resource description framework (RDF) model and syntax specification*, W3C Recommendation, W3C Consortium.

McGuinness D. L., van Harmelen F., (2004), *OWL Web ontology language*, W3C Recommendation 10.2004-03.

Perry M., Herring J., (2012), *OGC GeoSPARQL-A geographic query language for RDF data*, OGC Implementation Standard.

Prud'hommeaux E., Seaborne A., (2008), *SPARQL query language for RDF*, W3C Recommendation, W3C Consortium.

Rodríguez M. A., Egenhofer M. J., (2003), *Determining semantic similarity among entity classes from different ontologies*, IEEE Transactions on Knowledge and Data Engineering, 15(2), 442–456.

Sikos L. F., (Ed.), (2015), *Mastering Structured Data on the Semantic Web*, Apress, New York, USA.

Sinha G., Mark D. M., Kolas D., Varanka D. E., Romero B. E., Feng C.-C., Usery E. L., Liebermann J., Sorokine A., (2014), *An ontology design pattern for surface water features*, Proceedings of Geographic Information Science: 8th International Conference (GIScience 2014), (Duckham M., Pebesma E., Stewart K., Frank A. U., Eds.), Springer International Publishing, Vienna, Autria, pp. 187–203.

Stoter J., Lemmens R., Kobben B., Bakker N. J., (2006), *Semantic data integration in a multiple representation environment*, ISPRS - Workshop on Multiple Representation and Interoperability of Spatial Data, Hannover, Germany, pp. 22–29

Tanasescu V., (2007), *Spatial semantics in difference spaces*, proceedings of the International Conference on Spatial Information Theory: Foundations of Geographic Information Science (COSIT), (Winter S., Duckham M., Kulik L., Kuipers B., Eds.), Heidelberg:Springer-Verlag, Berlin, Germany.

Ulutaş D., Kara G., Cömert Ç., (2016), *Semantic definition and matching for implementing national spatial data infrastructures*, Journal of Spatial Science, 61(2), 441–459.

Vangenot C., Parent C., Spaccapietra S., (2002), *Modelling and manipulating multiple representations of spatial data*, Advances in Spatial Data Handling: 10th International Symposium on Spatial Data Handling, (Richardson D. E., van Oosterom P., Eds.) Heidelberg:Springer-Verlag, Ottawa, Canada, pp. 81-93.

Varanka D. E., (2009), *A topographic feature taxonomy for a U.S. national topographic mapping ontology*, Proceedings of the 24th International Cartographic Conference - ICC 2009, Santiago, Chile.

Wang Y. H., Meng H., (2009), *Hierarchical ontology on multi-scale road model for cartographical application*, Proceedings - 2009 International Conference on Environmental Science and Information Application Technology (ESIAT 2009), Wuhan, China, pp. 330–333.

Yi S., (2013), *Learning ontologies for geographic entity matching and multi-sources data fusion*, 21st International Conference on Geoinformatics, Kaifeng, China, pp. 1–5.

Development of a Volunteered Geographical Information Mobile Application for the Management of Urban Affairs

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Abstract

Volunteered Geographical Information (VGI) was first put forward by Goodchild (2007) and became available throughout the world in a relatively short time associated with developing social media. VGI is a position-based genre of citizen science and has recently become a rapidly developing field in the field of data collection. Even though, it is an up-to-date and developing research area and many successful works have been carried out in the most of the developed countries, VGI is a very new field of research in Turkey and its applications are still limited. Therefore, within the context of this paper, the researches on VGI will be summarized and the stages of developing a social responsibility mobile application that will increase communication between the user-authoritative institution based on VGI will be explained. In this mobile application, users are all citizens. Authorized institution is municipalities, police directorates etc. Thanks to the this mobile application, users upload into the system by adding photos, location and description of urban problems, such as uncollected garbage, a wrong parked vehicle or a pit that can damage vehicles etc. This urban problem that is uploaded to the system is seen by the related institution and afterwards, the institution shares the information such as photos, description of work done to solve the problem in the system for the purpose of informing the users. Since this application is also an open social media mobile application at the same time, all users will see the sharing and feedbacks made.

Keywords

Volunteered Geographic Information (VGI), Mobile Application, Social Media, Citizen Science, Urban Affairs

1. Introduction

Volunteered Geographical Information (VGI) is a position-based genre of citizen science and has recently become a rapidly developing field in the field of data collection. Generally, the mean of VGI is summarized by Goodchild (2007), Sui (2008), Elwood et al. (2012), See et al. (2016) and other researchers as 'the digital spatial data which is collected and edited not by data producers but by citizens who are not experts but willing to disseminate their spatial knowledge and observations' without any special invitation (Seeger 2008). From 2004 onwards, thanks to developing technology, individuals can create their own digital geographical information using high quality and free online maps (Goodchild and Li 2012). Thus, VGI has recently been used in a variety of scientific fields and applications. Applications such as OpenStreetMap, Wikimapia, Tagzania, the People's Map and Platial or The People's Atlas are most known for volunteer geographic information applications. If we look at the Wikimapia example, an individual with an Internet connection can choose an area on the world and provide an explanation, including links to other resources. Then, everyone can arrange this clarification and the results are monitored by volunteer reviewers, checking the accuracy and the importance.

One of the collaborative phenomena among 21st century orientation approaches is social media (Banger and Calisir 2014). Social Media is the digital platform in which the most common explanation and the sharing of information captured by the new generation of web technologies and the speed of communication are followed. Examples of social media include Facebook, Twitter, Instagram, Youtube, Linkedin, Panoramio, Flickr, Jive, Telligent, Chatter, wikis and blogs. When these platforms are taken into consideration, it is not necessary to limit social media's present importance to chat or entertainment. These platforms allow individuals to share position-based information. With this feature, social media platforms have become a widely used tool for location-based data collection worldwide.

VGI is a current and developing research area in the most of the developed countries, but in Turkey, it is a very new field of research and its applications are still limited. Some researches on VGI and social media are presented below.

Poorazizi et al. (2015) present a VGI framework for disaster management. Individuals generate VGI by using location based devices and sharing geo-tagged information such as photos, videos through social media. The authors show that the VGI framework can make possible data acquisition for disaster management.

Spinsanti and Ostermann (2013) publish a paper about a system to extract, to process and to analyze information gathered from social media on forest fires events. The authors present the GeoCONAVI (Geographic CONtext Analysis for Volunteered Information) approach and a prototype system using social media based information.

Werts et al. (2012) aim is to develop an integrated WebGIS framework for VGI and social media in soil and water conservation. For this purpose, they want to develop a framework for combining current technologies and social media and develop and online web mapping interface. So, thanks to this study, it is developed an integrated framework for future use in soil and water conservation.

Gulnerman et al. (2017) present a GIS tool of public participant to improve the capacity at local level where time and spatial data integration for crisis management. Thus, the authors evaluated and tested the potential of VGI and Public Participatory Geographic Information System in a neighborhood of Istanbul.

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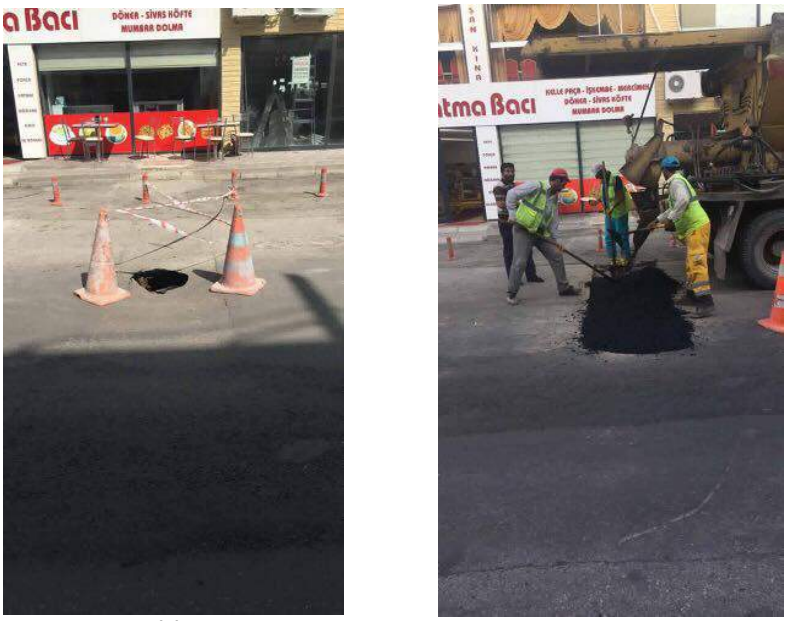
Gulnerman et al. (2016) publish a conference paper about a problem. Could they monitor or define the path of pedestrians and route of cars by using real time data within emergency period in Turkey. To do this, they aim to evaluate the social media data and spatial data to develop a VGI based on a predetermined time interval, using spatial and semantic analyses.

As technology grows rapidly and usage by individuals increases rapidly, the gathering and sharing of location-based information will also increase. Thus, participation of individuals in various fields of science, such as disaster management, health science, archaeology, basic sciences, will be inevitable.

In this study, our aim is to discover the potential of VGI and social media integration in urban affairs. Citizens share information about events at any time anywhere in Kayseri by a mobile application. Thus, relevant institutions and organizations in Kayseri solve problems related to these events in a short time. For example; when there is a problem about road condition, citizens share information about problem reporting the location (Figure 1(a)) and then, another post is shared about fixing the problem (Figure 1(b)). Road condition, water supply network problems, traffic signs problems and traffic density are just some example about urban affairs.



(a) (b)

Figure 1: (a) Sharing about a road condition problem, (b) Sharing about fixing the road condition problem

In the second part of this paper, the stages of developing a mobile application that consist of VGI and social media integration will be mentioned. In the results and suggestions section, current research and application possibilities and in the field of VGI will be evaluated and mentioned about some benefits of mobile applications and VGI-social media integration.

2. The Mobile Application

This social media application developed for one of the most common mobile operating system, iOS. iOS has been first announced by Apple Inc. in 2007 to run on the iPhone devices (URL 1). It sustains its 2nd common mobile operating system position about sharing the world's market by 14.7% in first quarter of 2017 (URL 2).

Xcode is a IDE (Integrated Development Environment), especially to develop iOS applications. It is mainly capable to make users development in Objective-C and Swift languages. Besides Xcode allows to import different programming language libraries to connect the application to different platforms in which is web platforms like Firebase and Cocoapods.

Developed by Google, Firebase is a web platform that offers free usage in the sense that it can meet the needs of managing cross-platform applications. Today, applications are required to access the same database from every device regardless of platform. Development requires a management panel where many user uploaded developers can easily manage registration - session information, analyze usage data of applications, send user notification at the same time, test application, etc. FireBase provides separate access for each application equipped with features such as Realtime Database, Notification and Remote Config in new developer friendly interface without any need for application management, usage tracking, data storage, notification sending, and extra server and server side code writing. It also supports to login with social media accounts like Facebook, Twitter by using the Auth service.

CocoaPods is a dependency management tool for Cocoa Projects (iOS, OSX operating systems) written in Swift and Objective-C. In other words, third party libraries written for these platforms are an improved tool to include in the project.

The basic operating principle of the mobile application that consist of VGI and social media integration is shown in Figure 2.

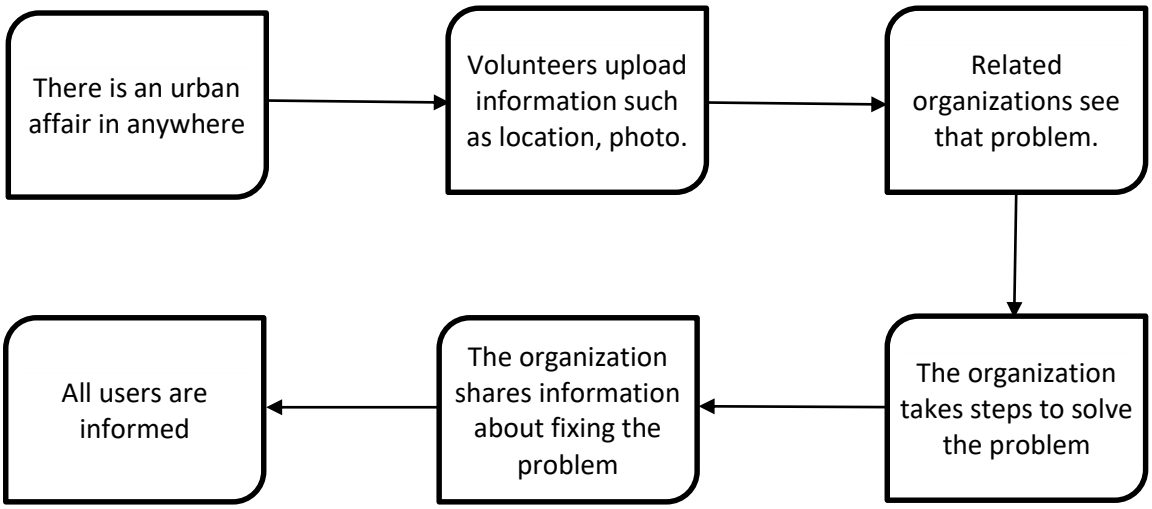


Figure 2: Basic operating principle of the mobile application

In this application user login with username and password combination or Facebook account. In order to connect the Firebase platform, the Firebase Auth Service has been used. In the main page (Figure 3) the user can see the other notifications sent by other users.

Figure 3: Main page of mobile application

To add a new notification, user should tab the "+" button, then the sharing page appears (Figure 4).

Figure 4: Sharing page of mobile application

In this page, user share three information: the user location, an image from photo gallery or captured by camera and the description or comment. When the user tab the "photo add" icon, dialog bar opens and asks the user to select from gallery or open the camera (Figure 5).

Figure 5: Information upload page of mobile application

When all the information are checked, the user could share this notification with services like police, fire department or municipality etc. by just tabbing the "share" button. Then, related organizations and institutions take steps to solve problem and share the problem solved over the mobile application to inform the citizens.

4. Results and Suggestions

In this study, we want to draw attention to relationship between Volunteered Geographic Information and social media. For this purpose, some studies about VGI and social media integration carried out in our country and in the world are summarized and for the management of urban affairs a mobile application which is consist of VGI and social media integration developed.

VGI is emerging as a research field that is rapidly gaining prominence through the widespread use of mobile technologies and social media. The use of VGI in urban affairs has many benefits. Two main benefits are presented here. Firstly, it significantly decreases the time and cost required to collect urban affairs information. Secondly, as the data is open and freely accessible.

In the future, the above-mentioned social media platforms can be further developed and their contribution to urban information systems enhanced. In the absence of such studies, it can be seen that volunteered geographic information and social media integration in our country will spread rapidly. Finally, we believe that users of VGI who are from different research areas willing to do useful things for public, will contribute to the awareness of other people and to the development of information sharing culture.

References

Banger G. and Çalışır, G. (2014), *Sosyal Medyanın Kurumsal İnovasyon İçin Kitle Kaynak Olarak Kullanımı*, Uluslararası Yeni Medya – Yeni Yaklaşımlar Konferansı, Çanakkale Onsekiz Mart Üniversitesi

Elwood S., Goodchild M.F., Sui D.Z., (2012), *Researching Volunteered Geographic Information: Spatial Data, Geographic Research, and New Social Practice,* Annals of the Association of American Geographers, 102(3), 571-590.

Goodchild M.F., (2007), Citizens as sensors: the world of volunteered geography, GeoJournal, 69:211-221.

Goodchild M.F., Li L., (2012), *Assuring the quality of volunteered geographic information*, Spatial Statistics, 110-120.

Gulnerman A. G., Gengec N. E., Karaman H., (2016), *Review of Public Tweets Over Turkey Within a Pre-determined Time,* International Archives Of the Photogrammetry Remote Sensing and Spatial Information Sciences, 1st International Conference on Smart Data and Smart Cities, Split, Croatia, 4-4, W1, 153-159.

Gulnerman A. G., Goksel C., Tezer A., (2017), *Disaster Capacity Building With A GIS Tool Of Public Participation*, Fresenius Enviromental Bulletin, 26, 1, 237-243.

Poorazizi M. E., Hunter J. S. A., Steiniger S., (2015), *A Volunteered Geographic Information Framework to Enable Bottom-Up Disaster Management Platforms*, ISPRS International Journal Of Geo-Information, 4, 1389-1422.

See L., Mooney P., Foody G., Bastin L., Comber A., Estima J., Fritz S., Kerle N., Jiang B., Laakso M., Liu H., Milcinski G., Niksic M., Painho M., Podör A., Olteanu-Raimond A., Rutzinger M., (2016), *Crowdsourcing, Citizen Science or Volunteered Geographic Information? The Current State of Crowdsourced Geographic Information*, ISPRS International Journal of Geo-Information, 5, 55.

Seeger C., (2008), The Role of Facilitated Volunteered Geographic Information in the Landscape Planning and Site Design Process. GeoJournal, 72(3): 199–213.

Spinsanti L. and Ostermann F., (2013), Automated geographic context analysis for volunteered information, Applied Geography, 43, 36-44.

Sui D., (2008), The Wikification of GIS and Its Consequences; or Angelina Jolie's New Tattoo and the Future of GIS, Computers, Environment and Urban Systems, 32(1): 1–5.

URL 1, Wikipedia: https://en.0wikipedia.org/index.php?q=aHR0cHM6Ly9lbi53aWtpcGVkaWEub3JnL3dpa2kvSU9T, [Accessed 20 October 2017].

URL 2, IDC. https://www.idc.com/promo/smartphone-market-share/os, [Accessed 20 October 2017].

Werts J. D., Mikhailova E. A., Post C. J., Sharp J. L., (2012), An Integrated WebGIS Framework for Volunteered Geographic Information and Social Media in Soil and Water Conservation, Environmental Management, 49, 816-832.

GIS Based Decision Support System Application for Investment Planning, Customer Related Compliance Management and Marketing Activities

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Abstract

All processes from planning to management are of critical importance at various stages such as the successful development of natural gas distribution projects in natural gas distribution companies, the completion of investments, and management of the operating period. Decision support systems are used in different processes such as construction and manufacturing, business management, customer care, emergency management and gas distribution control in these processes, which are started with the investment decision. In this study, it has been shown that the decision support mechanism can be used effectively and correctly when smart geospatial technologies are well positioned and used correctly in all levels of management centers where they do not consist only of database, digital map and query analysis. The whole project consists of 6 sub-decision support system modules called Investment Planning Decision Support System, Information Sharing and Reporting Decision Support System, Customer Relations Management Decision Support System, Natural Gas Master Plan, Emergency Management Decision Support System and Route Optimization Decision Support System. All these modules are collected on a single screen that can be accessed via the web and they designed to include mapping, table creation, and listing and graph-report generation functions. Each subsystem is grouped under separate headings in accordance to their purpose and qualifications. In this context, it will be mentioned about just two of them named Investment Planning and Customer Management.

Keywords

Smart Mapping, Multicriteria Analysis, Investment Planning, Spatial Decision Support System, Customer Complaint Management, Reporting.

1. Introduction

1.1. Literature

Decision Support System (DSS) is a computer based information system where users interact with the system in the decision-making process and it is used to help a business executive and professional employees make decisions. Decision support systems are often used for solving semi-structured problems, as well as for structured and unstructured problems. Systems are data and model based. The system allows users to set up models based on data related to a particular problem and one or more methods. It is possible to make faster and more accurate decisions (Çopur 2016).

A DSS is actually a problem-solving system. Information pollution, which is widespread in every area, can be seen as one of the most important reasons for the emergence of the DSS. For this reason, there is a growing need for such tools and systems that will help managers when they perform their duties (Bozkurt 2016).

Decision making has become an important part of many sciences, primarily management of organizations and businesses. Today, with the rapid developments in the field of information and technology, decision-making process is faced more frequently than the old one. In many cases, the decision maker is expected to consider more than one goal with multiple factors and criteria. In this case, the problem of decision making emerges as a multi-criteria decision-making problem. Multi-criteria decision-making is a subdivision of decision-making. It is based on the process of modeling and analyzing the decision process according to criteria. It has been developed because it has been observed that people cannot adequately evaluate different information coming from various sources. With multi-criteria decision making, strategic planning is possible. At the same time, a transparent and demonstrable model is presented, and very large quantities or scattered data are taken into consideration (Erdem Kocamustafaoğulları).

Multi-criteria decision making can be examined under three basic headings named selection, classification and sorting problems (Vassilev et all. 2005).

- **Selection Problems:** The goal is to determine the best among the alternatives or to make a good choice from within a cluster with many alternatives that are difficult or comparable to each other. Briefly, it is to choose the best among alternatives.
- **Classification Problems:** In such problems, alternatives are classified according to certain criteria or preferences. The aim here is to bring together alternatives that show similar features and behaviors.
- **Sorting Problems:** In ordering problems, alternatives can be measured from bad to good or identified (Yıldırım and Önder 2014).

The parameters include spatial information in many decision-making problems. Geographical Information Systems (GIS) is such a kind of high performance computer system collecting, questioning, mapping and analyzing the information

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about the existing objects and events coming from the world. GIS is widely used as a Decision Support System (DSS). GIS is the go-to technology for making better decisions about location. GIS made it possible to manage map-based data in electronic environment, which constitute a large part of the information gathered and produced in today's world. Making correct decisions about location is critical to the success of an organization.

Spatial analyzing methods has become widely used in connection with the development technologies of GIS and Remote Sensing area. Spatial analyzes provide very useful information about the space and incorporate spatial data statistics into the study. Spatial analyzes are needed at the points where classical statistics are inadequate. Spatial analysis is a set of techniques for analyzing spatial data. The results of spatial analysis are dependent on the locations of the objects being analyzed. Spatial analysis methods are used in studies where spatial dependence is important, spatial information of objects or events, and observations made in space and interaction of location information. Spatial analysis methods are applied in many different areas from city planning to geography, from mining to crime analysis, and they are becoming increasingly important. (Özcan 2016)

1.2. Main Objectives

According to the Natural Gas Market Law, natural gas distribution service is provided by the companies which win the tender for the Distribution Regions defined by the Authority. (Republic of Turkey Energy Market Regulatory Authority (EMRA)). The natural gas distribution activities for İzmir Region has started with the license 04/06/2004 dated and board decision number of 326 for 30-year period. The distribution region consists of 25 districts. İzmir Natural Gas Company is responsible with the distribution of natural gas in its region by making investments, supply with customer demands. The company must adhere to the license terms, Board Decisions, and processes for all activities.

İzmir natural gas distribution region is one of the most extensive area licensed by the Energy Market Regulatory Authority (EMRA) in terms of total investment and the amount of investment required to complete it at a certain time interval. It is inevitably confronted that investing in such a large area needs to be well planned and the advantages of smart information technologies needs to be used in customer information and management services. By the end of October 2017, steel pipeline length was 637 km, polyethylene pipeline length was 4.650 km, number of regional regulators was 157 and number of service lines was 155.000 which was constructed by distribution company[1] . İzmir Dogalgaz has reached 864.000 number of household subscribers. Such network data is stored in a inquirable structure and in an up-to-date infrastructure information system of the company.

2. Project Modules

In this project, GIS-based software adapted from decision support system model is presented. While the system model was being created, firstly the internal management processes of this model were analyzed. Investment Planning and Customer Management cover two of these processes. With the software model, it is aimed that the system users in the mentioned processes use the software as a tool of decision support system in line with their goals in their workflow processes. Thus, it has been shown that smart geographic information technologies can be used efficiently and effectively as a decision support mechanism when correctly positioned and used correctly at any level of management centers where database, digital map and query analysis do not occur.

2.1. Investment Planning Decision Support System

2.1.1.Purpose and Scope

İzmir Dogalgaz is a company responsible for carrying out natural gas distribution activities within the distribution area consisting of 25 districts, 896 neighborhoods and approximately 2,1 million households. İzmir Dogalgaz consists of the General Directorate building, 2 construction district chiefs, 2 operation district chiefs, 10 subscriber centers, 1 warehouse building and 24 RMS/A. Simultaneous evaluation of new customer demand during the investment process, investment plans to be made by managing these demand and advantages brought by smart information technologies are utilized.

Investment Planning Decision Support System is a system which analysis various parameters and different effect levels, and produces results quickly as reports and smart maps to determine the total investment potential in the distribution area.

In the case of a limited budget, the choice decision of the areas to be invested and the planning of the investment is to have strategic designation. When the planned investment is evaluated together with feedback, it can be seen that if these decisions are wrong, it can cause quite high costs. From this point of view, the system seems to be quite advantageous.

The system design process began with the determination of the workflow processes for the creation of investment plans are examined. While investment plans are prepared in İzmir Dogalgaz; main investment decisions are taken into account the parameters such as investment commitments for licensing requirements, existing infrastructure areas, and

[1] *The amount of the BOTAS turnover line was included in the steel line length. Pipeline length also includes service line length.*

demand intensity of customers who want to use natural gas. In these areas, technical studies and marketing studies are carried out. Customer demand information, other detailed information about the technical studies and all the marketing information collected for the dwellings are stored in the infrastructure information systems and they can be followed in detail through the map. As a result of the analysis and detailed evaluation studies of all this information, investment plans are verified.

The distribution license region area evaluated and analyzed by the system. The whole area is separated into varied fields adhering to the user selection criterions like customer demands, the remaining length of the network pipeline or investment cost. The output report and the results are dynamically simulated. The user just selects the parameters and determines the effect of that parameter and as a result of this process obtains the best and worst investment characteristics of the whole area in a few seconds. According to the output reports or results of the system the decider could make investment plans or determine investment priorities easily. Thus, optimization of investment is accomplished both in line with customer demands and the other spatial features and limited sources.

The simulation of the results can be done both on the map screen and on the prepared lists. At the same time, the system also reports on the amount of potential income to be achieved through the selected investment. Therefore, while the incoming customer requests are evaluated, the planned investments are optimized. If necessary, new values can be obtained quickly by changing the entered parameter values. The construction schedule is dynamically created at the district and street level, then the investment prioritization work can be organised easily.

The users responsible for determining the annual investment programs and the managers responsible for investment monitoring and checking are among the users of the system.

2.1.2.Methodology and Functions

With the **Investment Planning Decision Support System**, it is aimed to make the selection of the area to be manufactured quickly and to rank the results according to the different parameters that can be specified by the user and also the effect levels to be defined by the user. In accordance with this object the different data groups were determined. The existing GIS database of İzmir Dogalgaz Company were used. Moreover, the additional data requirements have been identified.

Digital design project data of pipelines and also the constructed values of pipelines are some of the required data for the system design. The investment period of the company is still proceeding so that another dataset belongs to natural gas service demands from the İzmir natural gas distribution license area. The data on which date, by whom and in which address is requested by customers should be available in the infrastructure information system. In the process of investment planning, the areas in which has the demands for gas service will be assessed as having a priority level. Potential status of the area belonging to the planned investment area and cost required to reach that area are also included in the parameters. Therefore, all these data groups are among the necessary data to be prepared in the existing system infrastructure.

- **Model Design**

With this system, it is aimed to arrange the distribution area within the framework of some criteria in the planning of the investment companies and the determination of the investment programs. The study area covers İzmir natural gas distribution license area. It is aimed to perform efficiency ranking for this whole area. This whole area, which can be expressed as an investment priority alternative, is divided into sub-areas called the *polyethylene zone* and *sector* within the scope of the project planning studies of the distribution network. 98 *polyethylene zones* and 3,550 *sectors* are designed in İzmir license area.

While the **Investment Planning Decision Support System** was being prepared, the positional and non-positional criteria used in investment planning were determined in the prepared interface application, the importance ranks to be used for the criteria are called the impact level and this leads the parametric value form that system users can specify. Thus, the user is able to determine the effect level of the parameter selected by the user and to report the result accordingly. The weighting of these criteria is also one of the basic features of the model which is determined by the user and the expert. For each criterion, the importance levels can be determined separately by the system users and according to this, system produces varying results. Due to the system outputs, the efficiency order is made for the whole area and accordingly the final selection is determined by the system user again.

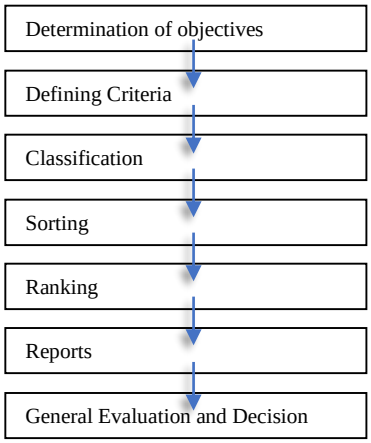


Figure 1: Investment planning decision support system model chart

The defined criteria within the model are listed below:

Demand Quantities: This criterion shows the number of household that has demand for natural gas service. Investments in natural gas supplies are customer demands coming from areas where constructing activities have not yet been completed. Within the scope of the license zone, all customer demands for natural gas usage are recorded in the system with smart map support. In the customer satisfaction policy, these requests are prioritized while preparing investment programs. Within the scope of the system, nearly 500,000 addresses and 200,000 customers demand as of today can be analyzed and reported. Demand intensity in any area is evaluated in terms of customer satisfaction. The number of households demanding for each sector is determined separately.

Design Project Pipeline Length: As a natural gas distribution company, design projecting studies are being carried out with the city development planning decisions, taking into account the city's 30-year growth projection as well as covering the entire license area. Design projects are prepared considering the as-built projects and the production and manufacturing process is realized in this direction. While making investment decisions about an area, estimated the amount of line in this area is a factor that directly affects all kinds of processes and costs and it is a criterion that can be considered as an important factor in investment planning decision.

(Investment to be made) Potential size to be reached: Another expected criteria for the selected area is related to what is the maximum potential to be reached with the investment to be made. In other words, this data also provides insight into the maximum reachable area and the maximum number of the household.

Regional Efficiency Character: The sector is separated according to the size of the supply of gas and the number of addresses that are not manufactured or pending manufacturing. In this context, a productivity score of 1 to 6 for each sector is given. The productivity score is as shown in Table 1.

Table 1: Productivity score grouping of sector units

SECTOR SCORE	GASSING STATUS of SECTOR	# of EXPECTING MANUFACTURING DWELLINGS in SECTOR
1	Whole Gassed Sector	>X
2	Whole Gassed Sector	<X
3	Nearby Whole Gassed Sector	>X
4	Nearby Whole Gassed Sector	<X
5	Non-Gassed Sector	>X
6	Non-Gassed Sector	<X

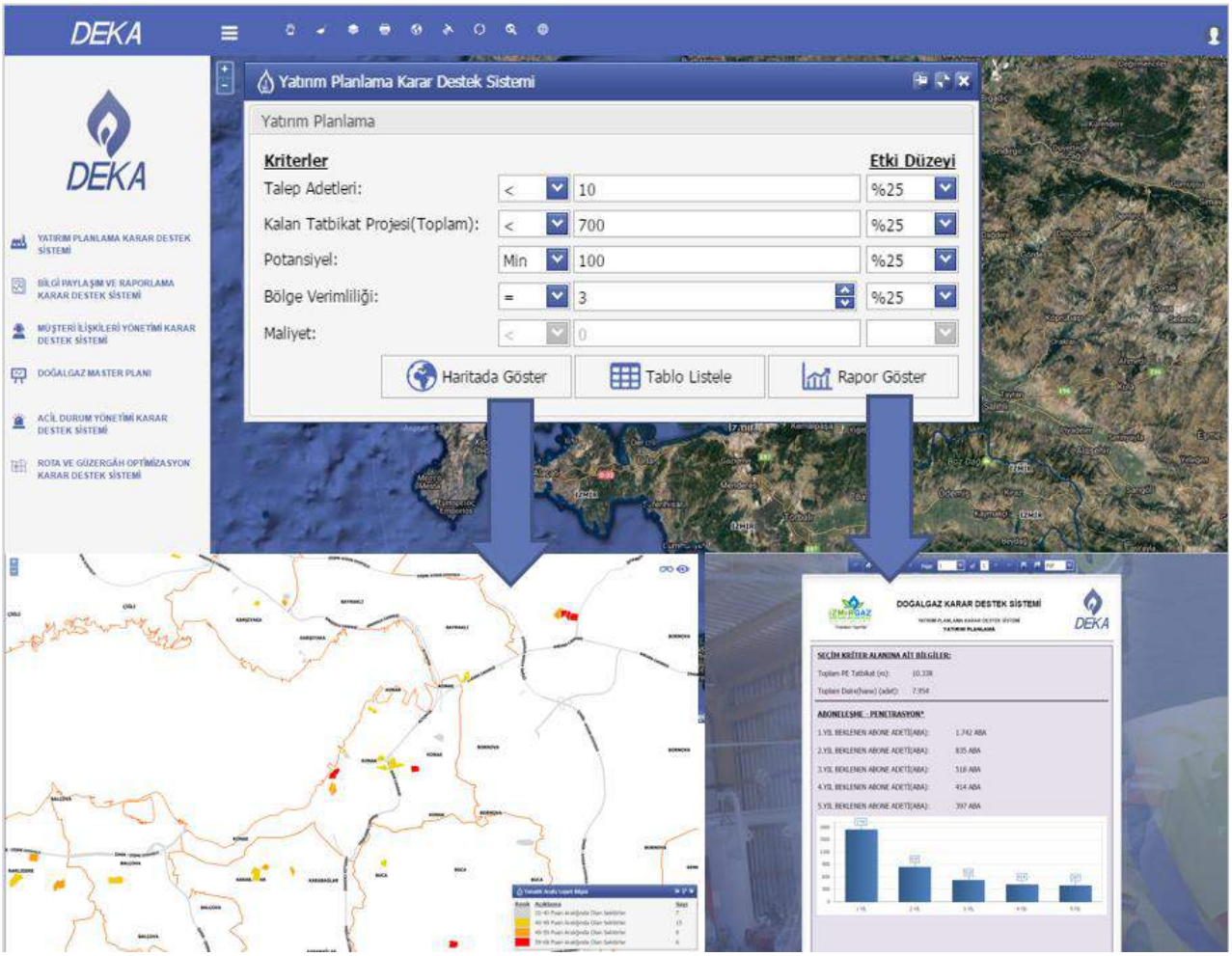


Figure 2: Screenshot of investment planning decision support system

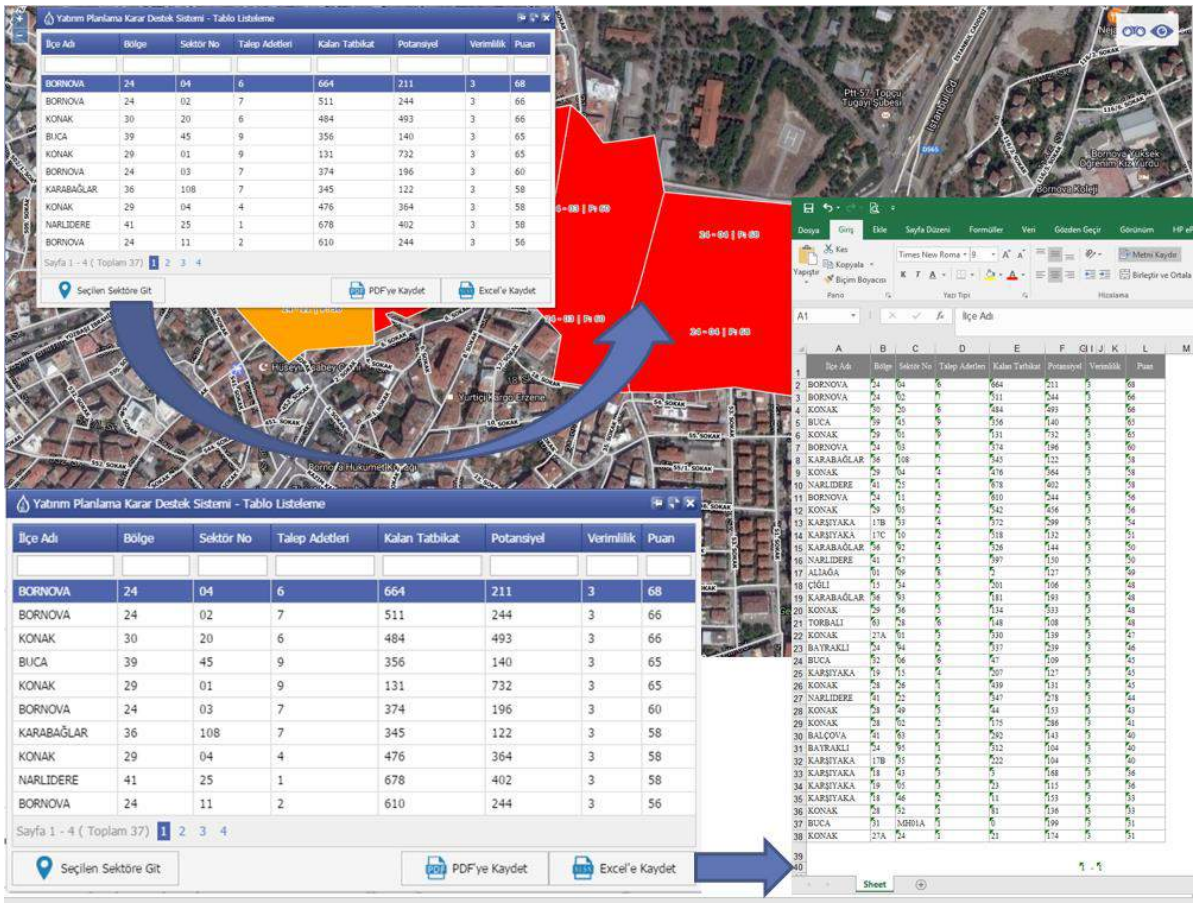
With the system, all data are brought to the same order according to the user's selection criteria, analyzed and the results are reported in only a few seconds. Briefly, the area covered by the company's investment responsibility and covering 25 districts is sorted according to productivity level. The system shows the selected area by means of user's selection. This process, (collecting the data, bringing together and evaluating etc.) which is accomplished by different departments of the distribution company has been made much easier and quicker with created system for the system users at all levels.

Using this system, it is possible to access the answers to the following questions:

- What are the highest investment potential areas?
- How is the distribution of areas changes depending on the criteria I have selected?
- Can I display areas on the map according to selection criteria?
- Can I display areas on the map according to criteria headings that vary according to the level of impact I have set for them?
- Can I display areas of the criteria headings that vary depending on the level of impact I have set?
- What is the first 5-year customer estimate for the areas according to selection criteria?
- Where are the most and least natural gas demand areas?
- What is the maximum number of dwellings I can reach with the investment I make?
- Can I create a report on addresses that have been added the construction program but not yet completed?
- What is the daily construction volume?

The output of the system is:

- ✓ Map of sorted areas (sectors) by ranking according to given criteria and impact levels
- ✓ Addresses and list of the sorted areas (sectors) ranking according to the criteria and effect levels given
- ✓ 5-year income (subscription) projections selected in accordance with given criteria and impact levels



İlçe Adı	Bölge	Sektör No	Talep Adetleri	Kalan Tatbikat	Potansiyel	Verimlilik	Puan
BORNOVA	24	04	6	664	211	3	68
BORNOVA	24	02	7	511	244	3	66
KONAK	30	20	6	484	493	3	66
BUCA	39	45	9	356	140	3	65
KONAK	29	01	9	131	732	3	65
BORNOVA	24	03	7	374	196	3	60
KARABAĞLAR	36	108	7	345	122	3	58
KONAK	29	04	4	476	364	3	58
NARLIDERE	41	25	1	678	402	3	58
BORNOVA	24	11	2	610	244	3	56

Sayfa 1 - 4 (Toplam 37) 1 2 3 4

Figure 3: Efficient field sequence table

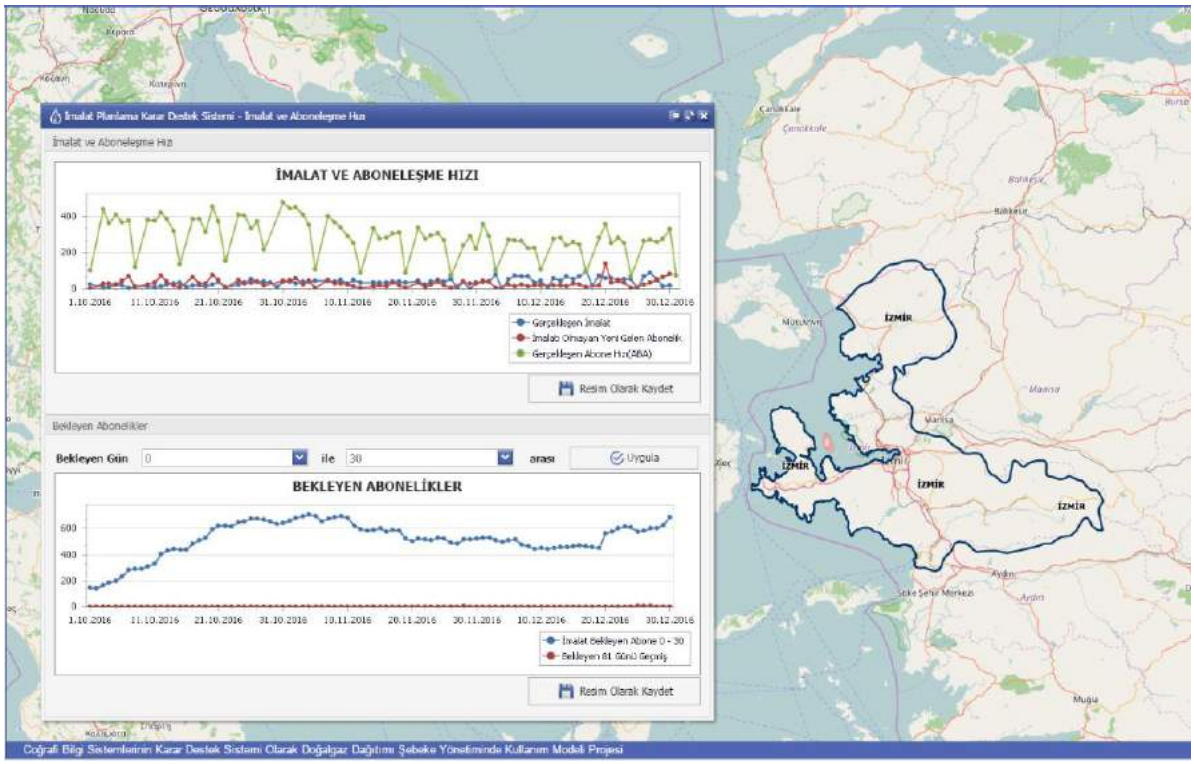


Figure 4: Construction and subscription speed graphic display

After the preparation of investment plans and programs the following process is the construction period. Another step that progresses in parallel with this process is the subscription period of the demanding customer. In other words, the beginning of the customer's subscription period triggers the construction process; the customer subscription process also occurs after the start of the construction. Depending on the investment program made, the stage of the construction process can also be monitored through the system. The aim at this point is that subscription process is related to being able to be included in the network within the determined period in the *Natural Gas Market Law Distribution and Customer Service Regulation.*[2] Addresses that have completed the subscription process instantly can be reported via the system and it can also be questioned which of the addresses are in the construction process. Thus, revisions are made in the construction program and priorities related to customer service become easier to follow.

2.2. Customer Relations Management Decision Support System

2.2.1.Purpose and Scope

İzmir Dogalgaz Company has been operating in the natural gas supply segment since 2005 and it provides natural gas for its domestic customers in reliable and economic conditions with its natural gas distribution license for 30 years obtained from EPDK. With an annual 3,2 billion m^3 gas volume that provides natural gas distribution service for 864,000 BBS customers and infrastructure services to population of approximately 2,4 million. The number of customers is increasing day by day and as of today, there are 10 customer centers serving different locations.

The Customer Relationship Management Decision Support System is aimed to create a structure in which smart systems are used in customer relationship management. Customer demand suggestions and follow-up of complaints, marketing and customer-based field studies and spatial decision support system for potential customer management activities were established. Through the system, natural gas customer requests and areas where complaints of different subject headings are concentrated can be shown through smart maps, followed by follow-up, and according to the analysis result reports, support mechanisms are provided for managers' decisions. Therefore, the system is used as an effective tool in determining management strategies.

The customer services & call center department personnel and also the department managers of these services are designated as target users of this system.

2.2.2.Methodology and Functions

During the system development process, the data requirements have been determined and detailed in parallel with the objectives determined. After the data sources were identified, the data were collected and the database was created. Some of the the required data for the operation of the system has been collected as provided by the integration methods by using the existing Customer Services Information Systems software. All data are prepared on an address basis. Using the address database for all data provides shoving all the results locally on the map screens.

The system model is structured under 3 headings as "Complaint Management", "Customer Research Management" and "Potential Customer Management".

- **Complaint Management**

With the interface software developed by complaints management, it is possible to analyze the complaints instantly depending on the choice made by the user and the results can be presented to the user again in visual reports. The selection criteria can be exemplified by distribution based on the type of complaints on a district basis or comparative reports on the year and the complaint. Integration of the system with *Emergency Call Management System (187)* is also achieved.

It is possible to access the answers of the following questions by using this system. The system gives answers supported with the **reports** and **lists** and also smart **maps** together.

- ✓ Where are the most complaints about infrastructures coming from?
- ✓ According to the subjects, which district has the highest number of complaints?
- ✓ Can I get a list of addresses where complaints from the selected date range come in?
- ✓ What is the average number of complaints per subscriber per district?
- ✓ Can I compare the complaints in the past years comparatively?
- ✓ According to types of complaints, what is the most complaint point and in which areas is it concentrated?

[2] Natural Gas Market Law No 4646 and *Natural Gas Market Law Distribution and Customer Service Regulation article 36.*

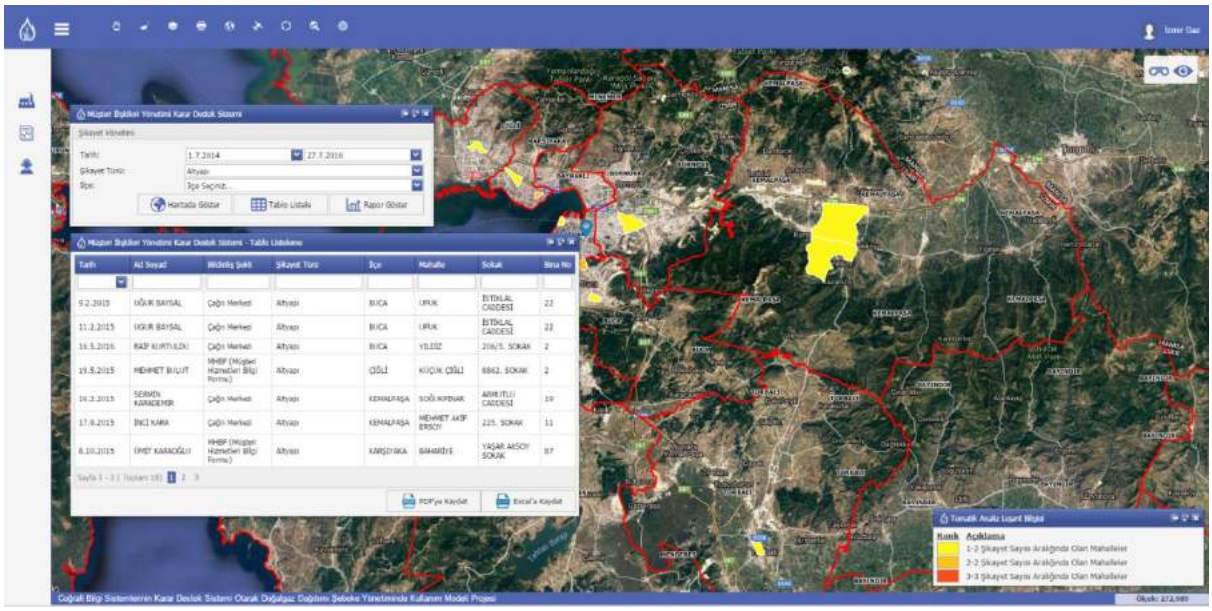


Figure 5: Screenshot of complaint management

- **Customer Research Management**

Marketing activities such as marketing, promotion, and customer research conducted by customer services within the scope of management. Map-supported reports are created and analyzes can be done on purposeful works. The data used are also prepared in the existing GIS database. The results of the study can be displayed with the system interface application and reports are produced.

It is possible to access the answers of the following questions by using this system.

- ✓ Can I create a map of the marketing activities in the last 3 months?
- ✓ Can I display in which areas the marketing work is concentrated according to the teams?
- ✓ Can I prepare a list of direct marketing work addresses together with team names that work?
- ✓ How do the rates of housing change according to the results in different marketing activities vary according to the regions?
- ✓ According to the activity of natural gas usage incentive activities, according to the reasons for not using natural gas, how does the distribution of the natural gas change in which region?

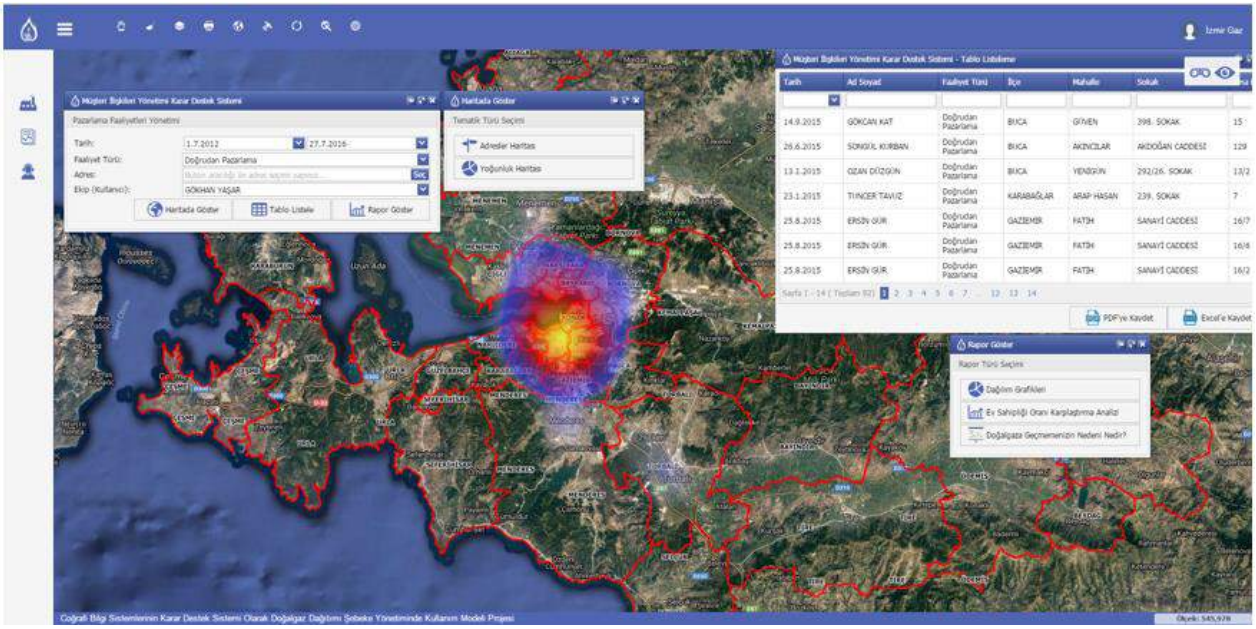


Figure 6: Screenshot of marketing activities management

- **Potential Customer Management**

This system shows the potential customers. In the context of potential customer management, a model is prepared. This model reports addresses that have not yet been used for gas even though natural gas investment has been made. With this system, addresses that have been invested but have no customers can be reported instantaneously and the total investment potential of the city can also be reported. These reports include increasing the effectiveness of marketing-subscribing, building consciousness on this issue, programming investments etc. can be used in various studies.

It is possible to access the answers of the following questions by using this system.

- ✓ Can I create an address list of current potential customers who are provided with gas supply?
- ✓ Can I create a map of where the non-customer subscribers are more intense in which district?
- ✓ Can I get a distribution report based on gas supply zones according to subscription rates?

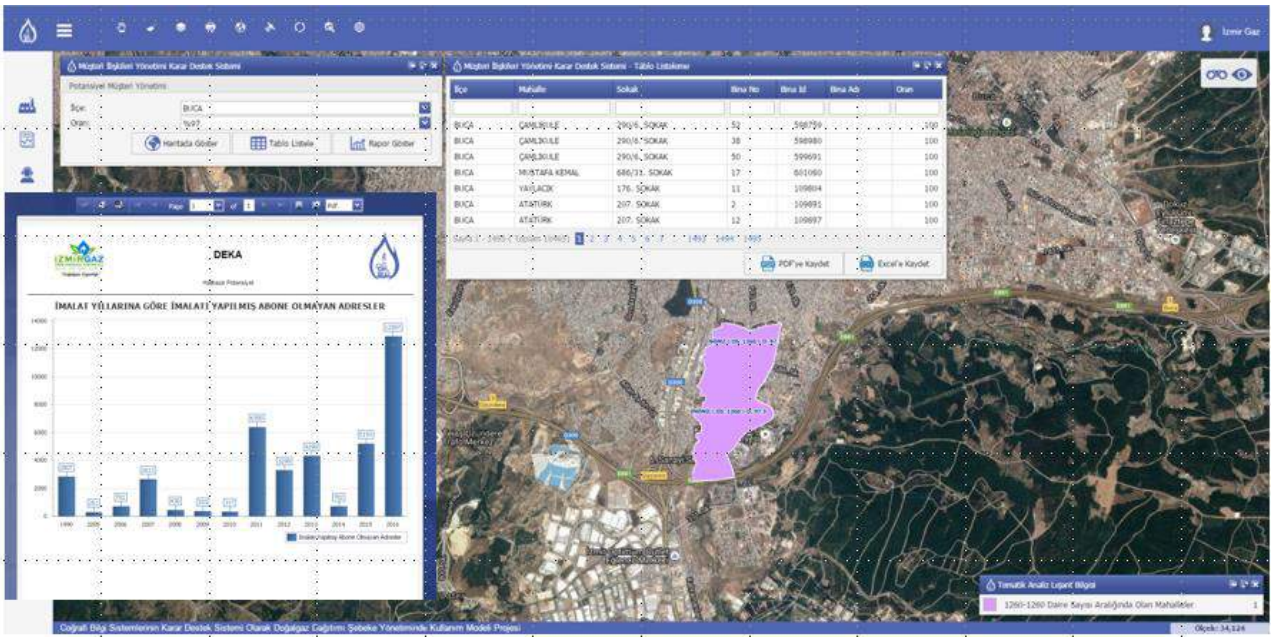


Figure 7: Screenshot of potential customer management

3. Discussion and Conclusion

Geographic Information Systems(GIS) can be used as a Decision Support System for the purpose of having faster data and making more accurate analysis with this data by the organizations that deal with the geographic data by means of this characteristics GIS has an importance of for the infrastructure companies.

This study aims to develop a model that shows the using of GIS as an DSS for the processes that called *investment planning* and *customer relationship management*. These are some of the processes of İzmir Natural Gas Company. This model provides efficient and impact analysis for both the managers and employee with the characteristic of its principle expressed decision at every level.

By means of Investment Planning Management; the selection of the maximum efficiency area to be planned for investment has been made parametric by removing it from the personality. Using the system, 5 different parameters can be used and each parameter are calculated according to the user's selection and effect levels and all results are displayed in the same map on map within 5 seconds, both as table-list data and as report. According to the results obtained, the decision maker is able to run the system again when necessary and take new results again with only different parameters in terms of their effect levels in only ~ 5 seconds.

By means of Customer Relationship Management; the number of complaints and their spatial distribution can be monitored from the map according to the topics of the customer profile we are obliged to provide services. Areas of intense concentration of complaints can be more easily assessed, thus service quality is improved. With Potential customer management, address analysis, which is already available to the network but is not subscribed to, is only made in 6 seconds.

In general, visual reporting has been provided for the creation of the decision mechanism. With the inquirable database model of GIS, **visual** reports are also supported with **tables-lists** or **graphs** so that the decision support mechanism can be constructed in a triple structure. By integrating with different systems at the database level, duplication is prevented,

maximum advantages are taken from current data and lost time is avoided. For all data used by system, the data entries and data creation activities used by the system were collected by different users in different departments in the company by means of MapInfo and interface applications which are a GIS software and the data entries were made by different software through the same address database. Then, all these data were collected together and evaluated in this project.

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References

Bilgen S.G., (2009). *İzmir Doğalgaz Bilgi Paylaşım ve Yönetim Sistemi (NGISS).* TMMOB Coğrafi Bilgi Sistemleri Kongresi, İzmir. http://www.hkmo.org.tr/etkinlikler/cbs/etkinlik_bildirileri_detay.php?etkinlikkod=17&bilkod=413

Bozkurt, Ö., Kalkan, A., Çeşmeli, M., (2016). *Karar Destek Sistemlerinin İşletme Yönetimi Açısından Önemi: Mermer İşletmelerinde Bir Araştırma*, Mehmet Akif Üniversitesi, Burdur.

Çopur, C., Komesli, M., Ünalı, M.O., (2016*). Elektrik Dağıtım Şebekelerinin Yönetimi için Coğrafi Bilgi Sistem Tabanlı Akıllı bir Karar Destek Sistemi*, Akıllı Teknoloji &Akıllı Yönetim.

Derviş, R., (2015). *Coğrafi Bilgi Sistemleri (CBS) ve Çok Nitelikli Karar Verme (ÇNKV) Yöntemi ile Lojistik Tesislerin Değerlendirilmesi.* Yüksek Lisans Tezi, Kara Harp Okulu Savunma Bilimleri Enstitüsü Tedarik ve Lojistik Yönetimi Anabilim Dalı, Ankara.

Kocamustafaoğulları, E. *Çok Amaçlı Karar Verme (Multi-criteria Decision Making).* George Washington University, Washington, DC.

Özcan, S.N. (2016). *Kentsel Hava Kirliliğini Etkileyen ve Şehir Planlama ile Kontrol Edilebilen Fiziksel Faktörlerin Mekansal İstatistik Yöntemleri ile İncelenmesi*. Doktora Tezi, Dokuz Eylül Üniversitesi, İzmir.

Vassilev et all. (2005). *A Brief Survey of Multicriteria Decision Making Methods and Software Systems*. Bulgarian Academy of Sciences, Bulgaria.

Looking at Process Management from GIS Window; "OBB BSK Process Management System"

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Abstract

Process; It is defined as the sum of people, materials, equipment, methods, and the environment that interact with each other to obtain a specific product or service. Each product and / or service produced is a result of a process. Increasing the quality of the product and / or service produced is made possible by a clear understanding of the production processes, correct distribution of the role-task, speculation and correct implementation of the designed speculation. Each step in the work process is essentially a chain of related processes (1)

Along with the transition of process management, all activities carried out are identified, measured and a control environment created for the audit. The process steps are clarified by process management, efficiency of cooperation and division of labor is gained, processes are clarified, authorities and responsibilities are determined. In addition, results can help determine the specification of performance indicators. The methods that used for process management allows a good management reach their goals. (2)

With an effective process management; it is possible to ensure to effective use of resources, reducing costs, preventing repetitions and defining priorities, roles, responsibilities, potential threats, risks and most importantly it is possible to foresee the possible consequences

Local governments with limited economic resources that produces services that will provide maximum benefits depends on the proper specifications of the processes and the correct implementation of the processes that are being designed and the effective monitoring and controling of the implementations.

Local governments are the main actors of many processes. Briefly operating all areas of life, serving from infrastructure to upper superstructure, planning to health, security to transportation, education and tourism. Local governments that wishing to produce more and more qualified services are obligated to manage their limited resources with well-planned processes.

The diversity of locally produced services with the multi-component, multi-tiered structure, the fact that the whole process is happens in a place in front of the public eye, which directly affects the lives of local people. Those are the reason makes the CBS an extremely useful tool in managing business processes.

Given the diversity and quality of the work they do, it seems that local governments are at the forefront of business groups that use or need to use process management systems and GIS the most. The multiplier effect that will make it possible to produce much more qualified products / services, İf local authorities that use these two tools with an integrated structure that communicates, speaks and communicates with each other instead of independent, unannounced, discrete way. (3)

Instead of prepared solutions for municipalities that produce services in many areas of life and have different priorities and approaches, it is seen that the systems created by the participation and contributions of the company oriented and product oriented, institutional employees are more durable and useful.

In our motivational work in this regard; Information on the "OBB BSK Process Management System", a CBS-based process management system prepared for the "Bitumen Hot Mixture (BSK) Construction Work" which is the largest contract awarded by a local government in the Republican Period, which is described as the Vision Project of Ordu Metropolitan Municipality. will be tried to be given. In particular, process management systems that come as a legal requirement in electronic document management are an internal requirement for governments that want to produce more, more qualified services with the tools they provide and the facilities they provide. With the addition of GIS, which offers many unique tools such as process management systems, analysis, query,

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completeness, locality, easy to understand and understanding, it is an extremely majestic and useful tool that provides many administrative tools.

In this study, with the OBB BSK Process Management System, which combines the basic principles of process management with the power of GIS, it is important to know how to coordinate, manage, monitor and report the road construction works scattered all over the province and how each process step affects the next step, it will be tried to express how such a large project containing the problem can be successfully managed.

Keywords

Local Governments, Process Management Systems, GIS, PostgreSQL, PHP

1. Introduction

The process is defined as "a set of interrelated and interrelated activities that make entries into output" in the ISO 9001: 2000 Quality Management System standard.

It is envisaged that studies on process approach will be carried out in all public institutions and organizations in the Information Society Strategy Document. The studies that are shown in this document "Strategic Priorities of Turkey" and which should be done about business processes are explained under the headings of Citizen-Focused Service Transformation and Modernization in Public Administration (6). In the implementation phase of this strategy which involves transformation to "public services in high standards"; While the business processes between public services and public institutions offered by the public to citizens and enterprises are being designed, the observance of user satisfaction will be adopted as the basic principle (1). The primary purpose of the service transformation will be to provide services that are redesigned in an efficient, fast, continuous, transparent, reliable and integrated manner, with services that are redesigned by combining and simplifying them according to user needs, "In redesigning public services, business processes will be standardized and services will be offered to all users at the same quality and time. In the presentation of the services, it is envisaged to enable personalization to suit the user's purpose and needs. In this way, it will be possible to observe the stage in which the requested service is in progress and to inform the citizens when necessary, and transparency will be provided in the provision of services. "It is stated that the process approach in public administration is an essential and legal obligation for all public institutions and organizations.

Main Goals of Process Management in the Public; (9)

- Identifiability
- Repeatability
- Consistency
- Scalability
- Controllability
- Creating Value Added

In summary, with effective process management; it is possible to foresee the most important possible consequences of ensuring effective use of resources, reducing costs, preventing repetitions, priorities, roles, responsibilities, potential threats and risks.

Persons, institutions and organizations that want to produce more and more qualified services have to manage their limited resources with well-planned processes. A perception that process management systems with Electronic Document Management System (EMS) should mostly be text-based should be included in the agenda of many local governments,

especially public institutions. At the beginning, the EBYS, which is based on user resistance, is a necessity of correspondence, hence public institutions and organizations, due to the ease, order and speed that the user provides.
Local administrations are the closest units to the public that produce service in all areas of life, from infrastructure to superstructure, from planning, from health, security, transportation, education, tourism to cradle. Almost all of the services and products produced by these units can take place in one place and / or can be associated with the place.
"OBB BSK Process Management System" which is an application blended by the habits and comfort provided by Process Management Systems and the power and capabilities of GIS in WEB environment constitute the subject of this article.
A GIS-based application was developed to manage the process in the "Bitumen Hot Mixture (BSK) Construction Work" which is the vision project of Ordu Metropolitan Municipality and which is one of the biggest auctions of a local government in the Republican history. The communication, coordination, monitoring and control between the Administration and the Contractor is done on the basis of GIS in the WEB environment in the road construction work of a total length of 752 Km which is being constructed in 19 cities within the scope of the tender with the developed "OBB BSK Process Management System".

2. Project Requirements

For a local government BSK is an unprecedented greatest auctions in the history of the Republic and grueling and extremely comprehenesive our municipality dares to build it, in the meantime, low number of personnel, the working area is too wide and scattered, the climatic conditions we have faced not convenient. It has been seen that the problems encountered can only be overcome by the very good management of the process, and that it is not possible to control the process through classical control mechanisms.

Process management system, which is understood to be needed, was evaluated to be more understandable and manageable by using GIS facilities and "OBB BSK Process Management System" was constructed as GIS based system.

3. Project Action Steps

- Learning of the Expectations of the Presidency Employees from the Implementation,
- Creating a Roadmap Flow Diagram,
- Defining Authority and Role of Contractor and Administration,
- Digitization of Graphs and Verbal Data According to the Tender Scope,
- Construction of Data Base Design,
- Preparing the WEB Application
- Data Entry and Creation of User Interfaces,
- Testing of the Developed Practice in a Single District Scale,
- Promoting the Applicant by Making 3 Meetings with the Contractor and the Administrative Person Firstly Separately Then Together,
- Improvement in Incoming Demands and Construction of New Developments
- Test of Practice by Users with Actual Data,
- Making Improvements
- Receiving a Commitment of the Application

4. Projects under the scope of the project:

After the project needs and the final goal of the project have been determined, meetings have been organized with interested parties to determine what needs to be achieved to achieve this goal and how the speculation should be. Firstly, the problems experienced in the procurement process were heard from the employees in the control organization of the Administration, and it was asked what way should be taken to overcome the problems. The same questions were asked once in a meeting held with contractor company employees and officials and evaluations of the bidding process were taken by the two parties. Authorization, duties and responsibilities are listed by reading the specifications and other tender documents related to the tender. The interviews made after the interviews and the readings were reported, the problems experienced in the rapord, the possible risks and the solution proposal were tried to be roughly summarized. Prepared report It has been tried to determine what needs to be done in order to better manage the process that has been discussed in a meeting where the representatives of the Contracting Entity and the Contractor are present together. After the meeting, a workflow diagram draft was prepared for the planned process and presented to the parties. After the demand and the improvements, the work flow diagram defining the roles has been established. It has been evaluated that it will facilitate the work of making GIS based platform over the continuous WEB platform and that the problems encountered in the process will be much more understandable.

Database tables have been created after determining which data is needed, by whom, by how often and by whom authority, duty, responsibility and roles are determined. The said tables; Protecting data integrity is built on the PostgreSQL database that our municipality uses in all GIS applications so that systems can talk to each other.

5. General Properties of the application;

On the one hand, while the process is being managed, on the other hand the general features of the application aimed at facilitating the life of the user,

- Designed with GIS based,
- Available on WEB platform
- PostgreSQL database and
- The PHP development environment is used,
- Authorization and roles are defined according to duty and responsibility,
- Maximum inquiry and reporting can be done with minimum data entry,
- All the stages of progress can be managed,
- Simple and easy to understand,
- Flexible,
- User friendly

Figure 1: Application Login Screen

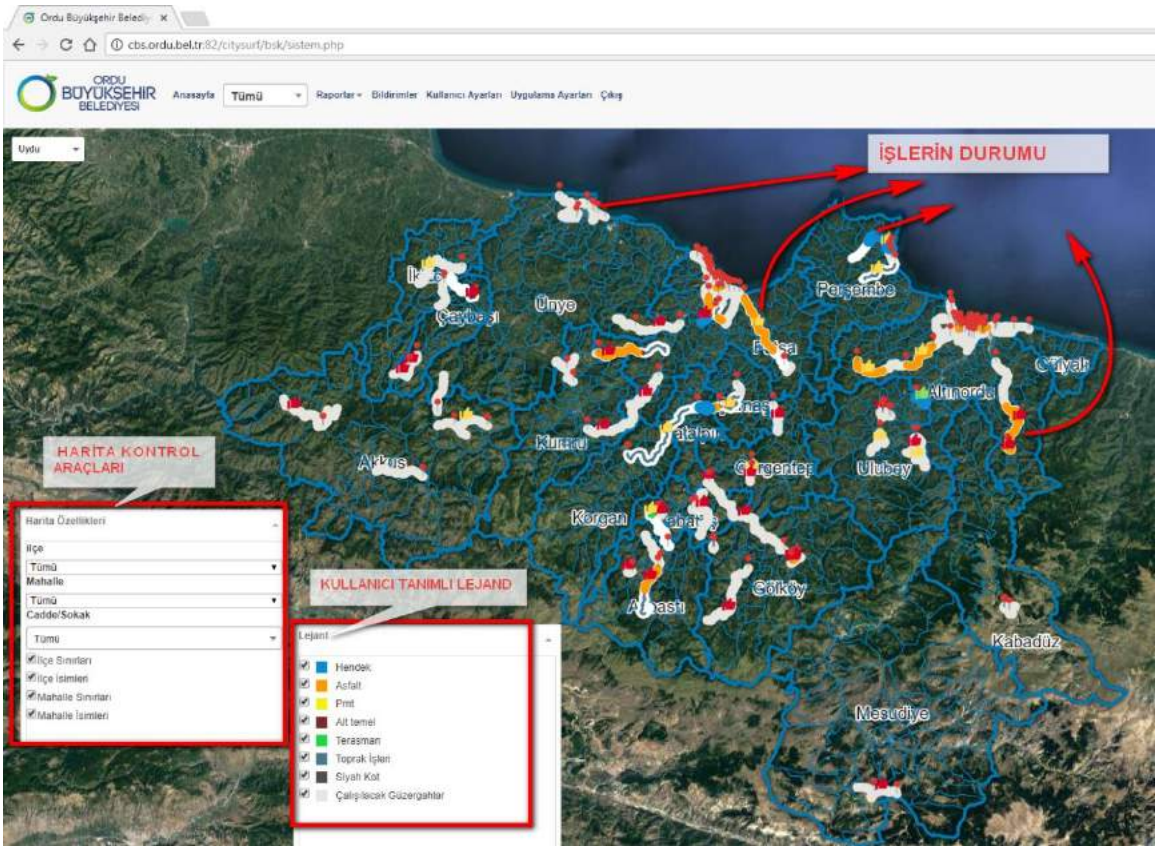

Figure 2: Application Opening Screen

With the application, all the work done in the context of the tender can be displayed on one screen and all work and processes related to the procurement process can be managed on a single screen.

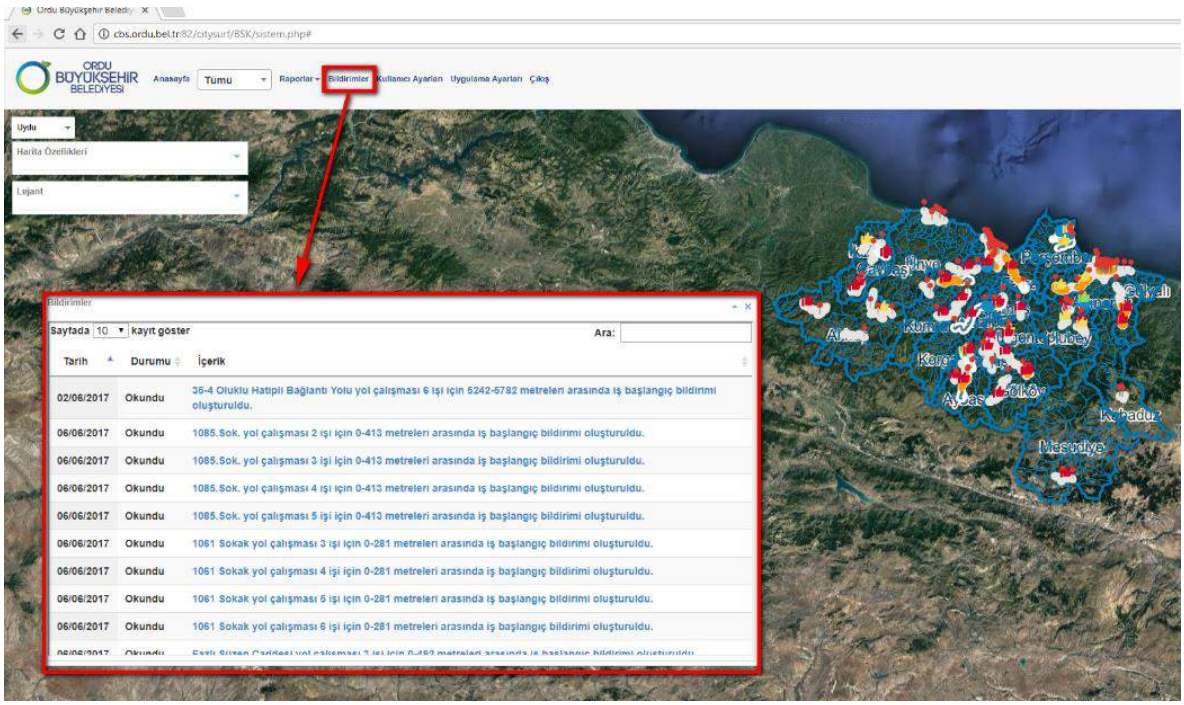

Figure 3: Notification Window

The application presents the rapid communication that is one of the most important elements of the process simultaneously to all elements of the process through the "notification screens".

At the same time, all notifications are recorded while the notifications are simultaneously sent to the concerned.

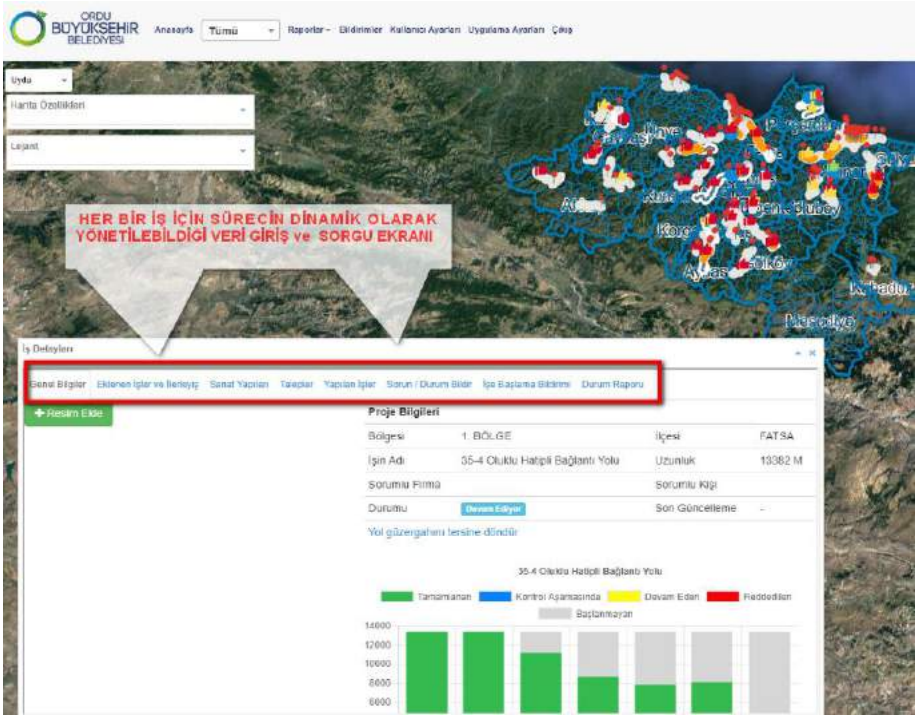

Figure 4: Information window for each process

All jobs can be displayed on one screen and the process can be managed while all the information, documents and images belonging to each job can be accessed from the same screen.

For each job; physical and material realization rates, compliance with the "work schedule" of the progress of the work, business progress graphs, control requests from the contractor, time to fulfill the demands, requests between the contractor and the administration, requests and notifications, problems encountered, it is possible to view it.

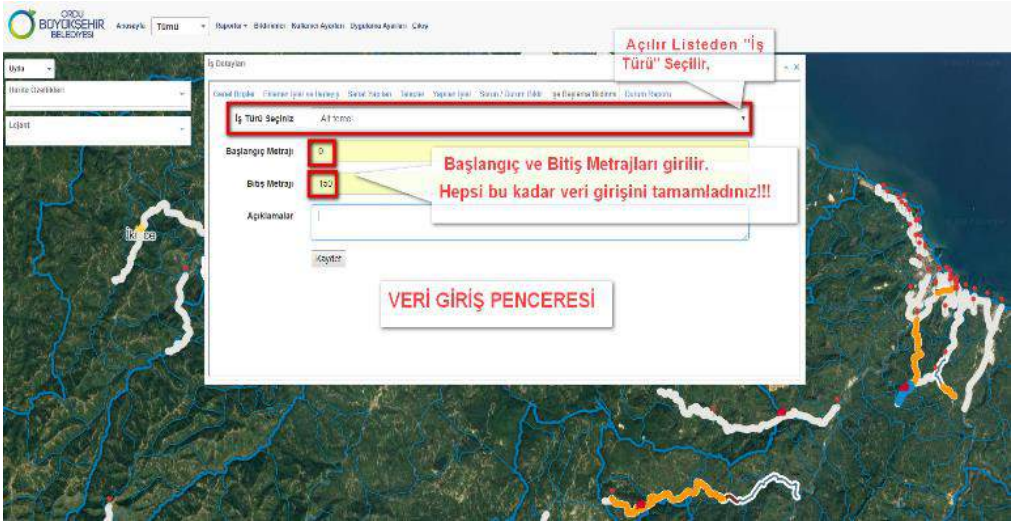

Figure 5: Data Entry Window

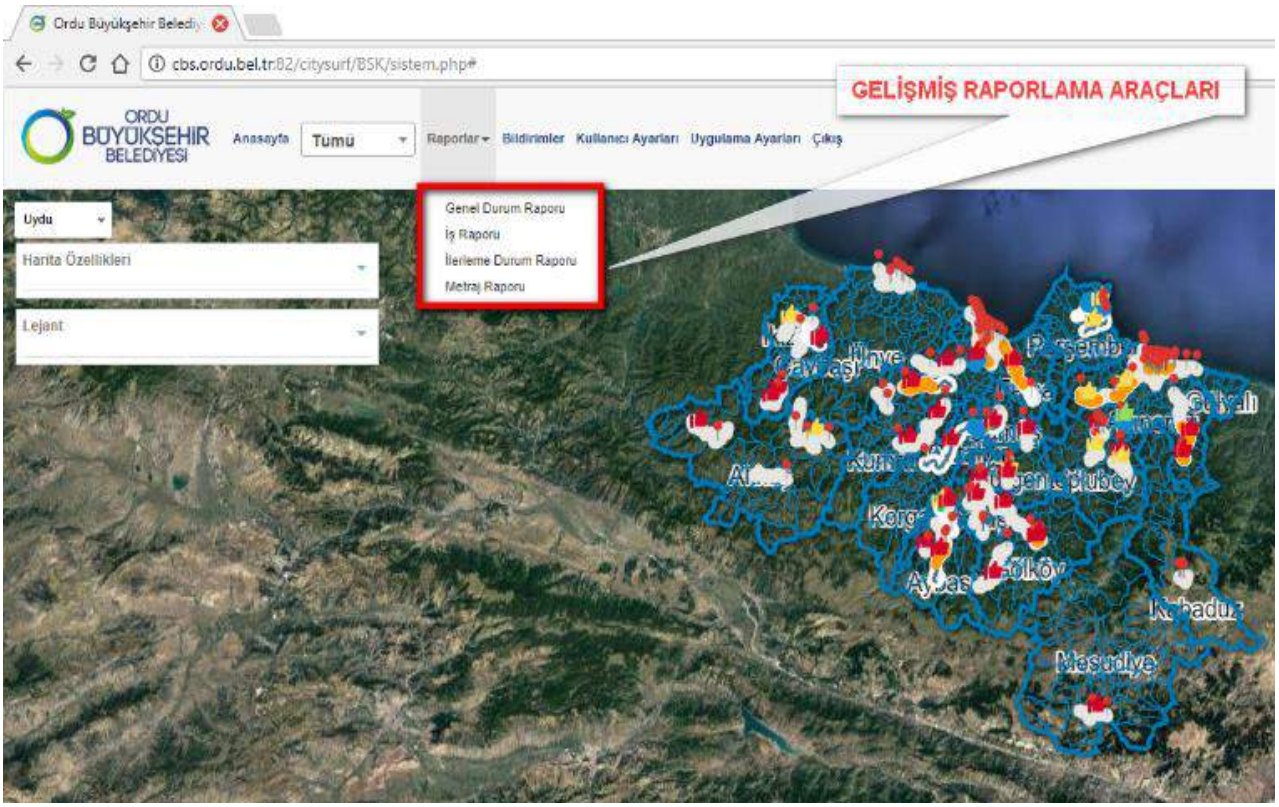

Figure 6: Advanced Query and Reporting Tools

The necessary arrangements have been made in order to make the data entry easy and fast for the user friendly application. Data entry process; starting with the choice of work to be done, and ending with the start and finish quantities.

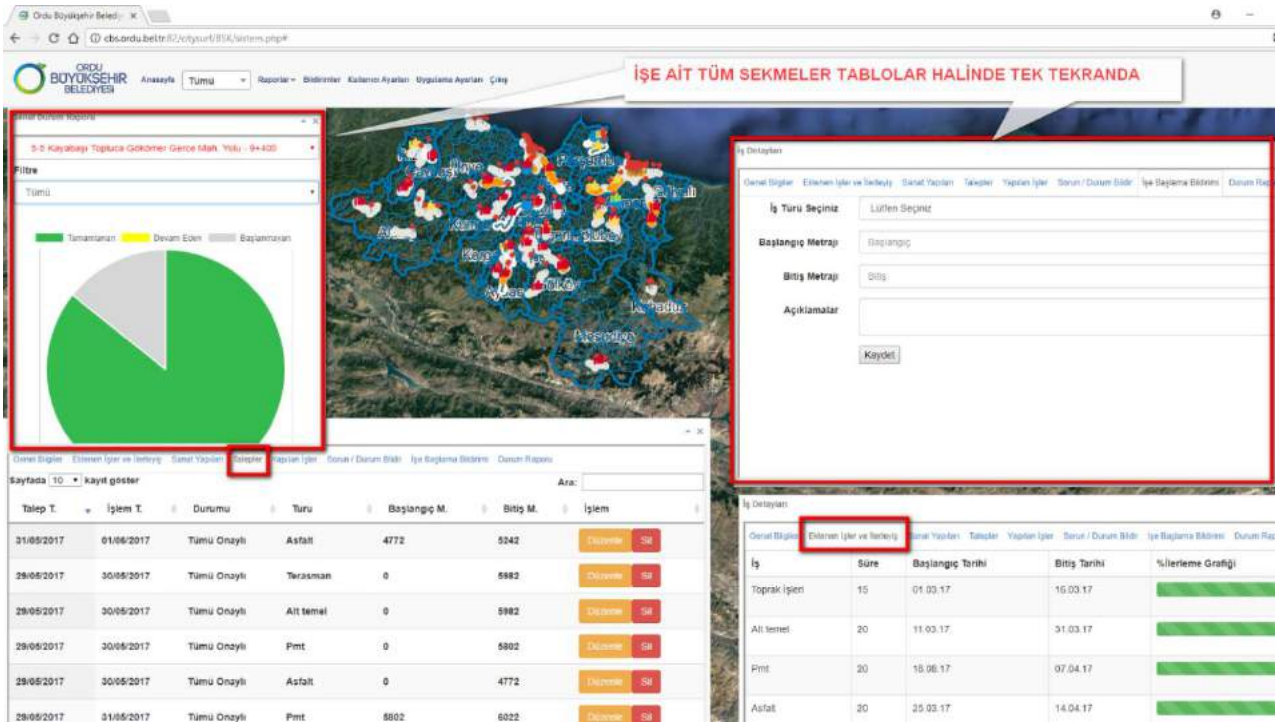

Figure 7: The whole table related to the process Graph And The Same And All On One Screen.

Acknowledgements

Process management, which defines all the activities carried out, gives measurable qualities, creates the control environment for the audit, gives efficiency to cooperation and division of labor, clarifies the process steps; is a legal requirement for all public institutions and organizations. It seems that process management is an internal requirement for each local government that wants to produce more and more qualified services beyond legal obligation.

The nature of the services produced locally, the multi-component, multi-tiered structure, the fact that the public is in front of the whole place, the results directly affecting the citizen's life, and being competing over time make the GIS an extremely useful tool in managing business processes.

A GIS-based process management system has been developed because it is not possible to manage the Bitumen Hot Mixture (BSK) Construction Work, which is described as the vision project of our municipality, and which is one of the biggest auctions of a local government in the Republican Times in one time.

Sustainability of the system; It has been the subject of the most attention and emphasis in the development and improvement stages, especially in design. With this understanding system; It is designed to facilitate the user's work and present the tools he needs directly. An intensive effort has been made to ensure that the system is not a necessity for the user but a necessity. One of the most important parameters regarding the sustainability of data-driven systems is, of course, regular data entry and keeping the data constantly up-to-date. In this context, the data entry is kept as easy as possible, besides its usefulness for the user to input / output data as a result of an internal necessity and not an internal pressure and forcing. OBB The communication between the BSK Process Management System and the contractor and the control organization is provided in a fast and secure manner. work items can be monitored on a single screen and on a regional basis. While all process steps and processes related to the development of the project are recorded, the point reached in the process can be easily understood by everyone. With the advanced querying and reporting options, it is possible to solve the existing problems without increasing the size while generating alternative solutions for potential problems.

With "OBB BSK Process Management System" which is a GIS based process management system; authority and role can be defined according to duties and responsibilities, maximum inquiry and reporting can be done with minimum data entry, all phases of the process can be managed effectively.

"GIS Based Process Management Systems" is very important for the efficient use of limited resources for local governments, who are the main actors in the field of infrastructure, planning, health, security, transportation, education, tourism, is considered a vehicle.

References

Akdemir, Prof.Dr.Ali and Ulukan, Prof. Dr. I. Cemil (2012). Strategic Management Anadolu University, AOF Publications No: 1647, Eskişehir.Aras, Arzu, A. Sustainable Process Management, Istanbul, KALDER Publications, 2005.

Ayanoğlu, M. and Turan, H. "Transition to Business Process Management and Implementation Results", III. National Production Research Symposium Proceedings Book, Istanbul Kültür University, 2003.

Bayraktar, Erkan, "Management of Production and Service Processes", Istanbul, Çağlayan Kitabevi 2007.

Carr, David and Johansson, Henry, Best Practices in Reengineering. New York: McGrawHill, 1997.

Dinç, E. and Abdioğlu, H. (2009). Institutional management understanding and accounting information system relation in enterprises, Journal of Balıkesir University Social Sciences Institute, C: 12, No: 21.

Eyuboglu, Filiz, "Process Management and Process Improvement", Istanbul, SistemYayıncılık, 2010.

Gürpınar, Hussein. (2012). Project Management in Information Technologies, RTÜK, Ankara.

Heldman, Kim. (2002) Project Management Professional Study Guide, Sybex Inc., Alameda.

Özer, Mehmet Akif, "Process Improvement Strategies for Businesses", Karınca, Cilt.80, No: 949, 11-27, 2013.

GIS as a Public Relation Tool in Municipalities

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Abstract

The municipal word was derived from the word "beled" in Arabic meaning city and started to be used in its present meaning since Tanzimat period (Reorganization Period 1839-76) The municipalities are public entities established to meet the locally qualified needs of the people in the field of activity and the decision makers are legal entities selected by the local people. (one)

Every citizen living within the boundaries of a municipality benefits from the services that the municipality has repeatedly offered throughout the day or faces the unfavorable outcome of services and practices that the municipality has failed to provide, incomplete and / or poor quality. (2nd)

Developing and conscious societies are becoming more inquisitive and more efficient and useful than municipal services. The municipalities, under the pressure to provide more and better services despite their limited resources, must constantly be active in the sight of local services, producing innovative, creative and lasting solutions. The municipalities that want to be more sensitive and effective against the expectations of the local people and to be faster, more economical and efficient in the provision of services have to establish continuous and healthy communication with the public besides innovative service policies. (8)

(9) From this perspective it is understood that gaining the trust and support of the people for municipalities has a bigger preference than the other public institutions. It is impossible for all decision-making bodies to be able to fulfill their functions, services and activities, even their assets, without the support of the masses of the people, as determined by the people.

In order for the municipalities to gain the support of the people; it is necessary to use the communication techniques to establish a healthy communication with the public, to give information about the municipality works, to learn the information from the people, to learn the complaints and reactions and to develop appropriate policies to increase the effectiveness of the decisions. (7)

All of these are possible only through studies of the public, which are carried out effectively. (6)

Public Relations in general terms; "Words, actions or events that affect the people; At the same time, it is an activity of loving, accepting, counting and adopting itself to an organization, a target mass of the enterprise. "(2)

From the window of the municipality, Is seen as "a process aimed at promoting the services of the city which is directly related to, taking criticisms and suggestions, keeping the plans, projects and services in sight in this frame and preparing new projects".

Developing technology, especially the developments in the information sector and the possibilities that these developments bring to our day brings new tools to our lives. The widespread use of an extraordinary tool such as the Internet in the field of management offers new possibilities for developing communication and interaction between the state and the public. While the opportunities provided by the means of communication and information in public administration activities require the re-auditing of public relations, it also makes possible more participatory, more transparent and more auditable service production and presentation processes. (5)

With a consciousness of urbanity that will work for the benefit of the citizens, which attach importance to their wishes and expectations, and which will be developed with the open, transparent and innovative municipality concept dominating the participation and control of the people; It will not be as difficult as it is supposed to reach the goals of " People's Municipality " and " Urban Public Supporting Municipality " (9).

It is obvious that this goal can not be attained with the methods and tools of traditional people. (3) Some of these goals, which can be described as utopian; It is the starting point of this study that it is possible to reach to the public with continuous methods of communication and interaction, easy to understand, easily accessible and low cost methods and tools. As their responsibilities increase day by day, municipalities whose incomes do not increase at the same level and are constantly under pressure are also required to transfer these decisions to the citizen correctly while taking objective decisions with an innovative approach based on knowledge.

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It is thought that it is extremely important for the municipalities that it maintains to benefit from the GIS, which is the strongest means of understanding the space and the means of directing it, in establishing healthy communication with the public, which carries out its existence and all its activities in one place.

The unique tools that can be understood from the projects carried out by Ordu Büyülehir Municipality that the GIS is an extremely powerful communication tool for the municipalities in every measure, especially the metropolitan municipalities, with its easily understandable outputs.

It seems that the municipalities benefiting from the possibilities offered by the GIS, besides architecture and engineering applications, are very useful for the implementing units, the public, and the GIS professionals.

In this study, it is investigated whether it is possible to carry out the relocation of people to a different level with GIS applications where the flexibility of the WEB is brought together with the power of the map expressed as "the price of a thousand words". The experiences gained during the usage of GIS tools developed / used by Ordu Metropolitan Municipality will be shared.

Experience of Ordu Metropolitan Municipality; it would not be an exaggeration to say that one of the most important means of making communication and interaction with the public and the strong and direct expression possible is the GIS.

Keywords

Municipality, New public administration, Public relations, GIS, Satisfaction, Urban

1. Introductıon

No matter where in the world the public institutions and organizations are able to maintain good service to the public and to provide continuity by providing social support to the public. For this reason, these institutions and organizations are obliged to transfer their activities to the citizens, activities they have planned and / or planned to do, and to shape the service policy and presentation in line with the requests, wishes and complaints. This can be done through two-way communication that will be established by means of public relations (1)

Public Relations, defined by different disciplines in different ways over time; "The target group which is people, that is, by detecting the perception of the people through various means and methods; at the same time it is given to the whole of the efforts that constitute the whole of the policies which will lead to the functioning of the institution or the organization and the future according to the expectations of the people by constantly communicating with the public.

Citizen-focused, the ultimate destination of public relations activities, is also a major area of concern for all local governments, especially the municipalities. The municipalities can continue their citizen-focused practices; depends on the ability of the citizen to detect and understand the perception well and to react correctly. In an institution such as the municipality, which is intertwined with the public and whose organs are elected by the people, it is vital for the public to perceive and trust the municipality.

In Law No. 5393, Article 13, Hemşehri (Fellow city/Countryman) law is expressed as follows; "Everyone is a citizen of his own country. Hemşehriler has the right to participate in municipal decisions and services, to be informed about municipality activities and to benefit from the help of municipal administrations. The municipality carries out necessary work on the development of social and cultural relations among the citizens and on the protection of cultural values ". As you can see, participation, transparency, transparency and citizenship orientation of the new public administration principles are also expressed in the law of citizenship. In the new legislation and the studies conducted by the local governments, it is aimed to put the citizen-oriented principle in the forefront.

The municipalities, general decision-making organs are institutions that come and go according to election. This makes municipalities more sensitive to the wishes and wishes of the people than other parts of public institutions. Because the municipalities are closely interrelated with the daily life of the people, even small delays and disruptions can often

cause great reactions by the people. Most of the time, politics and actions that serve the interests of the people are not enough and it is necessary to explain it to the right people. (1)

The municipalities are their own institutions of the people, they come out of the election, they are for the people of the city, in principle their resources are provided by the people of the city and they spend these resources for city service in accordance with the decisions of the people of the city. For this reason, the people of the city want to be aware of this process and wonder if the resources are being used effectively. The municipalities are also obliged to provide this support to the city people in this process. Otherwise, a profile of city people dissatisfied with the municipality emerges, which creates a dangerous situation both for the financial support of the people and for the political future of the mayors. In this respect, we can say that " municipalism, in fact, is totally related to a people (9). "

It is important for municipalities that the four main purposes of public relations are; "To inform citizens about the work done by the local organization, to place and develop the sense of citizenship and responsibility, to enlighten the people about the activities carried out, to place the sense of participation in the administration".

Local governments use a variety of tools to reach the target mass. Public relations are one of the most important and effective means of reaching the target group.

Changes in the social and political structure have made the municipalities more sensitive to the public relations. For municipalities, public relations have a special importance. On this situation, it is important that the municipalities have a determined administrative structure with the votes of the people and that the people are self-directed intermediary institutions.

Many municipalities today; there are units that undertake the task of organizing relations between the people and the administration, or at least transferring their work to the public, even with different islands. (Sezen, 1991,1).

However, these units should serve realistic purposes by becoming signage units, and should do more planned and programmed work than cut cutting, which plays a more active role in terms of integration with the people.

1.1 Traditional Public Relations Tools; (one)

1.1.1. Written Tools

- Establishment Newspaper
- Journal
- Brochure
- Newsletter
- Annual
- Handbook

1.1.2. Tools for Eyes and Ear

- Radio and Television
- Film and Slide
- Internet

1.2.3. Organization Activities

- Exhibits
- Events
- Meetings
- Workshops
- Contact with groups and representatives
- Public Opinion Surveys, Surveys and Referendum

The main purpose of the municipal administration is to reach people through relations; "To make a positive impression on the local community should be to increase the efficiency and efficiency of local services."

The municipalities are institutions established to meet the needs of the people. In the process, the areas they serve expanded and the service diversity of the municipalities decreased. It is not possible for the municipalities that are trying to produce services in every area of life to have a chance to catch all these works at the same time. Besides good planning, it is extremely important for public support that people need to be informed about the buildings and / or things to do. The support of the people depends on the belief that it does some useful and important work for him. The best way to do this is to explain and explain the management as if it is really important to do a number of things and to do what they do with the mass media (Güz 1992, 3).

For this reason, it is important that the municipalities are closely related to the people. The formation of this bond between the public and the municipality is made possible by effective communication. Relations with the public aim to use these mass media effectively.

It is not possible to obtain the desired results by using methods related to traditional peoples. Municipalities have to use faster, more efficient and more efficient means of communicating. Technological opportunities should be exploited, technological tools are not used until the last. In today's world, continuous communication with technological means and possibilities has become possible. The most visible and beautiful example of this is the use of social media. All institutions and organizations are trying to establish a continuous and healthy communication with their target mass with social media tools.

Almost all of the activities he pursues are in order to establish healthy communities with the people who are living in a place, the municipalities, their presence and all their activities in a place; it is assessed that it is necessary to make use of the mistake of understanding the place and making use of the GIS, which is the most powerful means of managing and analyzing data about it.

Our experience in the three-year metropolitan municipality, where GIS is an extremely useful tool in the field of public relations, is also understood in our engineering architectural areas, which we are familiar with for use in areas such as reconstruction, planning and infrastructure.

Spatial data in the power and data to rapidly transform to information in the field of GIS classic municipal activity space and all the work and operations for people living on simplifying accelerate is efficiency also increases in an undisputed manner.

The answer to the question of whether or not it would be possible to use GIS in the field of public relations would in fact be the same as the answer to the question of whether the relations between the public and the public stated in the education and research report will be met by GIS facilities.

General purposes of public relations;

- ✓ To determine the tendencies, manners and behaviors of the public about the organization and to make suggestions for making improvements in accordance with the results obtained by the organization,
- ✓ To help the organization to establish and adopt the corporate identity,
- ✓ To contribute to the development of democratic values,
- ✓ To develop mutual respect and social responsibility feelings between the establishment and the people,
- ✓ To prevent disagreements and misunderstandings,
- ✓ To provide counseling by understanding the real causes of human attitudes and behaviors,
- ✓ Analyzing future trends and forecasting results.

It is clear that the above listed aims can be met by GIS capabilities.

The belief that the people of the region are aware of the importance of the municipal government and the city they live in and the fact that they are satisfied with the distribution of the services and the decisions they can make, the fact

that they are aware of the structures and the works to be done in order to see them as a habitable area now and in the future, and it feels like it belongs there.

With GIS, the public is able to inquire as to whether the services are being equitably distributed, while seeing what the municipality is doing, while seeing what is done / done.

With GIS, the municipalities have taken the initiative to improve and improve themselves by opening themselves to the evaluation and inspection of the people. It may be possible for the people of the city to trust such a municipality, to provide support, and thus to have a positive perception.

2. GIS Based Public Relations Practices

Ordu Metropolitan Municipality will not be able to mention these applications because it is outside the scope of studying these applications together with web pages and e-municipality applications. We will try to provide information on the GIS-based public relations practices being carried out by our municipality in accordance with the spirit and spirit of the work.

2.1 White Table GIS Integration

White Table, which was established for the first time in 1994 Istanbul Metropolitan Municipality within the scope of 24 hour service, is the most common public relations activity that has been implemented by many municipalities in our country since day one. The White Table Unit communicates to the relevant departments in order to resolve the complaints and opinions of the citizens by phone or in person, verbally or in writing. Requests and complaints are made by the members of the unit and returned to the citizens.

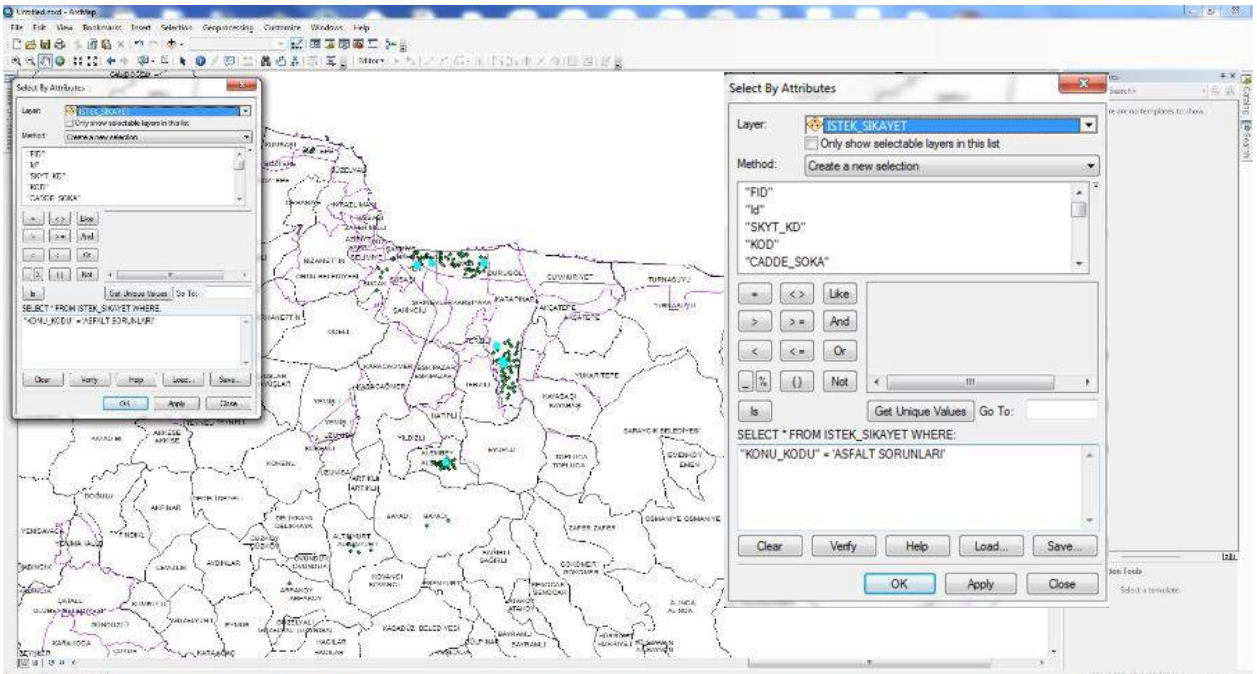

Figure 1. White Table GIS Integration

Incoming requests and complaints are related to the location, in which area the complaints come, and the thematic request complaint maps can be easily understood by the related units. Historical records of requests and complaints, repetition

and repetition are recorded, while other spatial data are superimposed on each other, trying to determine the source of the problem and attempting to solve the problem with permanent solutions to be provided.

While trying to determine the existence of the problem, the source, the possible solution proposal with the spatial analyzes made, the possible effects of the planned solutions to be put into practice are tried to be determined in the groups and layers that will affect them.

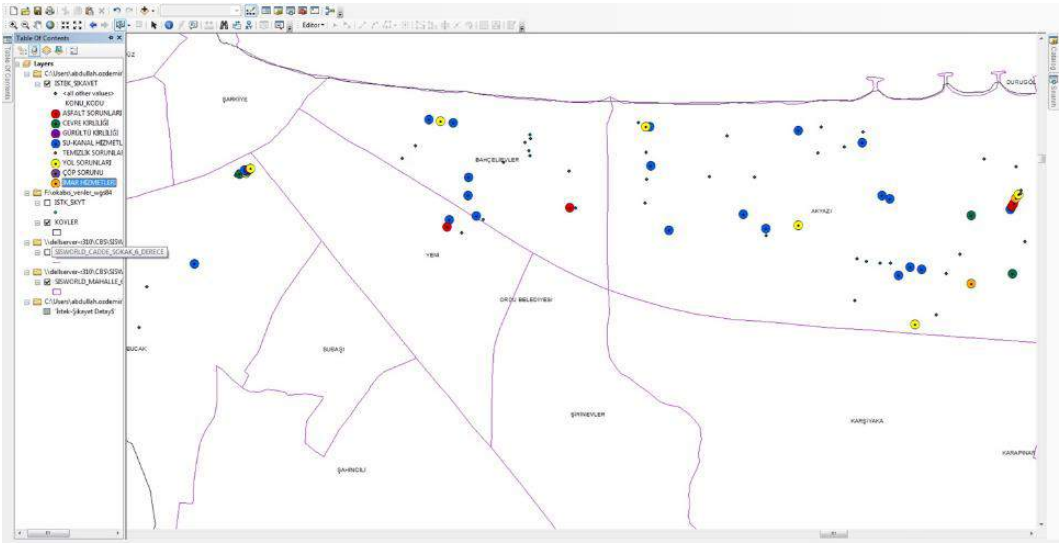

Figure 2. White Table GIS Integration

2.2 Ordu Spatial Investment Monitoring System (OSIMS)

The studies carried out in the whole of the city with the project database of the Ordu Spatial Investment Monitoring System (OSIMS) or more in the name of Project Database; thanks to maps and satellite imagery. While information about each application made / made by our municipality can be obtained with OSIMS, the spatial distribution of investments is shared with the whole public. The honesty that citizens expect from their management has the opportunity to inform about municipal activities while transparency is met.

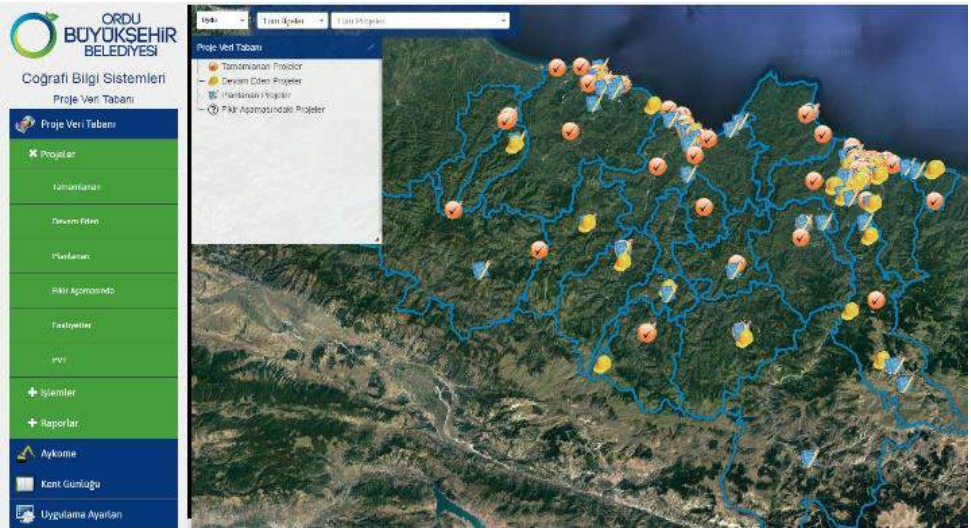

Figure 3. Ordu Spatial Investment Monitoring System (OSIMS)

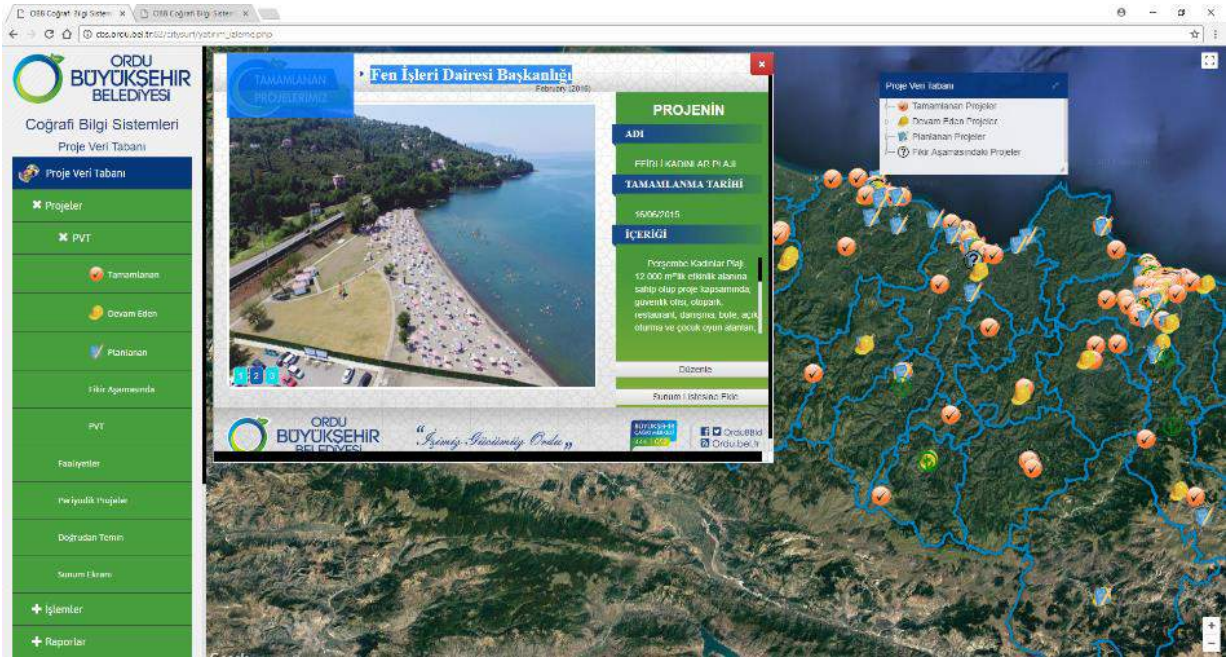

Figure 4. Ordu Spatial Investment Monitoring System Information Card (OSIMS – Card)

2.3 Ordu City Diary

With the application of City Log, which is a means of linking with other GIS-based people, all events and activities related to the city and the city from the opening to the funeral, from sports meetings, meetings, festivals to closed roads are presented to the public. With Ordu City Log, which is the opening screen of the Ordu, many of the information that citizens need in order to do their daily planning can reach Spatially over a single screen. On the one hand, while the archives of the city's agenda are kept, the city-dwellers, who are informed about the structures and the buildings to be built in advance, are valued and feel themselves special and belonge to city.

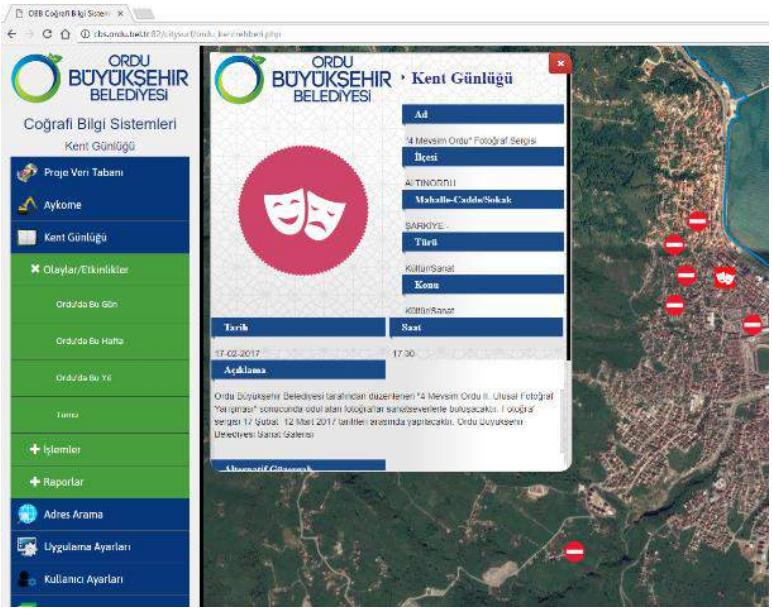

Figure 5. Ordu City Diary, Events

Pre-announcement of the works will increase the confidence in the municipality while ensuring that the work is done in the direction of a certain plan and program. Increasing public support will open the way for the municipality to produce more radical, more permanent solutions. High-level satisfaction will result in a stronger municipality, a stronger municipality more qualified service delivery, more qualified service will be in the form of more satisfaction, and the snowball effect will increase the quality of service and social welfare significantly.

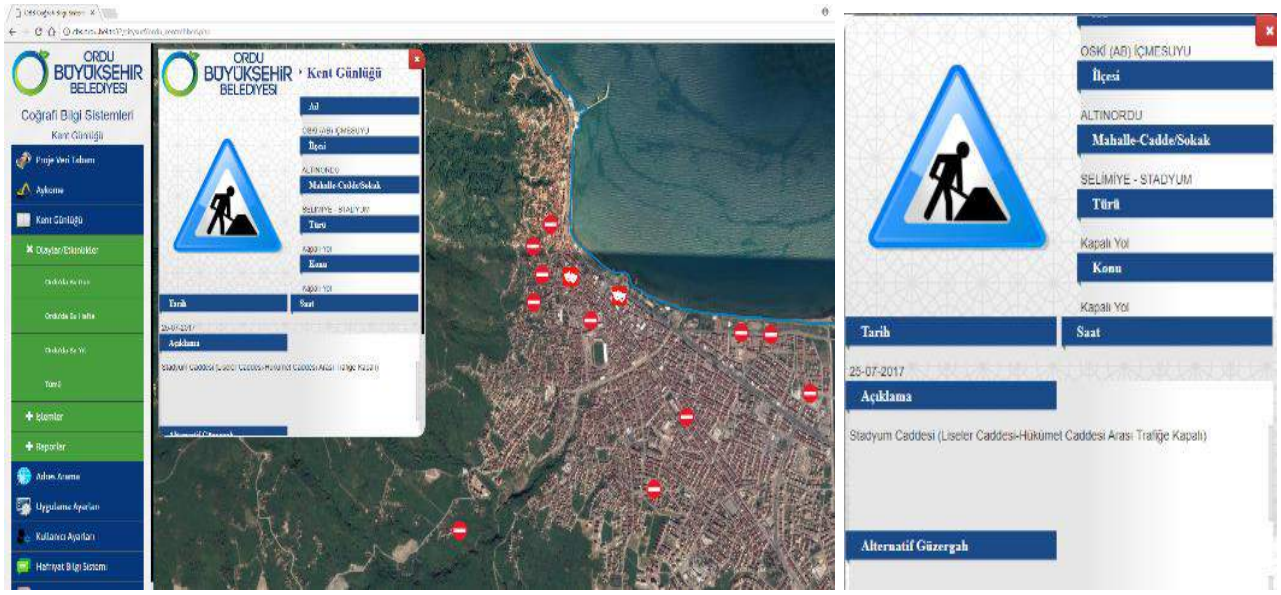

Figure 6. Ordu City Diary, Closed Roads.

Acknowledgements

The municipalities are those that are equipped with the duty and responsibility to provide various public services in the geographical area to which they are entitled and for which they are granted administrative and financial autonomy.

Being the closest managerial units to the public, municipalities are more advantageous in terms of efficiency in public service provision than central administration.

Community support is the first condition for the success of local governments. (4) The municipalities that are selected by the public and need the support and support of the people of the city need professional units to provide continuous communication with the public.

People's relations as a management understanding and practice directly affect the success and productivity of the municipalities, as they are in all other organizations, aiming at the improvement and development of the managerial functioning and service as a whole in the municipalities.

To establish good and continuous communication with the citizens at every stage of service; helping municipalities make meaningful and useful decisions, and introducing the services they provide to the management to show them more sympathetic and closer to them. (3)

Many public organizations that are aware of the importance of reaching the public through channels are either forming units to operate in this area or are carrying out some work on this area.

Developing technology, especially the developments in the informatics sector, and the possibilities that these developments provide are causing changes in the municipalities as well as in other areas. In this context, the Internet and Web sites are important tools used in relation to the public. Because today, without the use of the Internet it is almost impossible to carry out effective public relations practices. (9)

The widespread use of many technological tools and innovations, especially on the internet, offers new possibilities for developing communication and interaction between the state and the public. The new and powerful tools provided by means of communication and information have led to a re-examination of public relations in public administration.
It is obvious that targets such as "People's municipality" and / or "Urban public that support the municipality" can not be reached / attained with the methods and tools related to the traditional people. The municipalities, which have increased workload and limited resources, are thought to need innovative means of communication and interaction with the public, strong means and direct narratives.

It is estimated that almost all of the activities it maintains are inevitable to benefit from GIS in order to maintain healthy communica- tion with the public, who are living in a place, their presence and all their activities in one place.

Requests and complaints delivered to the White Table in the Ordu Metropolitan Municipality are held as Spatial and comprehensive analyzes are carried out in which many existing data related to the area, subjects are included in the calculations. With the findings obtained as a result of the analyzes made, the subject of the complaint comes down to the origin and trying to produce permanent solutions.

With the flexibility of the WEB, the Ordu Conservative Investment Monitoring System blended with the strengths and abilities of GIS, the ongoing and completed investments planned by Our Municipality are registered as Spatial, the spatial distribution of investments, the investment process, and the momentum with both the municipality employees and the citizens It may be shared. When the people sees what is done in the city and sees the diversity of the study area and the size of the study area, it can display a more relaxed attitude instead of accusing the municipality due to delayed services.

With the "Ordu City Diary", which is the opening screen of the Ordu, which offers the opportunity to consolidate the urban and urban culture, many of the information that urban people need to do their daily planning can be accessed positively through one screen. It seems that the municipalities can not meet and meet the ever increasing demands for services with traditional approaches and insights. In order to get rid of such a burden, municipalities are required to transfer these decisions to the citizen in an easily understandable way while making objective decisions with an innovative approach based on information.

In addition to effective management, effective resource management, effective management, and effective communication, GIS is experienced as a very useful tool, or almost a "life preserver", for over three years, which is a necessity beyond mere necessity for municipalities.

References

ACAR, Muhittin: Public Relations in Municipalities, DPT Publication No: 2337- SPGM: 423, Ankara, December 1993.

ACAR, Muhittin: "Public Relations Survey in Turkish Public Administration, DPT Publication, Ankara, January 1994.

ÖZÜPEK, M. Nejat (2013). Public Relations in Municipalities, Konya: Education Publications.

PELTEKOĞLU, Filiz Balta (2012). What is Public Relations ?, Istanbul: Beta Publications.

TARHAN, Ahmet and BAKAN, Ömer (2013). Public Relations and Citizen Perception in Municipalities, Konya: LiteraTurk Academia Publications.

TORTOP, Nuri (2006); Introduction to Public Relations, Judicial Publications, Ankara.

UYSAL SEZER, Birkan: "The Local Government's Environment-Public Relations and Opinion Research", Amme Magazine, Volume 20, Issue 1, March 1987.

RAIN, Aslı (2011). "Political Participation and Public Relations: An Investigation on Internet Sites in Ankara Central District Municipalities", Turkish Journal of Administration, 471-472: 185-204.

YALÇINDAĞ, Selçuk: "Belediyelerimiz and Relationships with People, TODAİE Yay. 1st Printing, Ankara, December 1996.

YAYINOĞLU, Pınar Eraslan (2005); Public Relations in Local Governments, Birsen Publishing House, Istanbul.

Izmir Metropolitan Municipality Geographic Information System Studies

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Abstract

İzmir Metropolitan Municipality Geographic Information Systems Branch Directorate conducts many studies that analyze and report the spatial information in the project development processes related to the priority issues such as infrastructure, construction, environment and natural resources by providing online access to the spatial information needed by the users in their jobs and transactions. In addition, graphic and / or non-graphical data used in the institution is brought to certain standards and plays an active role in storage, management and sharing. In this report, our municipality describes the process of translating verbal and graphical information into intelligent data format, transferring data to the system through inter-unit interoperability principle and keeping the system alive. In particular, information on Smart Road / Mobile Mapping, Urban Information System, Geographical Cemetery Information System, Infrastructure Information System and GIS-MIS data mapping processes and their continuing processes are planned to serve both the institution and İzmir citizens are given.

Keywords
Interoperability, Intelligent Data

1. Transport Information System

Many studies have been completed within the scope of storing, updating and sharing of transportation data determined by the Geographical Information Systems Branch Directorate correctly and rapidly and the information about roads and roads in the municipality borders (traffic direction, number of lanes, traffic signage, signaling etc.) "Smart Road Project" studies are being carried out in order to collect the panoramic photographs and transfer them to the Geographic Information System Database (CBSVT), to prepare the necessary software for updating all these data, to be connected with the 2-dimensional city guide that our municipality has and to provide internet and intranet service. With the project in question;

- The information about tranformation will be kept up-to-date (location and status of signaling and traffic signs, one-way / two-way roads, open / closed roads, asphalt roads, etc.) by gathering information on transportation under a single database and using rule-based software,
- With the help of the other data available in the Geographical Information System Database (CBSVT) and details of the road, many inquiries can be made for decision making processes of the managers will be accelerated,
- Coordinate reading, horizontal distance, vertical distance, oblique distance, circumference and area measurements can be done on panoramic photographs and inventory can be created for these details,
- A reliable "Shortest Path Analysis" can be done with the route directions and address data transferred to the database,
- Panoramic photographs of all İzmir roads will be collected and a historical archive of the city's status will be obtained.

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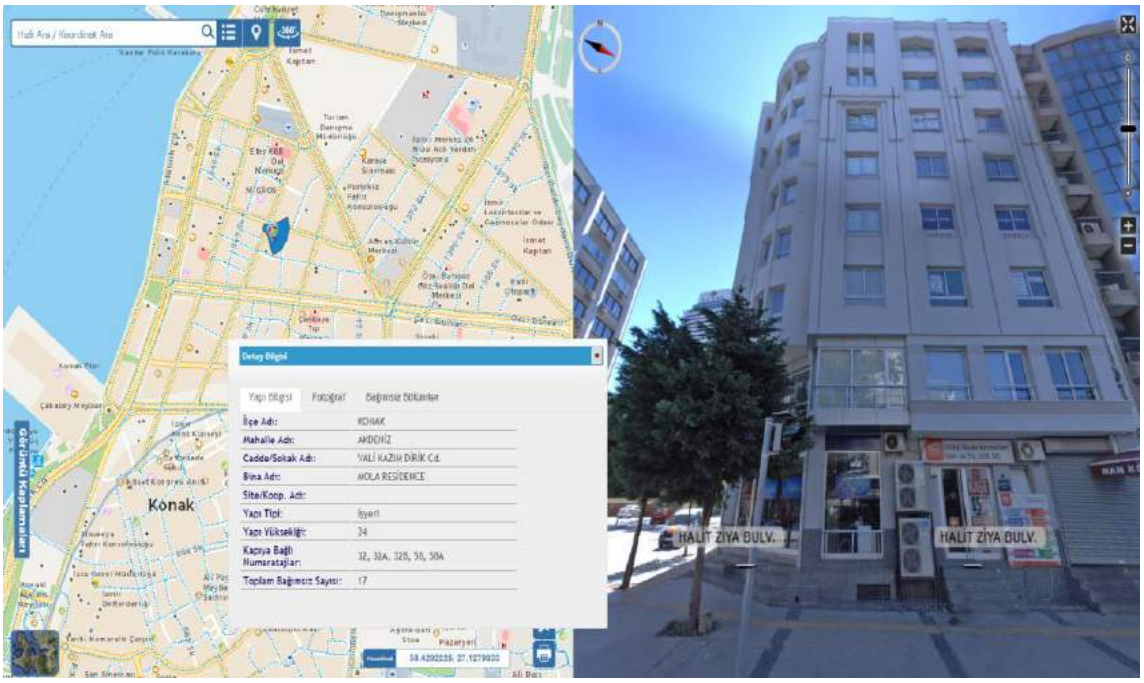

Figure 1: City Guide

The project which is expected to be completed in about 1.5 years has started in November 2015 and the tender process has been completed on May 2017. The project, which covers 30 districts and has panoramic views of the roads of 22.000 kilometers long, will be opened at the beginning of 2018. This project will facilitate many technical operations, save time and labor in field works, especially in case of emergency, rapid traverse analysis "which is presented correctly and quickly to vehicles such as fire brigade will be able to make quick transportation to the scene and ensure that the constantly changing / living field situation is kept up to date in the system.

Figure 2: Measurement on panoramic photo

2. Urban Planning Information System

İzmir Metropolitan Municipality can evaluate the current plans of the city as a whole and provide easy access to the plans and to monitor them in such a way as to be a base for the projects by presenting the development plans, present maps and

cadastral maps together, has continued to live and experience the project of Reconstruction Information System, which has been acted through the principle of interoperability within the organization, in order to ensure the analysis and synthesis that are essential.

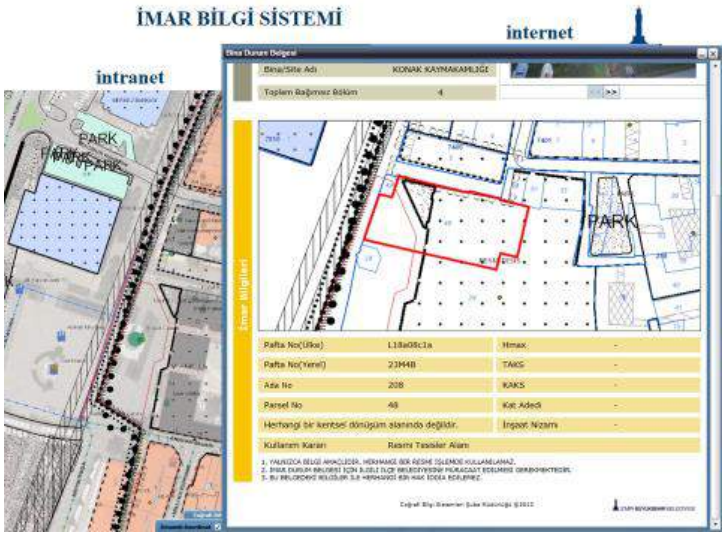

Figure 3: Urban planning data

All data recorded in the reconstruction information system are stored in CBSVT which is the spatial server of İzmir Metropolitan Municipality. The control processes of the plans transferred to the system by the staff of the GIS Directorate are provided by the Directorate of Reconstruction and Urban Planning. In addition, each of the districts are carrying out their own plans to record their plans and data entry / update operations can be performed in the work started with Konak District Municipality and recorded directly in CBSVT. In addition, each of the villagers is carrying out their own plans to save their plans in the system

For example, data input / update operations can be done in the work started with Konak District Municipality and the changes are recorded directly in CBSVT.

All the application development plans recorded in the system are presented to the employes of İzmir Metropolitan Municipality in the intranet environment and this information can also be seen in the district municipalities that request it.

Figure 4: Smart 1/1000 scale application development plan information

3. Geographical Cemetery Information System

The Geographical Cemetery Information System has been put into practice in order to make it easier for the citizens visiting the graveyards to reach the graves of their close relatives and a total of 17 cemetery areas have been integrated into the system so far. In this project, each grave in the cemetery is positioned by measuring from at least 2 points and all grave photographs are taken and paired with verbal data. With this project:

- To reduce the time required for visitors to graveyards to find the graves they seek and to ensure that both witnesses and officers save time and manpower,
- On special occasions, it is possible to greatly reduce the confusion experienced by the visitor,
- To find the sought but not found grave sites in any cemetery by searching in the common data base and to be able to navigate to other graveyards when necessary,
- Due to the necessity, spatial planning can be made on the basis of digital map data and new grave sites can be established in order to determine new burial sites,
- By means of the system, it is planned to reach the various statistical information such as the causes of medical deaths, male-female ratios, ages and countries of the deceased persons, and even more, by using these statistical data, it is possible to produce thematic maps which constitute the subjects such as disease and crisis management.

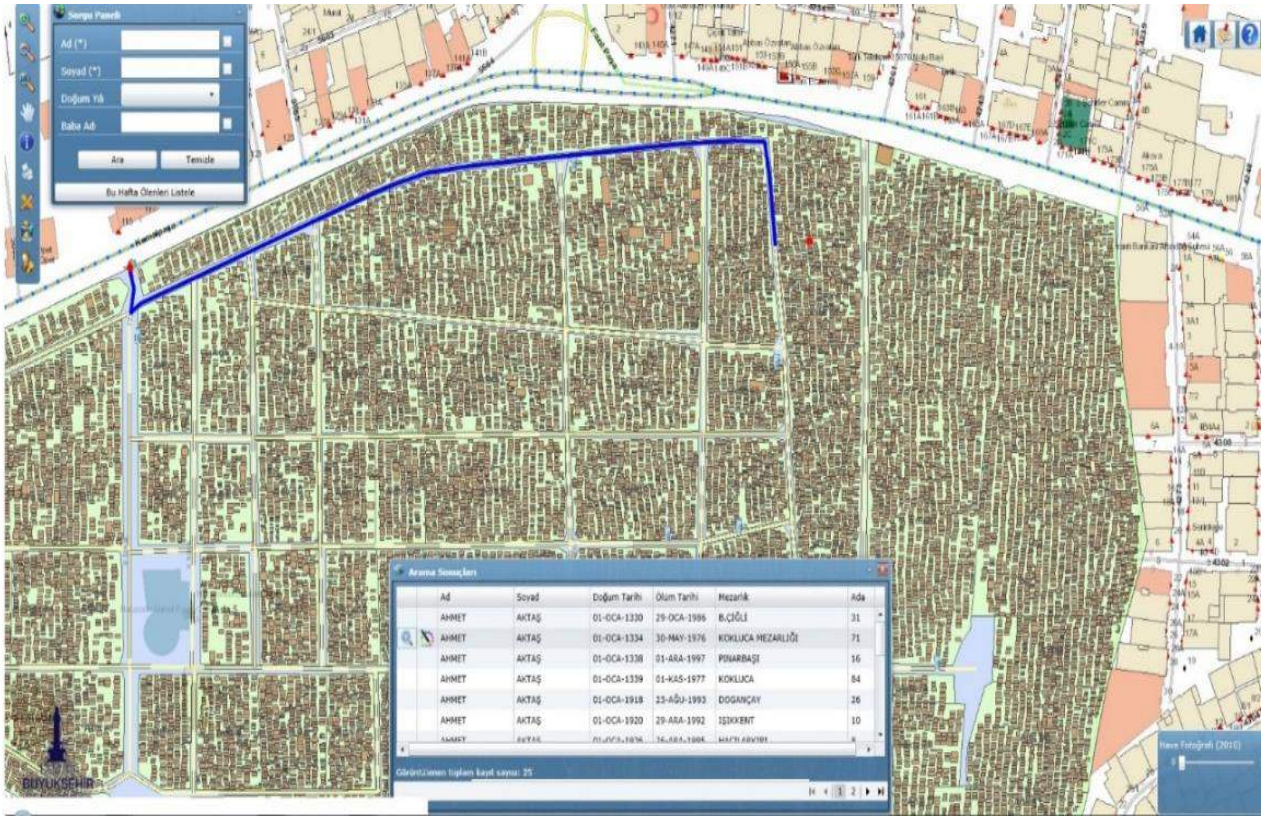

Figure 5: Grave Questioning and Shortest-Cut Analysis

In order to maintain the system, graveyard updating software has been prepared and used by the Cemetery Department to provide a new burial site drawing, photographing and matching with the grave site. In addition, the cemetery areas that have been transferred to the system but are still being buried can also be updated in a positional manner, the grave site can be drawn and the photographs can be added.

4. Infrastructure Information System

Within the scope of the infrastructure works carried out in the İzmir Metropolitan Municipality, the Geographic Infrastructure Information System Project called CAYBİS has completed the studies planned to record all the excavation license information as positional, to follow up the institutional excavations and to give excavation permits on the same dates instead of different dates. necessary trainings were given in the subject. It was also ensured that all applications for

excavation requests were made via the system and in a positional manner, so that these data could be transferred to CBSVT.

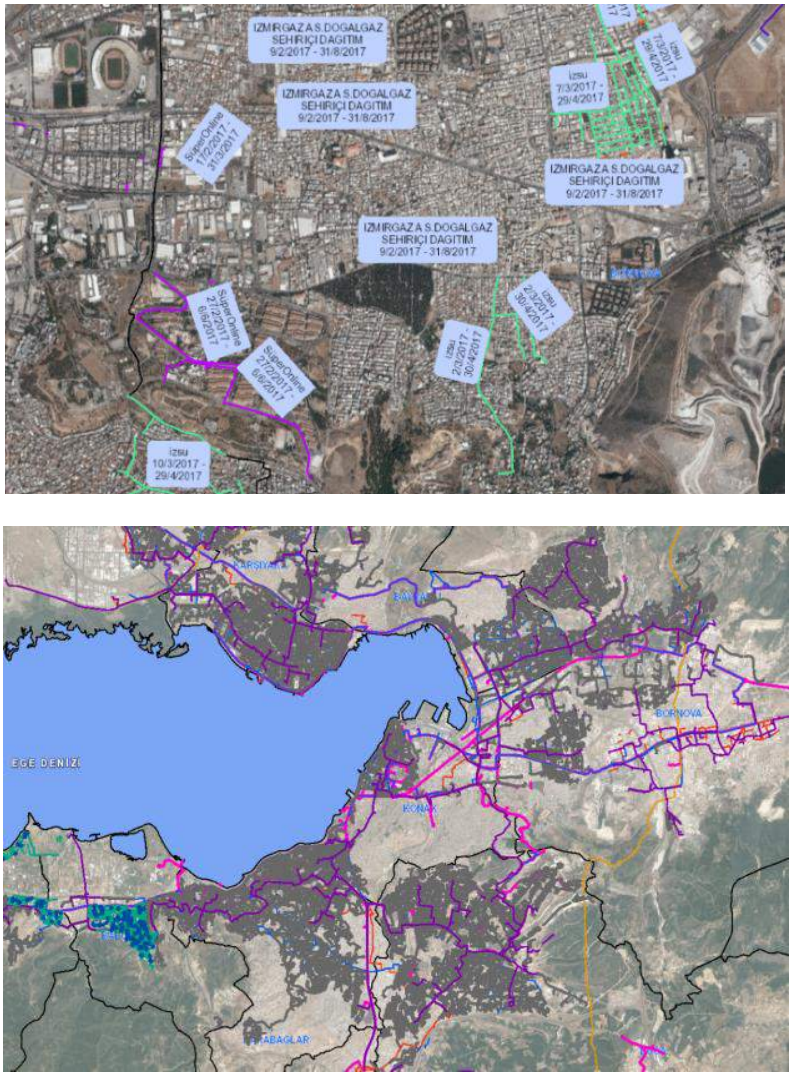

Figure 6: Geographic Infrastructure Information Screens

In the system it is obligatory to add spatial information files showing the streets where excavation is to be carried out during the application for excavation. In order to enable the geographical information to be easily prepared by the infrastructure companies, the "Geospatial Infrastructure Data Production" application has been prepared and given to the requesting institutions by the Geographical Information Systems Branch Directorate. In this way, it is easy to make inquiries such as where, when and where all planned excavation work is done and whether there are illegal excavations.

The first part of CAYBİS project, which is targeted to be realized under two main headings, registering the application phase as a position system, has been completed. The second part, "as-built data integration into the system process" continues. In this phase, interviews with infrastructure companies are carried out, and the archival attribute information that needs to be transferred to the database is collected and software is prepared for this.

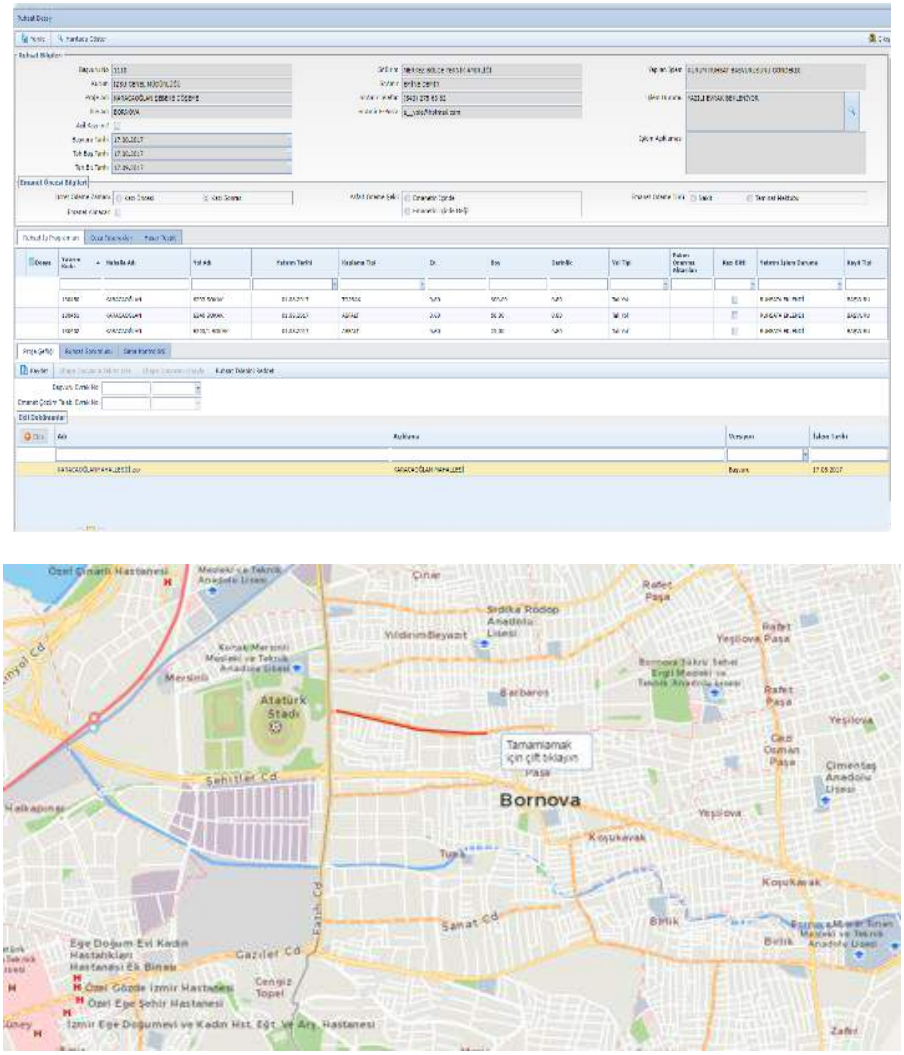

Figure 7: Geographic Infrastructure Information Screens

5. Mobile and Desktop Applications

The software that enables the managers of our municipality to easily access the spatial data they need in the decision making process, to monitor infrastructural works and the projects of our municipality and to interrogate and query the cadastral information and urban plans via mobile devices was prepared and presented to the managers.

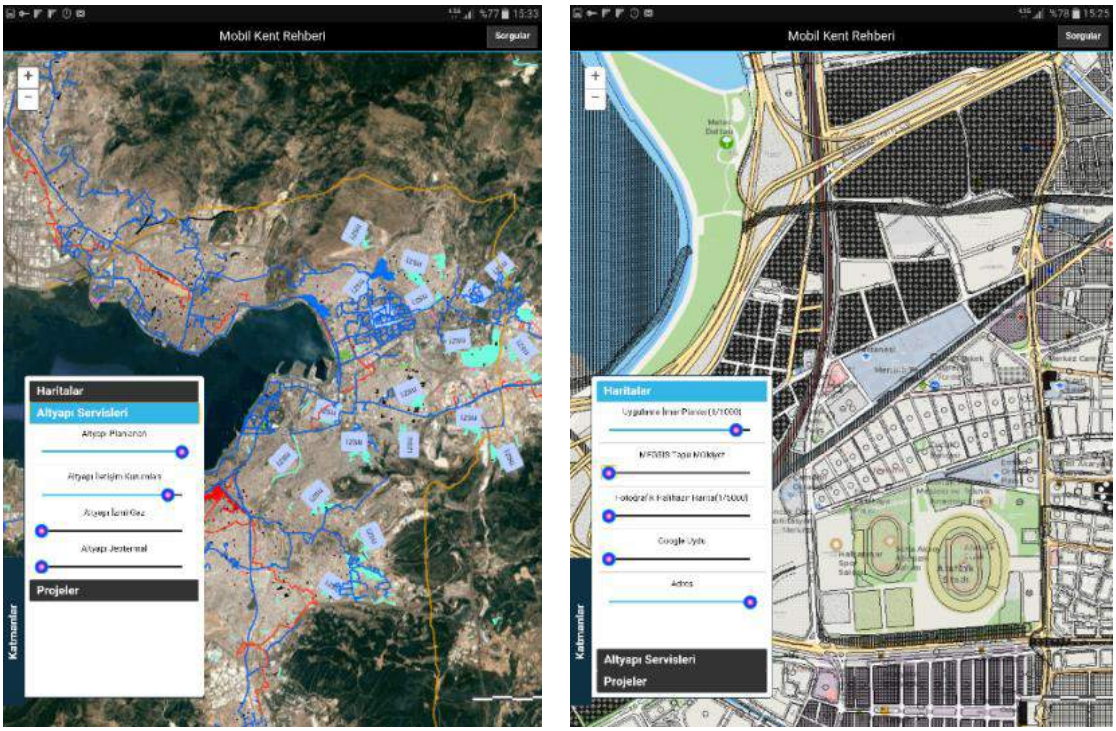

Figure 8: Mobile Application Information Screens

In addition, the mobile applications(which prepared by our software development staff) used to display the application development plans, current maps, cadastral maps and aerial photographs stored in the system using cad software are presented to the service of the users. And also, development process of showing the results of the queries made on MIS applications on the map is ongoing. In particular, a web-based application has been prepared in order for the address components to be entered into the system by the Address and Numbering Branch Office and to be easily displayed / selected via the MIS programs in the studies where this information is used. This application, which is initialized by integrating into HIM application program, will be adapted to all MIS softwares one by one.

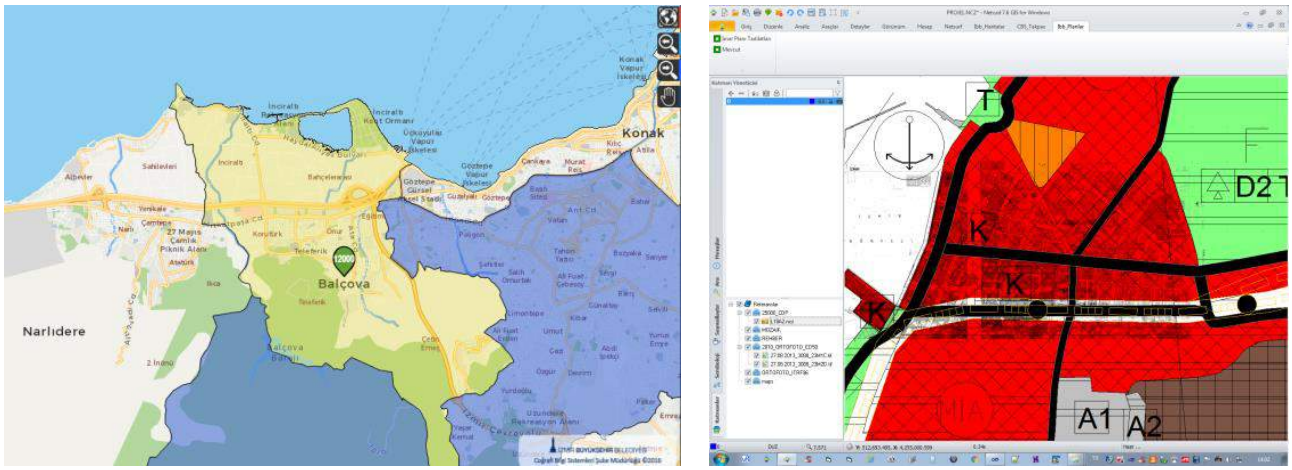

Figure 9: MIS Integration Studies

6. Conclusions

Local governments continue their efforts to establish the City Information System with the authority given by the Law No. 5216. However, the establishment of a system, the collection, storage, analysis and presentation of data is not as easy as it is expressed. Time is needed to plan, manage and mature a set of organizations that will take place within the system as a whole. Unfortunately, many applications that are made available to the staff for use without the enough knowledge, appropriate hardware and software will be vanished. it is very important for managers to be committed to GIS and data operators to be conscious about it, thus the system can be kept alive. Therefore;

Geographical Information System;

Ensure that all public and private institutions and organizations become aware of how valuable and important information the spatial data is and that the information needs to be produced and shared once by the owner,

Transformation of the National Address Database (UAVT) into the Spatial Address Recording System (MAKS) and the fact that the Land Registry and Cadastre Information System information is shared in place is one of the greatest evidences.

Geographical Information System;

It shows how necessary it is to keep the data in the databases as smart data instead of being stored in the personal computers as datalists, to make the queries and analyzes needed and to display the result values on the maps,

Projects that all local governments, public institutions and organizations try to develop with different names such as e-guides, city information system applications, management applications are one of the greatest evidences.

But Geographical Information System Is Still;

Is busy explaining and teaching to the highest authorities that a new project or existing information can be stored in a system under certain standards, can not be updated and maintained by the authorities in a few days, but a much healthier system can be built in the long run.

Geographical Information System;

Is busy telling data operators that smart data production should be rule-based and in certain standards.

And Geographical Information System;

Is busy trying to express that it is right to produce and share smart data in collaboration, otherwise confusion, duplication and waste can not be avoided, and it is right to decide together rather than making decisions on their own.

Integrated Information Systems: Silifke District Example

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Abstract

The Management Information Systems (MIS) used in local governments is one of the most important tools for making citizen-oriented services efficient and fast. It is a known necessity to manage the city using spatial inquiry and analysis thanks to Geographical Information System (GIS), Electronic Document Management System (EBYS) and Land Registry Cadastre Information System (TAKBIS). In this context, as it is in the case of the Silifke district, the MIS, GIS and EBYS systems are designed to be integrated with each other and with information systems of other public institutions. Through the Integrated Information Systems, real estate inquiries were made, analyzes were made and the transition between information systems was realized.

Keywords

Integrated Information Systems, Management Information System, GIS, EBYS, City Information System, Silifke

1. Introduction

Such as in the cases of added spa facility management, animal shelter management, library management, etc. that are expandable by the scope of the municipality MIS, subsystems, modules and modular structure and which fall within the scope of duty defined in accordance with Laws 5216 and 5393, It is known that it is as wide as possible. In this context, local administrations Organize Industrial Zones, Unions, Campuses, etc. the MIS application software modules that require different types of processes, functionality and services for administrators will need to be expanded and be open to the modular structure. TERAMIS MIS softwares that are used in the example that is the subject of the report have features that meet this idea developed with today's software technologies.

Explanation of GIS as expert personnel components that operate entirely with the computer hardware, network infrastructure and software tools necessary for the computerized management of the location and quality information of assets located on the settlements defined in the local administrations in a map frame (window) It shaped. In our example, the municipality is integrated with the existing NETCAD graphics and geo-application software.

Electronic document management system (EBYS), digital documents created in compliance with legal standards and their own standards can be submitted as additional document information and can be used for electronic documents such as electronic signature, mobile signature etc. in accordance with process definitions and processes of work orders and transactions we see them as system components that can be integrated with today's computer technologies. TERADESK EBYS has been developed to enable real person and legal entities to get the results of their business and transactions from e-government through the conversion of information and documents to e-government. According to our opinion, the EBYS is the name of an architect who communicates with all his counterparts for local governments and has links to all spatial (geographically) based data fields that are required in terms of Urban Information Systems (CIS).

It is known that information systems in the municipality for citizen-oriented location-space related services are always of critical importance regardless of the external data requirement, the form in which the data is given (printed and / or numerical). In addition to being efficient and fast in services, managers in organizational structures also play a key role in making the right decisions.

Since government agencies are required to produce work and expertise but some of them are necessary for other institutions as well, they are presented in the form of printed and valid documents (before information systems) in digital form, transactions exchanged with web services of shared data, it is possible to evaluate software-server-communication tools and expert components that provide it as e-government integrations. Similar integrations can be summarized as GIS and MIS integrations directly with the Identity Sharing System (KPS), Land Registry and Cadastral Sharing System (TAKPAS) Spatial Adres Registry System (MAKS) web services.

This is the information system in the Municipality of Silifke, which is mentioned in the main title; partly without integrity, and incompatible with co-management, it can be partially seen on the web environment (as far as the application is concerned) as to the level of the work described below.

2. Local Governments

The local government, also called as the management from its place, is a management system based on the management of local people by their own hands. The local authority is an administrative unit under the supervision of a local authority authorized to issue rules and obligations to the central government.

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Local governments, which are obliged to make best efforts to provide services related to urban and urban areas, have to meet the needs of the age and also to direct the technology according to their own needs. That is why they must use integrated information systems to serve urban and urban areas with advanced technologies. Spatial and non-spatial data should be transferred to information systems and more than one information system should be run in an integrated structure. With this information, local governments should make their decisions quickly and accurately.

3. Information Systems

Information systems are systems that store data according to established standards for obtaining data and presenting it to the user. It is inevitable that local governments that want to be active in the management of city and city services reach this information in the fastest way, support with geographical analysis, base the document and decide on this information.

3.1. Management Information Systems

Local governments use management information systems with databases, strong hardware, and network configurations that cover all of their units' activities. Interactive municipalities are systems that benefit local governments to work quickly and accurately, integrate location-based information production, staff and business management, fully-controlled audit, e-municipal and state information systems.

3.2. Geographic Information Systems

One of the most important contributions that bring the information age to central and local government geographic information systems are also having an increasing importance in our country, no doubt. The first steps in the field of GIS were taken in 1963 in Canada with the project of geographic information systems consisting of inventory studies aimed at determining the size and usage patterns of the country's land. Today, with more than 50 years of knowledge and support of satellite technologies, geographic information systems are now in daily life. Geographical information systems are a collection of geographic databases, software, hardware, personnel, standards and methods that come together for the functions of gathering, storing, querying, analyzing, submitting and exchanging the information needed for research, planning and decision-making bodies according to geographical bases.

GIS has application areas in many sectors such as urban and regional planning, agriculture, forestry, landscape planning, geology, defense, security, tourism, archeology, local governments, population, education, environment and medicine.

3.3. Electronic Document Management System

Topographical, Institutional communication tools and documents that form the legal basis of business processes have an indispensable prescription for the functioning and continuity of administrative systems. In this context, effective management of documents requires a structured document management system. It is important to consider national and international regulations and standards as well as the conditions that affect or determine the administrative and legal process in the process of structuring document management systems in institutions. In a structured system, it is necessary to treat confidential and coordinated documents of life based on trust together with public regulations. On the other hand, electronic documents management is one of the main components of e-government services in today's world where information and communication technologies directly affect corporate business processes. Acquisition of electronic services for public services performed in the business processes defined in the law requires the electronic transactions of transactions previously carried out with a wet signature to be carried out electronically. Beyond simple one-way information exchange in the web environment, e-government applications aiming at carrying businesses and processes carried out by institutions within themselves, with each other and with citizens, are based on complex electronic document management models. In parallel with traditional document management, electronic document management aims to manage within the life cycle the documents that are the evidence of the institutional processes that institutions create while performing their routine tasks, from all kinds of documentation, preserving their content, format and relational characteristics.

EBYS in brief; is an information system that includes all the programs and applications for the production of documents in the electronic environment or for the control, organization, use and archiving of documents in the electronic environment.

Local governments aim at standardization of correspondence, shortening of processes, increase of document reliability, preservation of institutional memory, saving (labor, time, stationery, etc.) and making a healthy archive by making in-house and out-of-office correspondences in electronic environment.

3.4. City Information Systems

Data of topographical, thematic, zoning, cadastral, property, administrative, environmental, plan, economic, population and demographic, social-technical infrastructures etc. will prevent repetition of data in a common reference system in a certain format and accuracy, collecting, processing and analyzing the information to facilitate the flow of information has led to the development of the urban information system.

The city information system is a system that analyzes the relevant information in a fast and healthy manner, which is necessary for the purpose of making the optimum decision about the fulfillment of the urban activities on the basis of the public services and managing these activities.

Information that forms the basis of urban information system (parcels, buildings, condominium), technical infrastructure (electricity, water, sewer, gas and other networks) and human. This information, which is related to each other, requires a healthy and appropriate scale of convenient mapping before all of them can enter the system. It is necessary to integrate institutions and organizations in the field of surveying and map production in an information system using the possibilities provided by computer technology and thus to organize the collection, storage, processing and presentation of geographical information in order to meet the user requirements of this system. Institutions using the same kind of knowledge should go for integration rather than a different structure.

The software used to create the city information system consists of three main parts. These are graphical sections that can perform processing such as compiling, storing, queried and updating of graphic information, different interpretations that can analyze and analyze the database part and graphical and non-graphical information which can transfer, sort, query, store and simulate non-graphic information to the system and specific application and analysis software that can be used for reporting.

The information systems that will be created if the data to be entered into the system are examined well and the appropriate software is selected for the input and processing of the graphical and non-graphical data, processing, analysis, getting the reports and similar processes are working in a healthy way. If the data structure used by the selected software system is not suitable for the data structure of the desired information system to be installed, information access becomes difficult and losses such as time and performance arise.

Municipalities have to make use of information systems to benefit from contemporary facilities and to provide better services to those living in the city. In organizations dealing with geographical information, traditional management systems cause unnecessary human power, unnecessary bureaucratic operations and redundant data repetition. Organizations that provide geographical benefit have begun using the city information system since the 1980s to keep up with evolving technology, to obtain faster and more accurate information and to make more accurate decisions based on this information. Jobs and volume increase in organizations managed by the city information system.

3.5. Integrated Information Systems Application

The local government that is the subject of this article is Municipality of Silifke, a metropolitan municipality connected to Mersin province. Silifke District is 85 km away from Mersin, east of Erdemli, west of Gülnar, north of Mut districts. Between the Taurus Mountains and the Mediterranean, the district has a surface area of 2590 km2..

Silifke Municipality;

- 88 Neighborhood
- 3,107 CSBM, (Street, Street, Boulevard and Square)
- 92.863 Building,
- 150,004 Independent Section, (Apartment house),
- 117,295 Population

It is composed of components.

The municipal management information system partially met user requirements but did not have the ability to adapt to new technologies. The e-municipality has had to enter a new process due to the necessity of location-based services and e-government policy.

Figure 1: Integrated Information System Model & Relationships

As a result of the research and examination based on the model in Figure - 1, a web - based management information system which is fully integrated with e - government applications and compatible with EBYS and GIS has been selected according to the requirements of today. In order to transfer the data generated in the past system in the current system, Teracity MIS was introduced by completing the data transfer within two months as a result of a good project and organization.

The municipalities are the basis of the results and outputs that lead to accurate, more fair and more reliable accruals and collections in the citizen's demands, especially in the real estate incomes, producing, presenting, updating and protecting the address components in accordance with the determined standards. In the present case, it has become a basic necessity that the address data of the public service institutions of our country and all the real and legal persons servicing them are linked to the government and the services of getting services are only meaningful and accessible. Municipalities; address, cadastre, zoning (reconstruction), technical infrastructure facilities, etc. for sustainable services. the basic data infrastructure should be based on the planning and implementation processes related to the city and share the current information to be produced from these data.

Within the scope of the Spatial Address Registration System (MAKS) project from e-Government applications; certified building documents of cities, documents for permission to use buildings and documents of burning buildings are stored in 2014 and are stored in a disciplined discipline with geographical (spatial) information conforming to standards and the data structure can be adapted and adapted to geographic information systems. However, since the address data before 2014 is stored in the form of text (txt) data in the National Address Database (UAVT) environment and used in the processes, transferring these data to the MAKS database is also a work load. This is the workload; licensed constructions and unauthorized constructions (building constructions formed in shareholding parcels) addressed in two different categories.

It is the initiative of the relevant institutions to evaluate the situation that MAKS and UAVT are presenting to municipalities and service institutions related to Web services of urban structure data generated by the above mentioned method in Address Recording System (AKS) environments with its current name. It is known that this situation can be evaluated by software technology and appropriate software projects due to the fact that the numerical data that can be taken from the source can be withdrawn with the software tool and it can be shared according to the law by the General Directorate of Population and Citizenship Affairs (NVİ) which is the project ownership institution.

With the help of web services, the address and construction documents taken from the NVİ server environment are of primary importance in terms of transactions related to the immovable property, as the municipal immovable (real estate) system is written in the relevant fields, related lines and related cells in the database tables.

The strategic operations that enable the related municipality to integrate the Management Information System (MIS) in the server environment; certified building documents, approved building use permit documents, and burned and destroyed buildings documents are processed at the time of the transactions or after the transaction is completed in the MIS immovable information tables.

A software product of the data presented with UAVT and MAKS services with a primary prescription; software analysis, design, development, code writing, necessary function tests and report output are planned and performed. Used MIS UAVT, MAKS, TAKBIS, KPS and so on. It is integrated with Web services. For example, a user who works on MIS needs a urban plan, cadastral, numbering, accrual, license, building use, instead of searching for the relevant unit or looking at the file, information can be accessed with the buttons in the address information.

Work was also carried out on the registration of the TC identity on the municipal registry information, obtaining the ID number from the Identity Sharing System (KPS) database and combining the duplicate registrants. When dealing with the developed editing tool, it is considered that data scanning and proper recording usage conform to the standards determined by NVI Repeated, incomplete or incorrect record information that occurred in the past years has been organized and made meaningful.

In the scope of KBS (City Information System -CIS) studies, submissions were given (reconstruction, cadastral, satellite image, numbering etc.) and studies were carried out for processing and submitting suitable ones to the system. In this phase, Netcad GIS 7.6 was used to manage the graphics data, and PostgreSQL was used as the database for storing graphics and non-graphics data. Netcad's special tools, Gisara and VGA, are used for various interpretations and reports that can analyze and analyze both graphical and non-graphical information. Netcad KEOS (City Automation System) applications have been used within the scope of citizens oriented services (e-plan, city guide etc.). All these activities are performed concurrently with the MIS has been commissioned in about 6 months.

Work has been done for the installation of EBYS which can work integrated with all mentioned information systems. TERADESK EBYS, which is able to read the records, cadastre and address information produced in the MIS and not to produce duplicate records, was commissioned with a 20-day study (Figure-2).

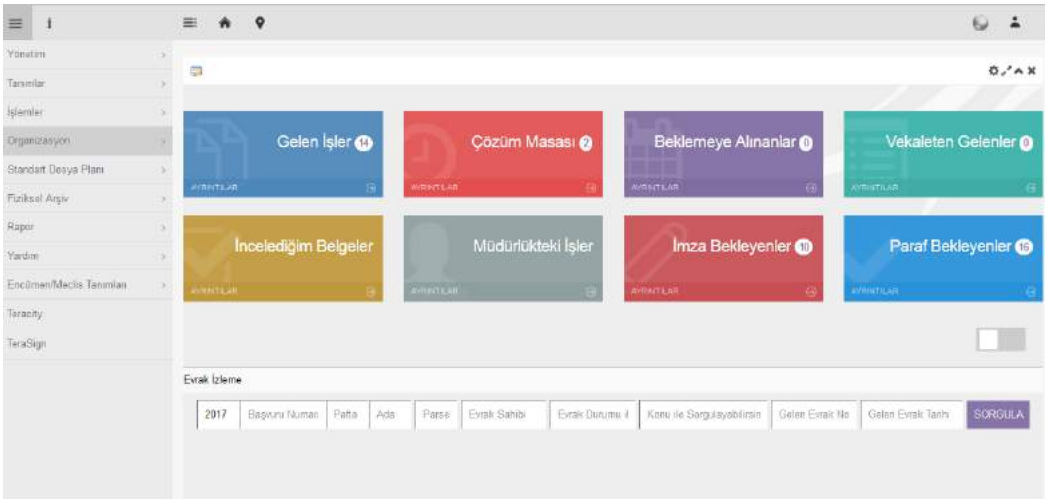

Figure 2: Application of EBYS

After the integrated systems, the MIS, KBS and EBYS systems established in Silifke Municipality have been working in connection with each other and the systems can be easily transited (Figure-3 and Figure-4).

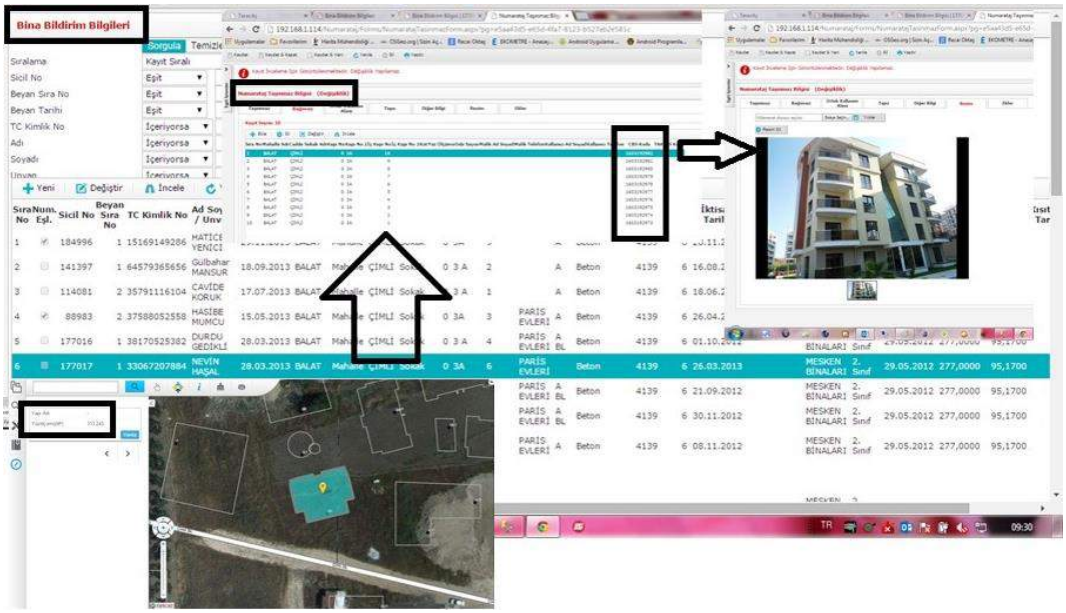

Figure 3: Switching from MIS to KBS

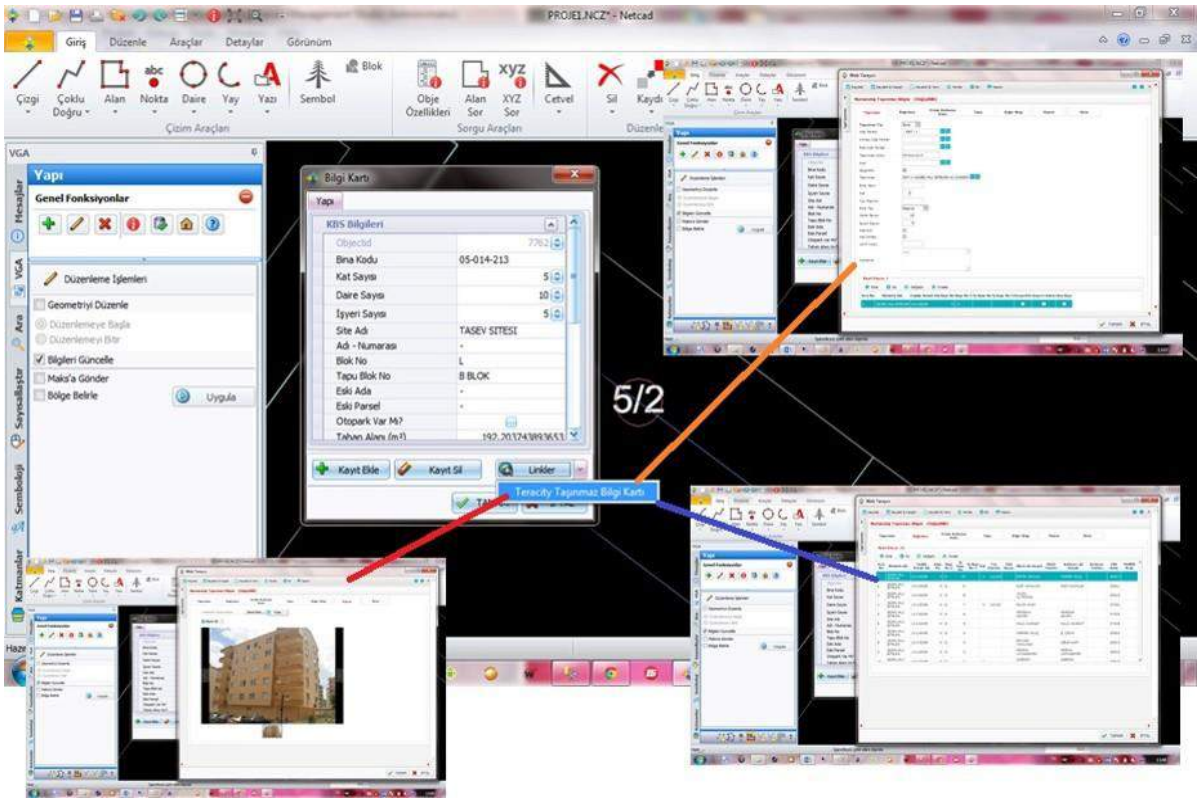

Figure 4: Switching from KBS to MIS

In addition, studies can be performed within a few minutes after the work done with database analyzes. For example; it has been observed that some of the advertisement declarations transferred from the existing system have entered the municipal jurisdiction of the metropolitan municipality and it has been understood that the statements should be closed. By defining the criteria in the integrated system (Road width 15m and above, Road Type Square, Boulevard and Street, Declaration to be declared, etc.), declarations were determined and closed with 5 min. Accrual record etc. in connection with the declarations. The necessary arrangements were automatically made in the fields.

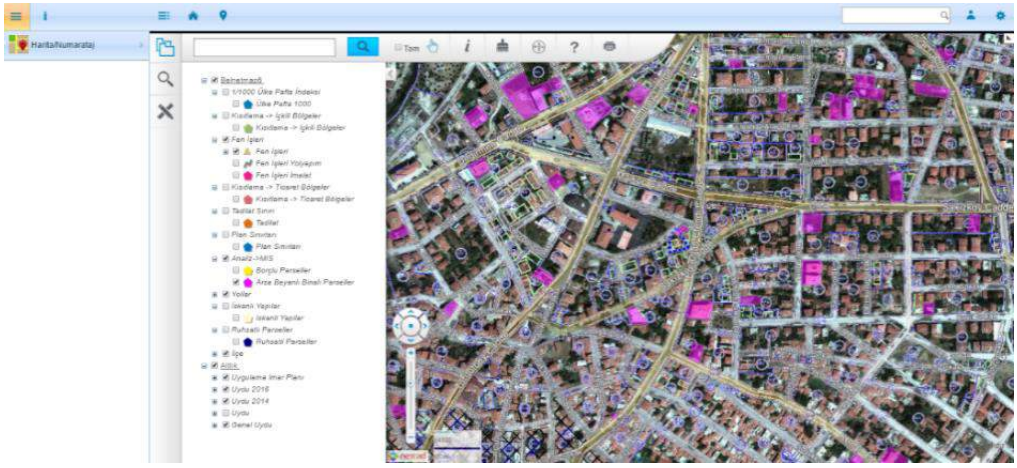

Figure 5: Sample analyzes on KBS

Analyzes based on location and thematic demonstration on the KBS can be used to manage the city easily (Figure 4). Some examples of the analysis applied in Silifke Municipality. The road works of the Science Directorate, the license or building use certificate information belonging to the Urban Planing Directorate, the declarations and accruals belonging to the Financial Services Directorate are some of the analyzes that can be seen on the thematic map momentarily.

We can say that we can easily see the result of the studies done in municipal incomes. The main responsibilities of the municipalities, correct accrual, justice between taxpayers, location based services and e-municipalities, increased the incomes of Silifke Municipality and their payment rates.

Table 1: Silifke Municipality Accrual Increases According to Years

Accrual Year	Total Accrual	Accrual Increase
2014	21,281,469.45	-
2015	21,870,761.11	2.77%
2016	31,705,973.69	44.97%
2017	32,812,342.84	3.49%

Table 2: Percentage of Accrual Rates of Payments by Municipality of Silifke for Years

Accrual Year	Total Accrual	The Total Payment	Payments / Accruals
2015	21,870,761.11	16,010,826.57	73.21%
2016	31,705,973.69	26,506,290.63	83.60%
2017	32,812,342.84	28,672,896.64	87.38%

As it is seen in Table - 1, the results of the studies made in 2016 resulted in an increase of 44.97% accrual and it is followed by the annual increases determined. The data in Table - 2 indicate that the studies also increase the payment rates.

Table 3: Total Payments Ratios of Municipality of Silifke e-municipal Payments

Accrual Year	The Total Payment	e-payment	e-payment/ The Total Payment
2015	16,010,826.57	-	-
2016	26,506,290.63	458,652.41	1.73%
2017	28,672,896.64	665,423.61	2.32%

Silifke Districts are subject to the geographical features of the taxpayers Ankara, Konya, Mersin, Gaziantep, Şanlıurfa and so on, the environment resides in the illicit. As a result of this work, we can see that e-municipality applications and internet collections are increasing day by day (Table-3).

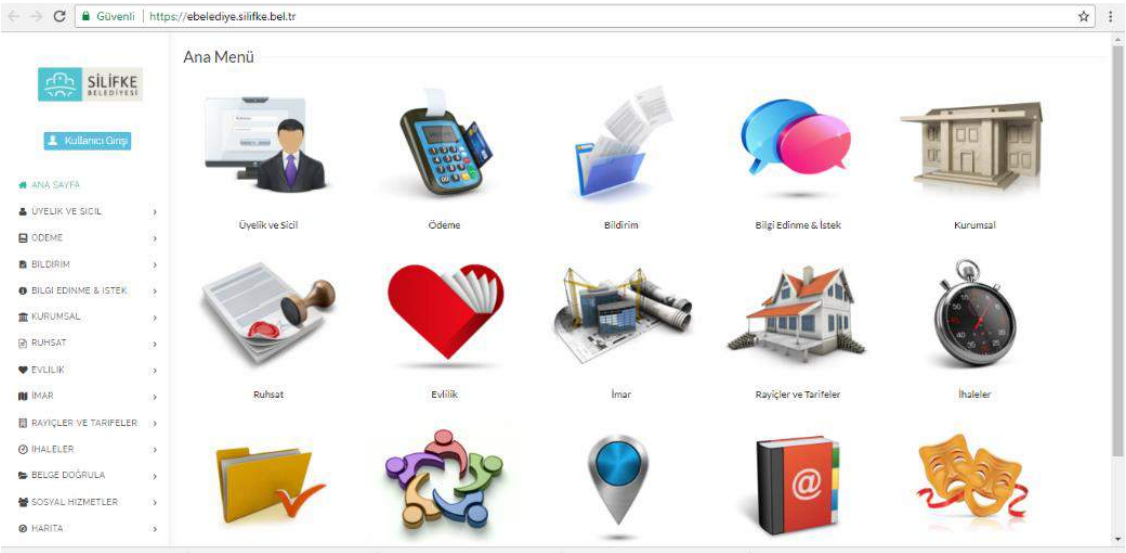

Figure 6: Silifke Municipality e-municipality applications

The e-municipality applications (Figure 6), which is included in the scope of citizen-focused services, provide services such as payment, marriage, building registration, city guide, e- services can be realized over the web.

4. Conclusions and Recommendations

Local governments and Public-Private Service Organizations have had to make investments in computer and information systems over the years in order to be able to fulfill the tasks and transactions in the field of their duties and responsibilities. In this sense, local governments obtained different times in the MIS, graphics data processing and GIS, EBYS, etc. Information system applications are at the forefront. The delivery and structuring of databases according to interoperability principles and the reflection of their outputs on citizen-oriented services are indicative of the efficiency of these systems. It is seen in Silifke Municipality example; existing graphical data processing (map, plan, project, etc.) and text data processing end-users' habits and data ownership tendencies are important considerations. Rule-based processes introduced by application software have a profound effect on good user training, especially on-the-job training. Compliance with the requirements of the legislation and standards of the reports, the availability of query and report customization options, and other important common data usage output. For integrated information systems, this means that existing equipment, network infrastructure and data evaluation as well as the ability to incorporate existing human resources into the process with good organizational and management support are impacting success. In the meantime, it is important to remember the role of administrative and contracting project managers in coordinating and sharing information. Information systems exist with the availability of data, updating by ownership without additional work with daily work and operations is essential for sustainability.

In every municipality where the use is received, such a project has a direct or indirect influence on municipal work and operations. For example, the downloading of real estate tax declaration / receipt transactions for a few minutes (filling the data base structure by reading from the system in order to create the declaration form) shows an increase in the satisfaction of the citizen as well as quick results.

With the process optimization achieved through integrated information systems capabilities, building seating area - m², independent section area - m², total area of common areas - m², distribution of total common areas per apartment (independent section) - m², etc. basic web service and MAKS source data, instantaneous or scheduled tasks from MAKS Relational İVTYS environment are taken instantly and used. At the same time, transactions are carried out in the direction of information coming from TAKBIS web services. This situation; provides accurate and accurate data in all services of the municipality. If this information can not be obtained from the system (if continued with the traditional method) it will necessarily result in the declaration of the citizen, the data of the past years or the initiative of the user, which would result in a transaction with different information / data. With the integrated urban information systems, interrogation of real property issues, analysis is carried out and transitions between information systems are ensured and citizen oriented services can be done efficiently.

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References

Alkış Z., (1996), *The Importance of Geographical Information Systems as a Decision-Support System in Administrations*, Coğrafi Bilgi Sistemleri Sempozyumu.

Bilgin M. F., Bilginol K., Sur N., Bektaş Balçık F., Uluğtekin N., (2016), *Review of National and International Urban Information Systems, Open Source Urban Information System Suggestion Approach*, TMMOB Harita ve Kadastro Mühendisleri Odası 16. Türkiye Harita Bilimsel ve Teknik Kurultayı

Comert, Ç., Banger, G., (1996), *National Spatial Data Infrastructure*, Coğrafi Bilgi Sistemleri Sempozyumu.

Greene, Reene, Wright (2001), *Open Access, GIS in e-Government*, ESRI Press, USA.

Hasal F., Kabran C., Kalkan S., (2016), *Projects for Improvement of Address Data Quality for E-Government and Examples of Reflecting on Municipal Revenue System*, TMMOB Harita ve Kadastro Mühendisleri Odası 16. Türkiye Harita Bilimsel ve Teknik Kurultayı

Şeker, D. Z., (1997), *Requirement of Establishing Land Information System in Turkey and Potential Problems*, 6. Harita Kurultayı

Ulger E., Demir H., (1995), *Urban Information System Design in a Model Area*, 5.Harita Kurultayı

Romaithi, K. Al (1997), *Non technical Aspects Hampering Implementation of GIS In Developing Countries*, http://www.gısqatar.org.qa/conf97/links/j2.html: (Eylül 2004).

The Most Common Usages for Geographical Information Systems and Future Modeling of Urban Growth

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Abstract

Urban growth models enable to be understood the urban changing, an effective environmental planning, development plans, create the urban policies and the urban planners and politicians' prediction and development of the possible growth of the urban future. Therefore, the necessity of estimating the urban growth is widely accepted. The modeling of Geographic Information Systems (GIS) has gained popularity in recent years as the success of the models is closely linked to computer technology. GIS, land use / cover modeling etc. is related to understand, plan of the urban growth and implement this knowledge. Modeling in GIS is simply an integrated representation of time, space and attributes that answer questions of what, where, and when. Techniques and methods related to the processing, visualization and visualization of a large number of spatial and theoretical data have only been possible with the development of this technology, and the model which allows for future predictions has made great progress in the digital environment. At the present day, many urban growth and modeling approaches have been developed. In order to better understand urban growth, researchers have created many urban growth models and many have made simulations that try to predict the future growth of cities. The researchers who used different methods tried mostly to direct the future with Autonomous Systems, Artificial Neural Networks and Statistical Methods. Cellular Automata, Agent Based Models, Artifical Neural Networks and Statistical Methods have been investigated in the study. The methods, common characteristics, strengths and weaknesses of which are evaluated separately in terms of urban growth have been put forward.

Keywords
Land Use, Geographic Information Systems, Urban Growth, Urban Growth Models

1.Introduction

Nowadays, the city population is 3.9 billion, and according to the Transforming World Atlas 2016, the population of the cities will reach 6.5 billion by 2050. In other words, it is predicted that more than 75 percent of the world population in 2050 will live in cities. However, according to the Population Reference Bureau, 2016 estimates, the majority of urban growth for the next 40 years will come to the fore in developing countries. Rapid increase in urbanization problems in countries like Turkey that are exposed to rapid urbanization; the destruction of agriculture and forest areas, pollution of the environment, transportation distress, noise pollution, deterioration of the ecosystem balance, and so on. It is necessary to make predictions for future development by using various techniques in order for the administrators and decision makers to take precautions before the problems brought by the urbanization. As many factors can be evaluated together quickly, forward-looking models can be easily implemented with GIS technologies. GIS is the most voluminous in terms of the scope and information systems in which information is handled.

In particular, contemporary satellite technologies and GIS integrate to enable the study and effective use of the earth's resources (Tekinsoy et al. 2003). Urban growth models in the context of GIS and alternative policies will be able to determine in what regions the city will have a density in the future and thus make it possible to control urban development with the plan decisions to be taken for risky regions (Tanrıöver 2011). Urban planners and policymakers lead the way in forecasting and developing the possible development of the city future, understanding the change in the city, effective environmental planning, development plans, and the formation of urban policies. Deterioration of urban structure; as well as problems such as heavy traffic, long journeys and the closure of traditional business areas, economic opportunities lead to social problems that lead to reduced access to vacant spaces and interactions that enable people to live together. Determination of the growth locations and quantities of the city is beneficial from the environmental and socio-economic point of view, in addition to ensuring that appropriate urban development plans can be realized in the future. For this reason, the necessity of estimating the urban growth is widely accepted (He et al. 2008; Guan et al. 2005). The models of urban growth in land use are classified in various forms in many sources. The general reason for this diversity is the complex nature of land use and the discipline of different disciplines. For this reason, the most common uses such as Cellular Automata (CA), Agent Based Models (ABM), Artifical Neural Networks (ANN) and Statistical Methods (SM) have been examined in the study of GIS and urban development for the future. First of all, different usage areas of these models are discussed. It is seen that each method works differently, has many application areas and is used by many disciplines. Then, the models were evaluated separately in terms of urban growth, their common features, strengths and weaknesses were put forward.

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2. Methods Used in Determining Urban Growth

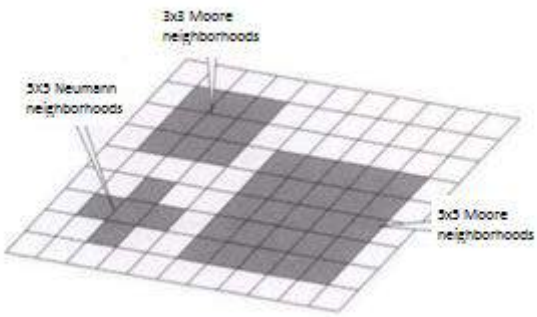
2.1 Celluar Automata (CA)

CA is expressed as cellular-based models in which spatial variations are represented by numerical values with a certain resolution and the state of each unit is specified by a number (Goodchild 2005).
There are five basic elements of CA. These; Grid network (lattice), state set, neighbors relation (determined by the nearest neighbors), transformation rules, time.

A, an automat; S is the set of states; T is the set of transformation rules, and R is the neighborhood of the automats; each automaton is defined by S and T clusters (Ayazlı, 2011).

S = {S1, S2, …, SN}
A ~ (S, T)
A ~ (S, T, R)

CA is an operating system that divides a state into cells and allows each cell to predict its future state according to the state of neighboring cells. In urban models, CA is designed in two dimensions as in Figure 1. The state of each of the cells in the shape of the forest area, agricultural land, settlement, etc. land use functions. Between cells, information can be exchanged or spread to neighbors, and in this sense CA can support spreading of knowledge to the site (Figure 2).



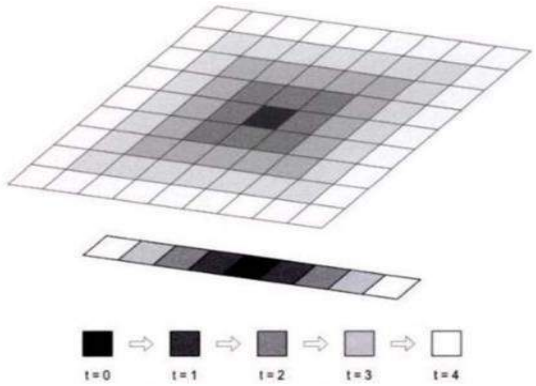


Figure 1: Two-Dimensional CA Neighborhoods (Ayazlı, 2011) *Figure 2: Information Exchange in CA (Ayazlı, 2011)*

CA is used as a modeling and simulation tool in many fields such as sociology, geography, urban planning, architecture in basic sciences such as physics and biology.

CA was proposed by Nogel in 1992 in the simulation of cloud production. After the model was successful, CA cloud simulation was developed by Dobashi and his friends in 1998 and various investigations were conducted on the developed methods (Hailong 2013). Karafyllidis, in his work in 1997, has attempted to determine the fire fronts in the forest using the CA modelling and used it to predict the spread of forest fires in CA models. CA image approach; have been used to study complex biological sequences without distinguishing specific gene sequences, improving structural class prediction of protein (Xiao et al. 2005). In recent years, with the Traffic Celluar Automa (TCA) models, it has become possible to capture basic phenomena that are very flexible and powerful in flowing traffic (Maerivoet, 2005). CA pedestrian behavior, material properties (corrosion, cracks, wrinkles, peeling, etc.), ant colons and pheromone tracks, etc. proved to be quite useful (Maerivoet 2005). CA pedestrian behavior, material properties (corrosion, cracks, wrinkles, peeling, etc.), ant colons and pheromone tracks, etc. proved to be quite useful (Maerivoet 2005). Dincer, in his work in 2014, mentioned about the applications of CA in architecture. The studies developed in the architect by using CA have been started to be used for educational purposes in architectural design studios, in the conceptual stage, in different scales such as mass solutions, settlement design and facade design. There are also different uses for CA beside modelling. They are random number generators. Due to the speed of parallelism, it is very suitable to be used in image processing, recognition, encryption applications (Göncü 2013).

White et al. (1997) developed a CA model to simulate the land use of Cincinnati, Ohio; Clarke and Gaydos (1998) simulated rapid urban growth in the San Francisco, area of California and the Washington / Baltimore corridor of East America, Li and Yeh (2000) in the Pearl River Delta. Ayazlı, in his doctoral thesis in 2011; It was aimed to determine the changes in land use in Istanbul with the influence of the Bosphorus bridges and connection roads and to determine the possible changes on land use by the CA method under the influence of the third bridge to be constructed. Remote Sensing, GIS, simulation, statistical and other techniques have been used in combination to accomplish this purpose.

With the effect of the third bridge, the urban sprawl model of Istanbul for 2030 was developed and land use changes over the years were determined.

Arsanjani simulated the years 2016 and 2026 by determining the amount of land change and the probability of development by using CA, Logistic Regression and Markov Chain (MC) methods in 2013 using land use maps of 1986, 1996 and 2006 (Figure 3).

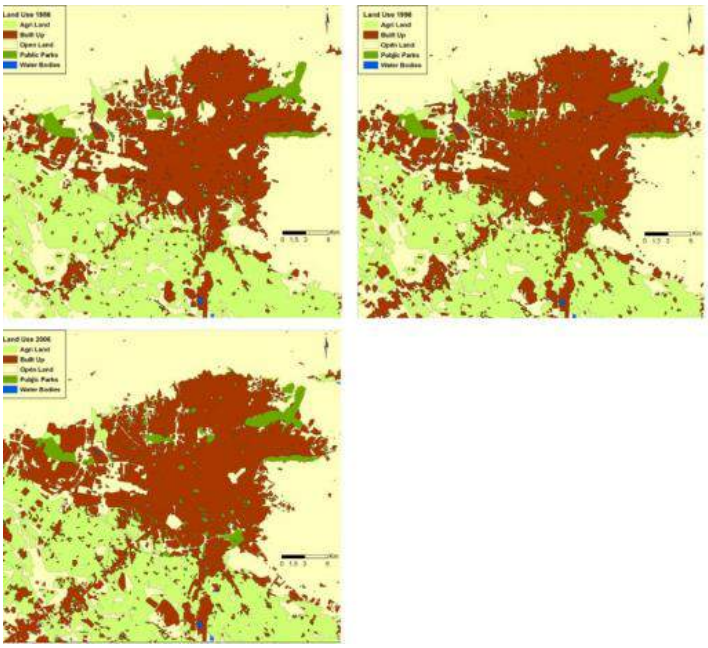


Figure 3: Land use maps for 1986 (upper left), 1996 (upper right) and 2006 (lower left) (Arsanjani, 2013)

Osman (2016), in his work in Greater Cairo Metropol (Egypt) region; aimed at finding a suitable urban policy to protect the arable land consumed by rapid urban growth over the last 50 years. He examined the changes in arable land from 2015 to 2035 according to three different scenarios using the District CA model. In the first scenario, he assumes that the growth of the history will be continuous with the tendencies of the growth of the present conditions, the second one will be a compact growth with strong constraints outside the determined growth center and the third one will grow with considering the level of protection of land and natural resources. According to this scenario, the tendency of growing the history is the worst result for the arable land, while the least effective is the second growth. In his work Nigussie (2016), he made estimations of 2050 for 4 different scenarios with the model of urbanism living in Istanbul. It was determined that the first scenario was the worst scenario and the fourth scenario had the most destructive consequences for the future. While the agricultural lands and forest areas were affected in the first scenario, the result of the 4th scenario was that the Canal Istanbul project would become urbanized in the river basins of Ayamama and Tavukcu. When the current urban processes are thought to continue in the coming years, this type of CA will have widespread use without anticipating the future model and direction of urban growth. Because this type of CA contributes planner, environmental scientist, etc. researchers working on the city, such as where future urban growth areas should be, assessing the effects of urban growth, providing structures to support development and making plans (Aydın 2015).

2.2 Agent Based Model

Agents can be defined as computer systems that are autonomous in action in order to achieve the goals that they have already been given in the environment in which they are placed. Each agent has an atmosphere of other factors and the material world. The agent perceives the world he is in, such as living organisms, with his perceptions, and he is in action with his activists (Cenani 2007). One agent is the tool to analyze the system. There is no universal definition of Agents since the features they contain exhibit changes in different disciplines, there is a recognition of a common feature of agents. Depending on the nature of the work being done, the agent may be a bacterium, insect, house, human, fish or a company as an interactive component of a system, but some must have the ability to adapt to change their behavior and thus their behavior in order to be an agent (Başlık 2008).

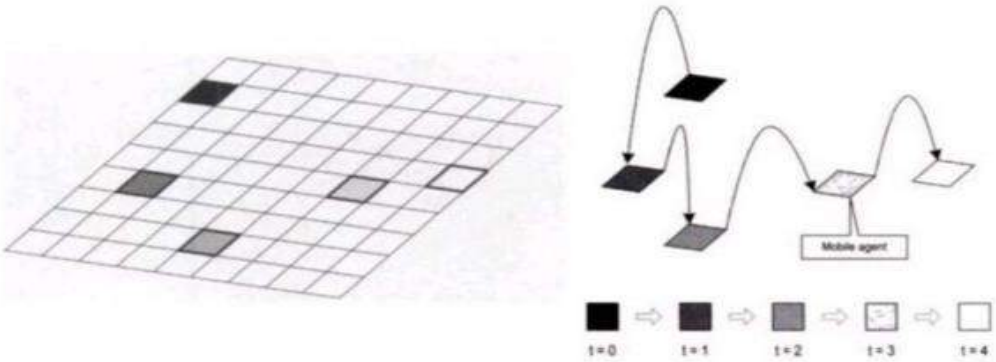


Figure 4: Vending (automat) movements of Agent Based Models (Benenson and Torrens 2004)

ABM has also found a place in many different and interesting applications in GIS. For example, Benenson, in 2004, used this model structure to model the behavior of families in cities and to identify the factors that influence household choice. In his study Cenani in 2007, it was thought to be the shopping center design the user movements simulate performs a model intended to be produced and the data obtained from research shopping centers such as multi-user venues in the design problems can help solve at an early stage. Dawson and colleagues used the ABM approach for manage to flood-prone areas of work (Davson et al. 2011), Crooks, in order to investigate a post-disaster in 2013, Welch, 2014, in Chrysomya Bezziana Despite the attacks, simulations were carried out using ABM and GIS technologies.

In addition, this model is also used to identify the main factors that cause land fragmentation in land use and land cover studies and to reveal the problems that these problems have on natural life and living species (Ahearn 2005; Parker 2005; Taillandier et al. 2012).

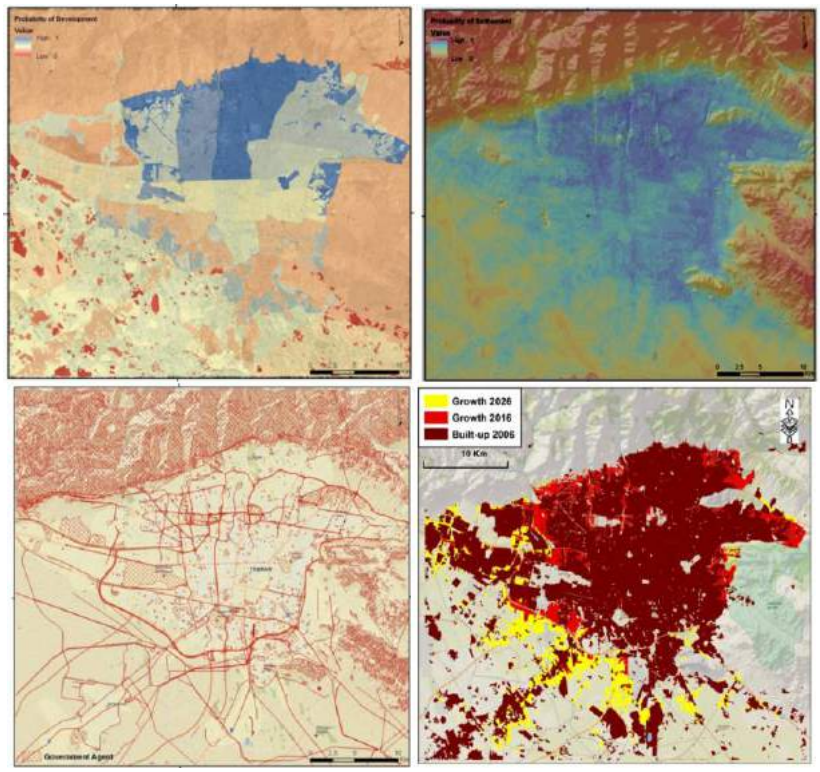


Figure 5: Simulation of the probability of development and future growth according to the domestic agents (upper left), the developmental agents (upper right), Government agents (lower left)

Tian, 2011, using ABM, tried to simulate the urbanization in the Phoenix region as an alternative to the previous model of the working group. Land use maps for 1990, 1995 and 2000 were taken as data and urbanization for 2010 and 2020 was simulated. They stated that the CA model gave decision rules for the purpose and that the ABM were more flexible than simulating the city dynamics.

In another study done in 2013 Arsanjani, in Tehran, ABM is using to simulate urban growth. The main determinants that will control urban development in work are expressed by three groups of agents, identified as government factors, developmental factors and indigenous factors. The behaviors of each agent group were identified using qualitative research and separately using multi-criteria analysis. Then the interactions of the agents are combined with the GIS's registration function. 2016 and 2026 growth forecasts of the Markov chain model with the correct predictions were made.

In his work in 2015, Zhang noted that the proposed model consists mainly of three components; GIS, external environment and agent based systems. GIS component; as a means of providing environmental recognition and decision-making rules. Component of external environment; land use, land, land prices, transportation and public facilities. Agent Based Systems; provide a flexible means of addressing interactions between various stakeholders, influencing various agents and urban growth.

2.3 Artificial Neural Networks (ANN)

ANN is a computer system that performs the learning function, which is the most basic feature of the human brain. They perform the learning process with the help of examples. These networks consist of interconnected process elements (Artificial Neural Cells). Each link has a weight value. The information is stored in these weight values and spread to the network. ANN suggests a different calculation method than the known calculation methods (Öztemel 2012). With the back-propagation feature in the structure of ANN, the model is under continuous control mechanism during the education phase. In the training process, data from the network are evaluated by targeting real world data (Guan and Wang 2000). In prospective modeling studies, this may be historical land use data. Then, depending on the results of these comparisons, weights and trends are set to minimize the difference between the output data on the network and the target data set. This process continues until the difference between the output and target data sets reaches a minimum level. After the training period, the network simulates the related land class (urban area) (Tanrıöver 2011). It is possible to see successful applications of this calculation method which is adaptable to the present ones, adaptive, can work with incomplete information, can decide under uncertainties and is tolerant to errors, in almost every area of life (Öztemel 2012).

Industrial applications; In Karahan, his doctoral dissertation in 2011, an international (export) demand forecasting application for the dried apricot product of Malatya province was applied by using the ANN model from the statistical demand prediction techniques in the study.

Financial applications; ANN studies in Turkey have been used mainly for predicting financial failures and bankruptcies. As a result of tests using the data obtained from the internet sites of the Central Bank of the Republic of Turkey and other stock exchanges between July 2, 2001 and July 13, 2006, the ISE index value was calculated by using forward feed ANN can be successfully modeled (Kutlu 2009).

Military and defense applications; Artificial intelligence techniques in cyber defense have been studied in general in the work he made in Şekenkaya in 2014. It is more appropriate to use artificial intelligence algorithms in which simple algorithms are not enough for the cyber defense software to fulfill its mission.

Health applications; Demirhan stated that in 2010, the sufficiency of Artificial Intelligence methods has been investigated in virtually every area of medicine and has the potential of application. In the course of his work, he stated that there is a need for further clinical trials before these still emerging methods are implemented in the real clinical environment, and they have examined the important clinical studies using these methods.

In the field of agriculture; Akkaya, 2007, aimed at ensuring that YSA's practices in various agricultural areas are taken into consideration, attracting the interest of researchers working in the field of agriculture, and considering agricultural methods as an alternative method to solve agricultural problems.

Özcan analyzed the settlement, ecological and geologically inadequate region, distance to city centers, distance to the main transportation axes, forest land, slope area and population data obtained by remote sensing method in 1975, 1995 and 2005, a database occured that can be applied to the neural network model (Özcan 2008).

Alkheder and Shan used remote sensing and ANN to simulate urban sprawl as a means of measuring vector data; which are classified as water, road, housing, commerce, forest, pasture and agriculture, in which direction they spread within a certain period of time (Alkheder 1999).

Li and Yeh (2001, 2002) form a model for the land use change of urban clusters in South China and integrate the parameter values that the ANN method learned into the CA model. Later, the models that simulate multiple regional land uses and alternative development scenarios were re-adapted to the new situation (Aydın 2015).

Tewolde created urban sprawl model using 2011 ANN and maps generated with 85.9% accuracy in Markov chains as data. Urban sprawl for 2020, Eritre, Asmara city was tried to be presented. The purpose of the work is to discuss the agricultural areas that affect urban sprawl and what is the power that leads to the loss of cultivated areas (Tewolde 2011).

Tanrıöver stated that the ANN model gave very good results in many studies but in 2011 he stated that, ANN made the most inadequate model in its study. Besides his model, will be held again with different weight and classes.

2.4 Statistical Methods

Markov Chain from traditional statistical models, multiple regression analysis, principal component analysis, factor analysis and logistic regression are very successful methods in interpreting socio-economic data. In the study, Markov Chain and logistic regression models used in urban growth were discussed. Other land cover categories probabilities that each land category defined in the Markov Chain change probability matrix (Transition Probabilities Matrix) can represent are calculated. In the matrix of probability fields, the number of pixels expected to change in each land cover is shown in the next time period (Eastman et al 2008). Markov Chain applied to develop dynamic models for land use patterns in the past years is widely used today to model land use changes in large spatial scales, both urban and rural areas, taking spatial-temporal transition models into consideration (Bozkaya 2013).

In Economics; Özdemir, the monthly changes in dollar exchange rates in the study conducted in 2010 and the monthly changes in the ISE national 100 endexi values are considered as two categorical series and the markov chain model shows how this ratio affects each other.

In the meteorology; in 2008, Dahamsheh used forward feed back propagation ANN, radial-based processor YSA, generalized regression ANN, and multivariable linear regression methods in the Markov Chain Added Conditional ANN Estimated Drift of Monthly Dry Seasonal Rainfall in 2008 (Dahamsheh 2008).

In Education; Alp 2007, Turkey Educational Statistics 2005-2006 has benefited from the Markov analysis in the course of knowing the probability that a student who has started to train using the data can continue until the stage of education (Büyüktatlı 2013).

Using the aerial photographs of 1960 and 1989, Hathout analyzed the urban growth in East St Paul (ESP) and West St Paul (WSP) in Winnipeg separately by using the Geographical Information System to determine the urban sprawl in order to determine the urban sprawl. Estimates were made with the Markov probability chains of urban growth of 1990 and 2000 (Hathout 2002).

Lopez vd. (2001) have developed a model on urban land use change and land cover estimation in their work on Morelia city in Mexico. In this study, the authors used Markov transition matrices and linear regression together. They concluded that the most powerful uses of Markov transition matrices are far from explanatory.

Logistic Regression allows to achieve error-free results by using logistic or probit regression instead of linear regression in the analysis of these binary variables such as working population, non-working population, restructuring, no restructuring, voting, voting or not voting if many variables in social sciences can be defined as two different values. Non-linear relationships among different categorical variables with Logistic Regression Model can be explained and predicted, especially in cases where complex socio-economic systems are affected by different categorical variables such as urban growth and normal course.

Logistic regression has many uses and different working areas. Today, logistic regression is widely used in medical science, in military settings, in the analysis of experimental data, in meteorology, in internal migration movements, in the field of education (Seven 1997) One of these uses is land use changes. The logistic regression model is a statistical model that allows us to conceptualize the interrelationships between spatial variation, dynamics and many factors on the invisible space. The regression model has been used in many urban surveys that measure and predict the impact of spatial and socio-economic factors on physical space. In particular, the possibilities offered by the Geographical Information Systems for the collection and storage of spatial data further strengthen this method and make sense of complex urban systems. The complex nature of systems can cause sudden emergencies or interruptions. In systems with complex structures, the center of their form is dynamics, so dynamics have critical preliminaries in these systems (Batty 2007).

Wu and Yeh (1997) used Logistic Regression Analysis method to model urban growth from aerial photos of 1978-1987 and 1987-1992. They have shown that various factors have changed their roles in the land development process, which is a significant change in the main determinants of land development over these two periods. Studies show that the logistic regression has a strong capacity in interpretation of urban development (Aydın 2015).

Eyoh tried to model the future urban expansion of Nigeria / Lagos with Logistic Regression and Geographic Information Systems using satellite images in 1984, 2000 and 2005 in 1984 and tried to estimate the urban expansion of 2030.

Tanrıöver, who aims to predict the urban development of Istanbul in 2040 and to reveal the possible effects of this development on ecology, has been preferred in the modeling study of the CA-based Logistic Regression method. Location, distance from road and water, height, slope and land use maps are defined as variables (Tanrıöver 2014).

3. Results and Discussion

Among the advantages of the CA model, flexible structures can be considered to be quite obvious for complex urban systems, and the availability of remotely sensed data and the appropriateness of GIS. In recent studies on these innovative technological advances, cellular modeling has emerged as a reliable tool for predicting urban growth (Couclelis 1997; Clarke and Gaydos 1998; Tanrıöver 2011). There are many ways to define transition rules within CA. Different models have different effects on the output of the output of the CA simulation. Many urban CA models have attempted to overcome this problem. The diversity of the model depends on the nature of the applications and personal preferences. It

is important to define the transition rules, but there is one common way to do it. There is no definitive method of how to select these terrestrial variables for urban simulations (Figure 5). When a series of variables are presented, it is difficult and time-consuming to decide which variable will be appropriate to estimate the probability of development. (Li and Yeh 2002; Tanrıöver 2011).

ABM are theoretical theoretical investigations or micro behavior simulations. To understand urban growth in a given metric, there are no reports of ABM. However, the ABM are an ideal tool to judge micro-scale urban growth complexity, like simple comprehensive projects (Cheng 2003). It catches emergency events, provides a natural environment for working in certain systems, and is particularly flexible in the development of geographic models (Couclelis 2002).

The ANN model has two important advantages over ABM and CA. The first of these is to show that the ambiguity of parameter values can be minimized while development alternatives are being generated and how these values are to be determined. The second is that this model can simulate alternative urban growth. Despite the fact that the structure of the network to be formed is not determined, the choice of network parameters is increasing day by day, despite the fact that there is no specific standard, problems can be shown only with numerical information, unknown how to finish the training and network behavior can not be explained (Öztemel 2012). The limitation of use of the ANN method is the "black box" model. For this reason, it is difficult to interpret the weights of a working ANN network (Aydın 2015).

Traditional statistical methods are not enough to model spatial-temporal data. The main reason for this is that the basic assumptions of the spatial and temporal data violate the normal distribution, the errors associated with variables, the independence of variables and the model truth (Olden and Jackson 2001). For this reason, two alternatives are usually adopted. The first is to be able to adapt the spatial sample to traditional analyzes, while the other is to develop a new statistical method based on spatial relation (Cheng 2003).

4. Conclusions

In order to minimize and control the harm to the nature and the environment of the urban growth, future modeling of the urban growth can be done in the GIS environment in the direction of the existing and alternative policies. Researchers have tried to integrate GIS with urban modeling techniques in the hope of enhancing the analytical capability of GIS technology and have done a lot of research in this regard. There are different classifications on simulation models in land use in the literature. Therefore, the models discussed in the study are mentioned about the most common uses. Many researches have been carried out with these integrated studies and came up with different usage areas such as GIS, remote sensing technologies, statistical methods, CA, ABM and ANN urban growth. These methods, which have many application fields, have been used by many disciplines. While each method seems to work differently, it seems that all of them have common features. All of these models have common properties such as the use of transition probability in a class transition matrix and the GIS weighted approach. In the models with strong and weak aspects (Table 1), it is weak that there is an uncertainty about the terrestrial variables, while CA has the strengths of being flexible, easy and understandable, having simple transformation rules.

Table 1: Strengths and Weaknesses of Models Under Examined

MODELS	CA	ABM	ANN	SM
Strenghts of Models	flexible structures	flexible structures	-	-
	easy	ideal tool for understanding decision-making complexity at micro scale	easy to understanding nonlinear spatial patterns	estimation of the obtained products
	understandable and easy conversion rules	providing a natural environment socio-economic communication		
Weaknesses of Models	not a definitive method of how to select local variables	there is no report that abm are applied solely for understanding urban growth on a certain scale	including its black-box and static nature difficult to interpret the network weights	ineffective in modelling spatial and temporal data

There is not a weak aspect of the ABM reflected in the literature, but it is not possible in every country to obtain the data used without estimating the urban development. Apart from that, the model is very strong because of the flexible nature, the natural environment, the micro-scale decision-making effect, and the social and economical interaction. ANN have begun to be used increasingly. In the development of the ANN method, the working mechanism of the human brain is taken as an example. But ANN is much simpler than the complex structure of the human brain. Non-linear relations are more successful than linear models in explaining non-linear relations because they can be constructed with logical expressions like "parametric and non-linear" and "," or "not". The black box takes out information from the outside and gives out the output it produces. What's inside is unknown. In other words, ANN does not have the ability to explain how the results are formed. This situation undermines the credibility of the network. Models are evaluated separately; While statistical methods are insufficient in modeling spatial-temporal data, it is observed that future predictions are more successful than other models. It has been seen in the example applications that the integrated usage of the models gives more successful results instead of being used alone. In this sense, the importance of integrated uses has emerged and it has been found that closer results are obtained.

References

Ahearn, S. (2005),*Modeling the interaction between humans and animals in multiple-use forest: a case study of Panthera tigris*. In D.J. Batty, & M. F. Goodchild (Eds). GIS, Spatial Analysis and Modeling Maguire (pp. 387-402), California: ESRI press.

Akkaya G.,(2007), *YSA ve Tarım Alanındaki Uygulamaları* ,Atatürk Üniv. Ziraat Fak. Dergisi 38 (2), 195-202, 2007 ISSN: 1300-9036.

Alp S. (2007), "*Türkiye'de Eğitim Sürecinin Markov Geçiş Modeli*", 8. Türkiye Ekonometri ve İstatistik Kongresi, 24-25 Mayıs 2007 İnönü Üniversitesi, Malatya.

Arsanjani J.J. , Helbich M., Noronha Vaz E. ,(2016) , *Spatiotemporal simulation of urban growth patterns using agent-based modeling: The case of Tehran*, Cities Volume 32, June 2013, Pages 33–42.

Arsanjani J.J., Helbich M., Kainz W., Boloorani A.D., (2013), Integration of logistic regression, *Markov Chain and Cellular Automata Models To Simulate Urban Expansion*, International Journal of Applied Earth Observation and Geoinformation, Volume 21, April 2013, Pages 265–275.

Ayazlı, E. **(**2011),*Ulaşım Ağlarının Etkisiyle Kentsel Yayılmanın Simülasyon Modeli:3. Boğaz Köprüsü Örneği,* Doktora Tezi, Yıldız Teknik Üniversitesi, İstanbul.

Aydın O., (2015),*Karmaşık Kent Sistemi, Kentsel Büyüme Kavramlarının Anlaşılması ve Kent Modelleme Teknikl*eri, Türk Coğrafya Dergisi Sayı 64: 51-60, İstanbul.

Başlık, S., (2008), *Dinamik Kentsel Büyüme Modeli: Lojistik Regresyon ve Cellular Automata (İstanbul ve Lizbon Örnekleri),* Doktora Tezi, MSGSÜ Fen Bilimleri Enstitüsü, İstanbul.

Batty, M., (2007),. *City and Complexity: Understanding Cities with Cellular Automata*, AgentBased Models, and Fractals, The MIT Press Cambridge.

Benenson, I. ve Torrens, P.M., (2004), *Geosimulation Automata-based Modeling of Urban Phenomena*, John Wiley and Sons, West Sussex.

Bozkaya A. Gonca, GÖKSEL Çiğdem,(2011) ,*İğneada Koruma Alanının Arazi Örtüsü/Arazi Kullanımının Zamana Bağlı Değişiminin Markov Zincirleri İle Modellenmesi*, ISSN: 2564-6761 Geomatik Dergisi Journal of Geomatics 2017; 2(2);94-105.

Cenani ş.,(2007), *Kullanıcı Hareketlerinin Etmen-Tabanlı Sistemler İle Temsili: Alışveriş Merkezi Örneği*,Bilişim Anabilim Dalı,İTÜ.

Cheng J., (2003),Modelling Spatial and Temporal Urban Growth, , International Institute for Geo-Information Science and Earth Observation (ITC), P.O. Box 6, 7500 AA, Enschede, The Netherlands.

Clarke, K. C., and Gaydos, L. J., (1998), Loose-coupling a and GIS: long-term urban growth prediction for San Francisco and Washington.

Couclelis, H. (2002), *'Modelling Frameworks, Paradigms, and Approaches*', in Clarke, K.C., Parks, B.E. and Crane, M.P. (eds.), Geographic Information Systems and Environmental Modelling, Prentice Hall, London.

Crooks T. A., Sarah Wise ,2013,*GIS And Agent-Based Models For Humanitarian Assistance*, Computers, Environment and Urban Systems 41 (2013) 100–111.

Dahamsheh, A.; Aksoy, H(2008), *Structural characteristics of annual precipitation data in Jordan*, Theor. Appl. Climatol. 88(3–4), 201–212.

Dawson, R.J., Peppe, R. and Wang, M. (2011), *An Agent-based Model for Risk-based Flood Incident Management*, Natural Hazards, 59(1): 167-189.

Demirhan A.,Kılıç Y.A,Güler,İ.,(2010) , *Tıpta Yapay Zeka Uygulamaları,* Yoğun Bakım Dergisi 2010;9(1):31-41.

Dinçer A.E.,(2014),*Hücresel Özdevinim Yaklaşımı İle Kitlesel Konut Tasarımında Sayısal Bir Model*, Bilişim Anabilim Dalı Mimari Tasarımda Bilişim Programı,İstanbul teknik üniversitesi, Fen Bilimleri Enstitüsü, İstanbul.

Eastman, R., (2008), *IDRISI - Taiga GIS and Image processing software, Reference Manual*. Worcester, Clark Labs, Clark University, USA: Worcester.

Göncü,E.,*Hafizalı Hücresel Otomat Sayısal Tasarımı*,Yüksek Lisans Tezi,İTÜ,Elektronik Müh.,Elektoronik Ve Haberleşme Programı,2013.

Guan, Q., Wang, L. and Clarke, K.C. (2005), *An ArtificialNeural-Network-Based, Constrained CA Model for Simulating Urban Growth*, Cartography and Geographic Information Science 32(4), 369-380.

Hailong W. and Meng Fanjun,(2013), *Real-time Simulation of Dynamic Clouds Based On Cellular Automata*, International Journal of Hybrid Information Technology Vol.6, No.5 (2013), pp.171-182.

He, C., Okada, N., Zhang, Q., Shi, P. and Li, J. ,2008, *Modelling Dynamic Urban Expension Processes Incorporating a Potential Model with Cellular Automata* , Landscape and Urban Planning 86, 79-91.

Karahan M.(2011), *İstatistiksel Tahmin Yöntemleri: Yapay Sinir Ağları Metodu İle Ürün Talep Tahmini Uygulaması*, Doktora Tezi, Selcuk Üniversitesi, Konya.

Kutlu B. Badur B.,(2009) *YSA İle Borsa Endeksi Tahmini Boğaziçi Üniversitesi*, Yönetim Yıl:20 Sayı: 63 Haziran 2009.

Li , X., and Yeh, A. G. O., (2000), *Modelling sustainable urban development by the integration of constrained cellular automata and GIS*, International Journal of Geographical Information Science, 14, 131–152.

Lopez E., Gerardo B., Manuel M., E. Duhaub,(2001*) Predicting land-cover and land-use change in the urban fringe A case in Morelia city*, Landscape and Urban Planning 55 (2001) 271–285.

Maerivoet S., M. B.D.,(2005), *Cellular automata models of road traffic*, Physics Reports 419 (2005) 1 – 64.

Nigussie, T. and Altunkaynak, A. (2016), *Modeling Urbanization of Istanbul under Different Scenarios Using SLEUTH Urban Growth Model*, J. Urban Plann. Dev.

Olden, J. D., and Jackson, D. A. (2001),*Fish–habitat relationships in lakes: gaining predictive and explanatory insight by using artificial neural networks.* Transactions of the American Fisheries Society, 130, 878-897.

Olden, J. D., and Jackson, D. A. (2001). *Fish–habitat relationships in lakes: gaining predictive and explanatory insight by using artificial neural networks*. Transactions of the American Fisheries Society, 130, 878-897.

Osman T. , Divigalpitiyac P. and Arima T., (2016), *Using The Sleuth Urban Growth Model To Simulate The İmpacts Of Future Policy Scenarios On Land Use in The Giza Governorate, Greater Cairo Metropolitan Region* , Internatıonal Journal of Urban Scıences, Vol. 20, No. 3, 407–426.

Özdemir A., (2007) *İşletmelerin Tahminleme Sorunlarının Çözümlemesinde Markov Zincirleri Analizinin Uygulanması,* Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü Dergisi Cilt 9, Sayı: 1,

Öztemel E.,2012,*İstanbul'da Kentsel Yayılmanın Yapay Sinir Ağları İle Öngörüleri,*ISBN 9756797396,Papatya Bilim Yayınevi,Ankara

Parker, C.D. (2005), *Integration of geographic information systems and agent-based models of land use: prospects and challenges, GIS*. In Batty, D.J. & Goodchild, M.F. (Eds.), Spatial Analysis and Modeling Maguire (pp. 403-422). Redlands California: ESRI press.

Seven, Z., (1997*), Değişken Seçimi Yöntemi Olarak Adımsal Lojistik Regresyon İle Adımsal Diskriminant Analizinin Karşılaştırılması*, Gazi Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi.

Şenkaya Y., Adar U.D.,(2014), *Siber Savunmada Yapay Zeka Sistemleri Üzerine inceleme*, Akademik Bilişim 2014, Mersin Üniversitesi, Mersin, 01-04 Şubat .

Taillandier, P., Therond, O. & Gaudou, B. (2012), *A new BDI agent architecture based on the belief theory. Application to the modelling of cropping plan decision-making*. In Seppelt, R., Voinov, .A., Lange, S. & Bankamp, D. (Eds.). Proceedings of International Congress on Environmental Modelling and Software (pp. 107-116), Germany.

Tanrıöver A.A.,(2011), *Adana Kentsel Gelişiminin Uzaktan Algilama ve Coğrafi Bilgi Sistemleri Kullanilarak Modellenmesi,* Doktora Tezi ,Çukurova Üniversitesi Fen Bilimleri Enstitüsü,Adana.

Tekinsoy, P., Aksaray, N., Yıldız, Y., Kandırmaz, M., Peştamalci, V., (2003), *CBS'nin Çukuroca Üniversitesi Kampus alanına Uygulanması,* 9. Türkiye Harita Bilimsel ve Teknik Kurultayı, 31 Mart-4 Nisan 2003, Ankara**.**

Tewolde E.,Mussie G., and Pedro C. , (2002) ,*Urban Sprawl Analysis and Modeling in Asmara*, Remote Sens. 2011, 3, 2148-2165; doi:10.3390/rs3102148. Journal of Environmental Management (2002).

Tian G., Ouyang Yun, Quan Q. ,Wu J.,(2011),*Simulating spatiotemporal dynamics of urbanization with multi-agent systems—A case study of the Phoenix metropolitan region, USA*, Ecological Modelling Volume 222, Issue 5, Pages 1129–1138.

Welch M.C., P.W. Kwan A.S.M.,(2014), *Sajeev Applying GIS and high performance agent-based simulation formanaging an Old World Screwworm fly invasion of Australia* , Acta Tropica 138S (2014) S82–S93.

White R., Engelen G., Uljee I**.,** *The Use of Constrained Cellular Automata for High-Resolution Modelling of Urban Land-Use Dynamics*, Environment and Planning B: Urban Analytics and City Science,Volume: 24 issue: 3, page(s): 323-343, Issue published: June 1, 1997,https://doi.org/10.1068/b240323.

Xiao X., S. Shao, Y. Ding, Z. Huang, X. Chen, and K.-C. CHÖ,(2005),*Using cellular automata to generate image representation for biological sequences*, Amino Acids 30(1):49-54 · March 2006DOI: 10.1007/s00726-005-0225-6 .

Zhang H., Jin X., Wang L., Shu B.,2015,*Multi-Agent Based Modeling Of Spatiotemporal Dynamical Urban Growth In Developing Countries: Simulating Future Scenarios Of Lianyungang City, China., Ecological Modelling 320 (2016) 334–347.*

Monitoring Climate Changes by Geographical Information Systems: A Case Study of Izmir Province

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Abstract

Climate is one of the most important factors that enable the existence of life on Earth. The climate has been studied by many scientists throughout the history for its influence on all living and non-living beings. Researchers have used climatological parameters (temperature, humidity, rainfall, sunshine duration, evapotranspiration etc.) with different methods and created a variety of methods. When putting these classifications into consideration, they have taken different criteria into account and have produced different classification indices according to these criteria. Some of these formulas are short and simple, some are very long and complex. Using these formulas, researchers have developed different climatic types in different regions. Using two separate climate classification methods, in this study, meteorological data from 1980-2011, which was taken from Turkish State Meteorological Service data service, were examined periodically and arranged according to determined classification methods. The data were processed in accordance with De Martonne and Erinç classification formulas by Geographical Information Systems (GIS) and the climate change of İzmir province which was chosen as the study area has been revealed between 1980-1989 and 2006-2011 time periods.

Keywords

Climate Change, Climate Modeling, De Martonne Climate Classification, Erinc Climate Classification, Geographical Information Systems

1. Introduction

Climate is the average of weather events (temperature, precipitation, humidity, pressure, wind) observed over a long period of time in large areas. However, weather conditions are short-lived weather events in smaller areas. As it can be understood from these definitions, there are differences between climate and weather conditions such as wide range of areas (Turkey climate, Mediterranean Region Climate, Marmara Region climate etc.) and observation for a long time (this period is defined as 30 years if sufficient data is available). There are various parameters that make up the climate: temperature, precipitation, humidity, pressure and wind. These parameters are called climate elements and they affect each other, also the atmosphere, alone or all together combined. If this affection last a short time, they create short-term weather effect, but if they last a long time, they create the climate.

Climate of an area depends on the latitude, ascension, ground shape of the area, and also its distance from the seas. Because it directly affects the angle of the sunlight, latitude is the most important factor affecting climate. Generally, lower latitudes are warmer and upper latitudes are colder. The altitude is also influential on the climate. As you go up, temperature drops 1°C every 200 m, and as you go down it increases 1°C every 100 m by the effect of friction. The sea is an intense moisture source and humidity which makes it an influential effect on temperature and precipitation.

From past to present, climate has affected people's lives, settlements, livelihoods and similar living environments. Knowing the climate of a region has a very important effect on anticipating and taking precautions aganist possible weather events. "For many years, many scientists have worked on the climate. These studies have produced so many climatic types that might be countless. However, as in every scientific discipline, climatologists have uncovered large climates by bringing together the scattered types, the more or less common ones." (Dönmez, 1984). Various climate classifications has been made by various scientists. There is a great difference between scientists in this regard. This situation can be interpreted as the difference between the views of various researchers, as well as the lack of a perfect formula working in every area. Some of the formulas used in classification are very simple, and some are very complex. But this cannot be interpreted as the longest formula would give the most accurate result. The criteria that researchers take into account in climate analysis are different. Some of these criteria can be defined as precipitation - temperature ratio, precipitation - evaporation rate, precipitation regime and vegetation cover (Klimatoloji Şube, 2014). The common point of all the classification studies is that income (rainfall) is equal to the amount of equations they produce and expenditure (transpiration, evapotraspration) is written to the stake and a classification is made according to the income-expenditure balance.

There are many definitions of climate change. One of them is an agreed definition by the United Nations Framework Convention on Climate Change (UNFCCC): "In addition to the natural climate change observed in a comparable time period, a change in the climate as a result of human activities directly or indirectly distorting the composition of the global atmosphere" (Gönençgil, B., 2014). Climate change occurs with many factors. Some of these factors are natural, some of them originate from human effects. These factors can be listed as follows:

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Natural Causes:

- The change in solar energy;

  -Sunspots
  -Movements of the earth
  -Duration of sunshine

- Changes in atmospheric components:

Atmosphere contains 78% nitrogen, 21% oxygen and 1% noble gases (water vapor, carbon dioxide, methane). The changes in these rates, especially carbon dioxide change, cause greenhouse effect and global warming.

- Change in the physical geography conditions of the earth;

This is presumed to be a change in climates as the orogenic (mountain formation movements) and epirogenic (continental formation movements) movements on the surface change the surface character, slope, aspect and elevation.

Human Causes:

Surface Change: The surface change is a change on the surface of the earth made by human activities. With increasing population growth; destruction of forests and agricultural lands, intensive urbanization and concretization, change in albedo ratios (solar reflectance ratio) have been caused to meet human needs.

Urbanization process: Since the 19th century, there has been an intense urbanization with increasing population. The intense urbanization has caused the cities to become irregular and complex, and the worst damage has been done to the areas where the city was founded. Natural characteristics of the cities from when the cities are first built have been lost and the cities have become almost anthropogenic islands. With the intense urbanization, air pollution in the cities has increased. With it, the effect of the greenhouse was felt more intensely in cities and the concept of "city heat island" was born.

Greenhouse Gas Emissions: The greenhouse gases that cause global warming are formed by the burning of fossil fuels. CO_2 is the most notable greenhouse gas in the atmosphere. The amount of CO_2 in the atmosphere can change for natural reasons like volcanic explosions, breathing of living things, or for human reasons like intensive use of fossil fuels (Gönençgil, B., 2014).

In this study, a climate classification is made with the raster of the study area which is created by enterpolating temperature, precipitation etc. data gathered from meteorological stations. These raster data consist of the sub-data which can be found in the oldest date and the data which is presently available. Thus, climate change in the study area can be questioned between two dates. Using precipitation, temperature, humidity, sunshine period, evapotranspiration etc. data, which are taken from General Directorate of Meteorology of Turkey within a period of 1980-2011, De Martaonne and Erinc classification methods, precipitation, temperature and humidity maps of İzmir province were created in the defined time period and various information about climate change has been gathered.

2. Study Area and Materials

İzmir province was chosen as the study area (Figure 1). İzmir is the third largest city of Turkey. The Madra Mountains to the north, the Kuşadası Gulf to the south, the Boat Burnu to the west of the Çeşme Peninsula, the İzmir province surrounded by the borders of Manisa and Aydin in the east, and the Gulf, which is also known by its name in the west. The Gediz River, which is one of the important rivers of the Aegean Region in İzmir province, has Küçük Menderes akarsuyu with its downfall. The coastal region is recessed due to the stretch of the mountains.

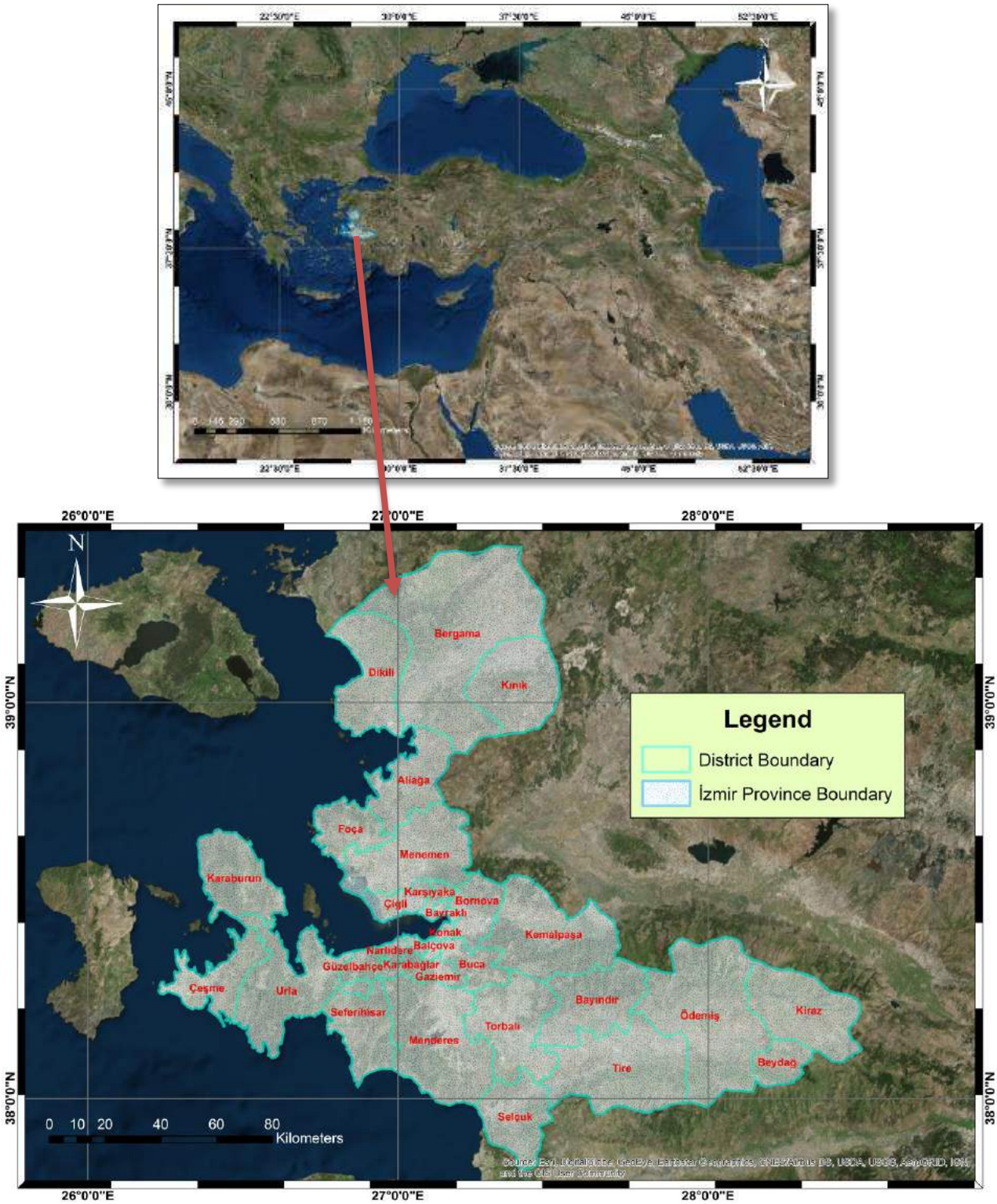

Figure 1: Study area

İzmir province has a climatic character according to the tectonic feature of the coastal Aegean strike with the gulf structure which is open to the sea effects and has an internal marine character in the middle latitude. The Mediterranean climate is dominated by the fact that it is located on the middle latitude and also for being a coastal city. The summers are warm and dry, the winters are warm and abundant, and the spring months are transitional. The sunshine potential is considered high. The wind situation creates an important potential for coastal shoreline to have a combination of different topographical structures. Depending on the amount of precipitation and the duration of sunshine, the soil structure has an appropriate climate characteristic in terms of agriculture (Atalay, İ.,1994).

The data used in the study were provided by the meteorological data management system of the meteorological departments within a time period of 1980 and 2011. This data include monthly temperature, precipitation, relative humidity and so on. Some data such as sunshine duration, evapotranspiration, water shortage and surplus are required in several classification formulas, but not all of those data were found in all stations of İzmir province which have common data in the period of 1980 and 2011. Therefore, only Erinç and De Martonne methods will be used in the study.

In climate studies, it is very important to understand the estimation of climate parameters and the complex structure of non-data points because meteorological stations cannot be found at every characteristic point of the study area. For this reason, it has been necessary to use interpolation methods so that station data can be spread over the entire working area within the İzmir provincial boundary. 8 stations' data in İzmir province and 7 stations' data which are very close to the boundary of İzmir were used in the study (Figure 2). Inverse Distance Weighting (IDW) interpolation method is used on the geographical points which is obtained from meteorological stations for creating the raster data which later to be used in determining the climate change.

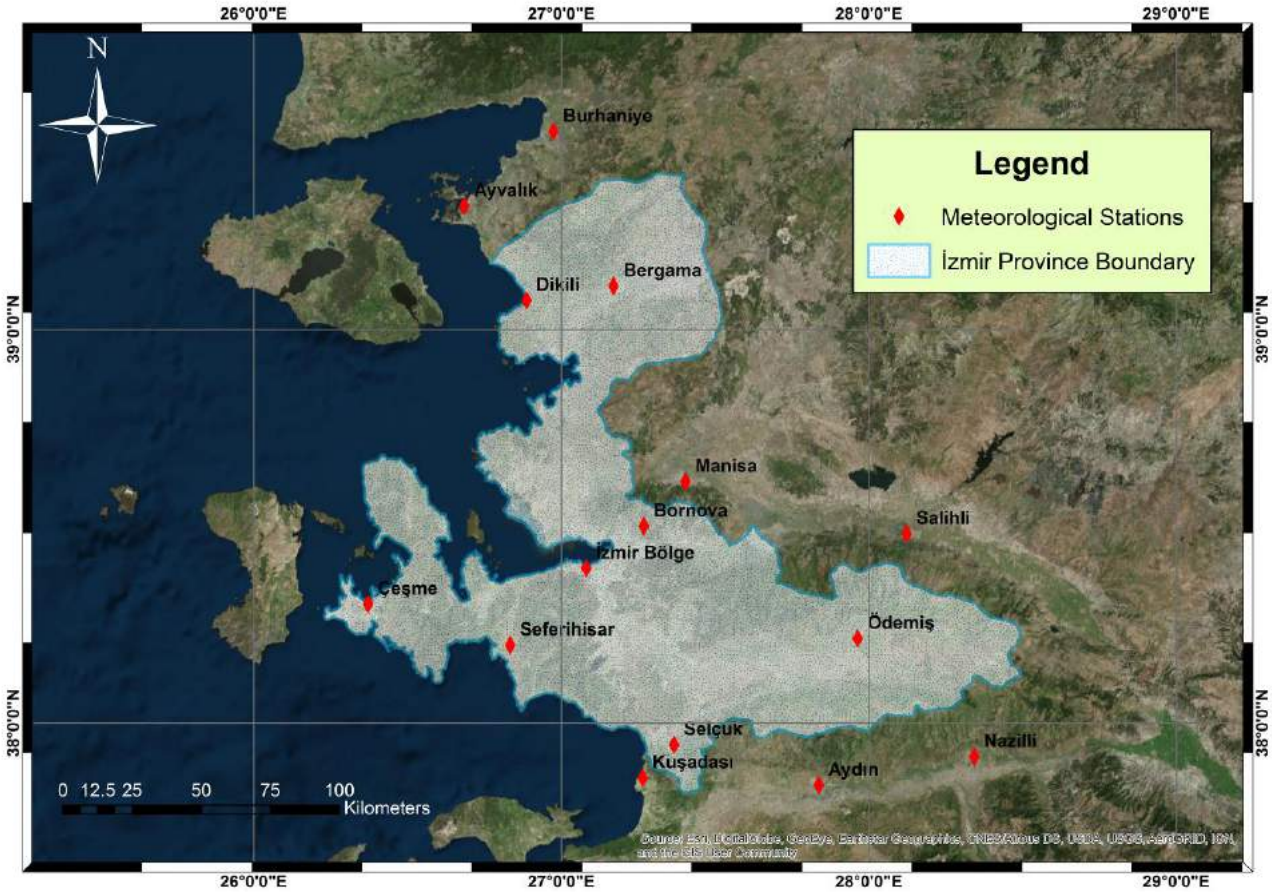

Figure 2: Meteorological stations

3. Methods

There are many climate classifications using different methods. In our work we will use De Martonne, who is called the first classification work used all over the world and named by his name, and the Erinç classifications which are most used in our country and which are most suitable for the country borders.

3.1. De Martonne Climate Classification

De Martonne climate classification is based on temperature and precipitation. This classification method is considered as calculating the average temperature and precipitation of July and January, along with the annual mean precipitation and temperature, unlike other classifications. With annual rainfall data, arid and humid climates can be found as results. İn the determination of arid climates, precipitation accounts with monthly evaporation too. According to De Martonne and Gottman, classification formula they developed is given below (Klimatoloji Şubesi, 2014):

$$I_a = \frac{\left(\frac{P}{T+10}\right) + \left(\frac{12 \times p}{t+10}\right)}{2}$$

To explain the formula elements:

(Reason for the addition of 10) = Fixed number for making t positive in places where the temperature is below 0 ° C
P = total precipitation for many years (mm),
T = Average air temperature (° C) for many years,
p = precipitation of the driest month (mm),
t = Average temperature of the driest month (° C).

Table 1 contains the classification indices of the final products.

Table 1: Indices of De Martonne classification formula

Climate Type	**Index Value**
Desert	0 - 5
Step (Semi-arid)	5 - 10
Step – Humid	10 - 20
Semi-humid	20 - 28
Humid	28 - 35
Very humid	35 - 55
Wet	>55
Polar	<0 (T < -5 C)

3.2. Erinç Climate Classification

In this classification, the amount of precipitation is directly proportional to the average temperatures and the classification indices are formed in this way. However, this created indices make the terrestrial climate appear to be more humid than normal. To prevent this, Erinc used average maximum temperature instead of average temperature. According to this method, months in which temperatures drop below 0°C are not considered in case of no evapotranspiration.

Erinç's formula is as follows (Şensoy, S., 2012) (Erinç, S., 1984):

$$I_m = \frac{P}{T_{om}}$$

To explain the formula elements:

I_m = Rainfall activity element,
P = total annual precipitation (mm),
T_{om} = Annual average maximum temperature.

Table 2: Indices of Erinc classification formula

Climate Class	**İndex Value (I_m)**	**Climate/Vegetation Cover**
Full Arid	< 8	Desert (Full Arid)
Semi-arid	8 - 15	Desert – Step (Arid)
Semi-arid	15 - 23	Step (Semi-arid)
Semi-humid	23 - 40	Dry Forest (Semi-humid)
Humid	40 - 55	Humid Forest (Humid)
Very Humid	>55	Very Humid Forest (Very Humid)

4. Results

4.1. De Martonne Method

According to the climate classification prepared using meteorological data between 1980 and 1989, İzmir has only "Semi-humid" and "Humid" indices, but according to the climate classification between 2006 and 2011, it has begun to have "Very humid" indices especially on the sides of Bergama. Bergama region has changed from "Semi-humid" class to "Very humid" class. The transition from the "Humid" class to the "Semi-humid" class has been the subject of Ödemiş region. On the sides of Konak-Balçova-Bornova there are transitions from "Humid" class to "Semi-humid" class (Figure 3 and Figure 4).

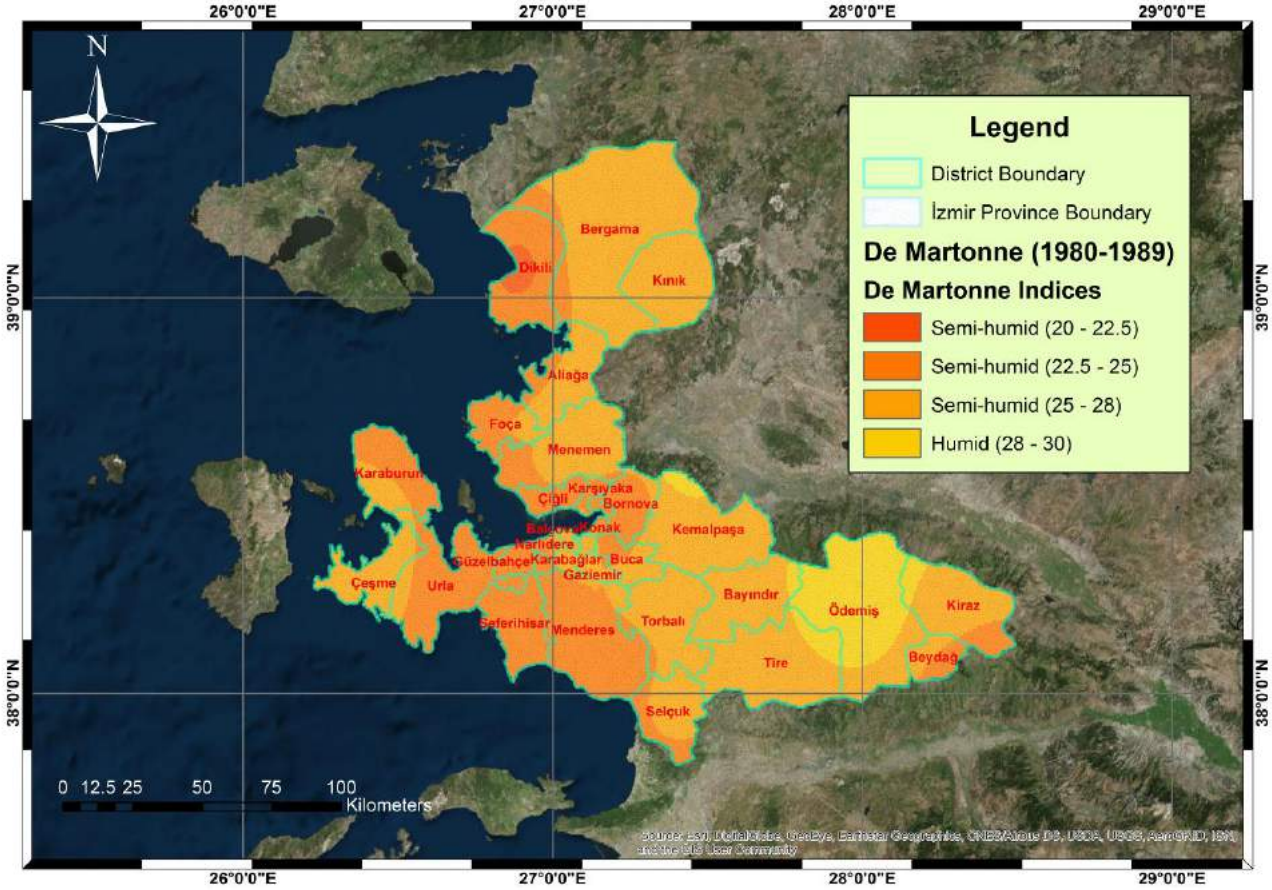

Figure 3: De Martonne (1980-1989)

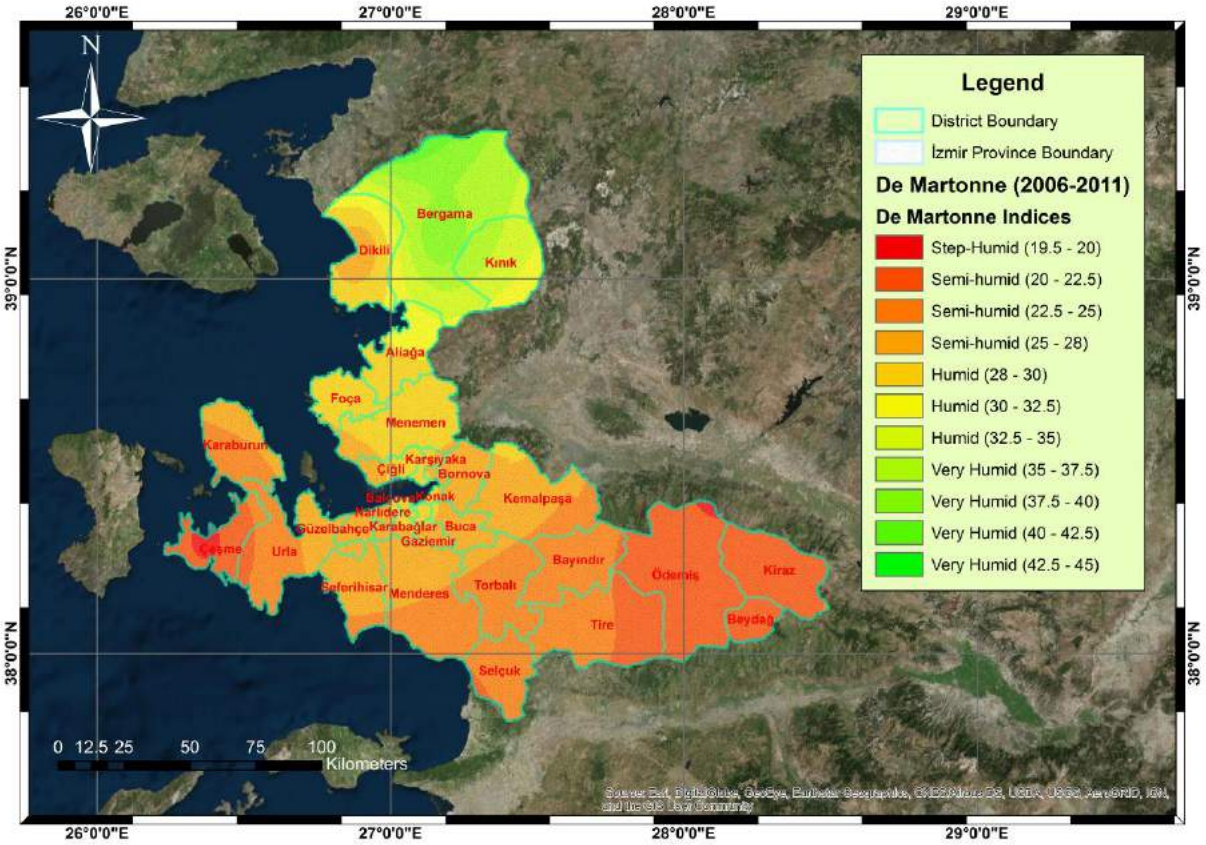

Figure 4: De Martonne (2006-2011)

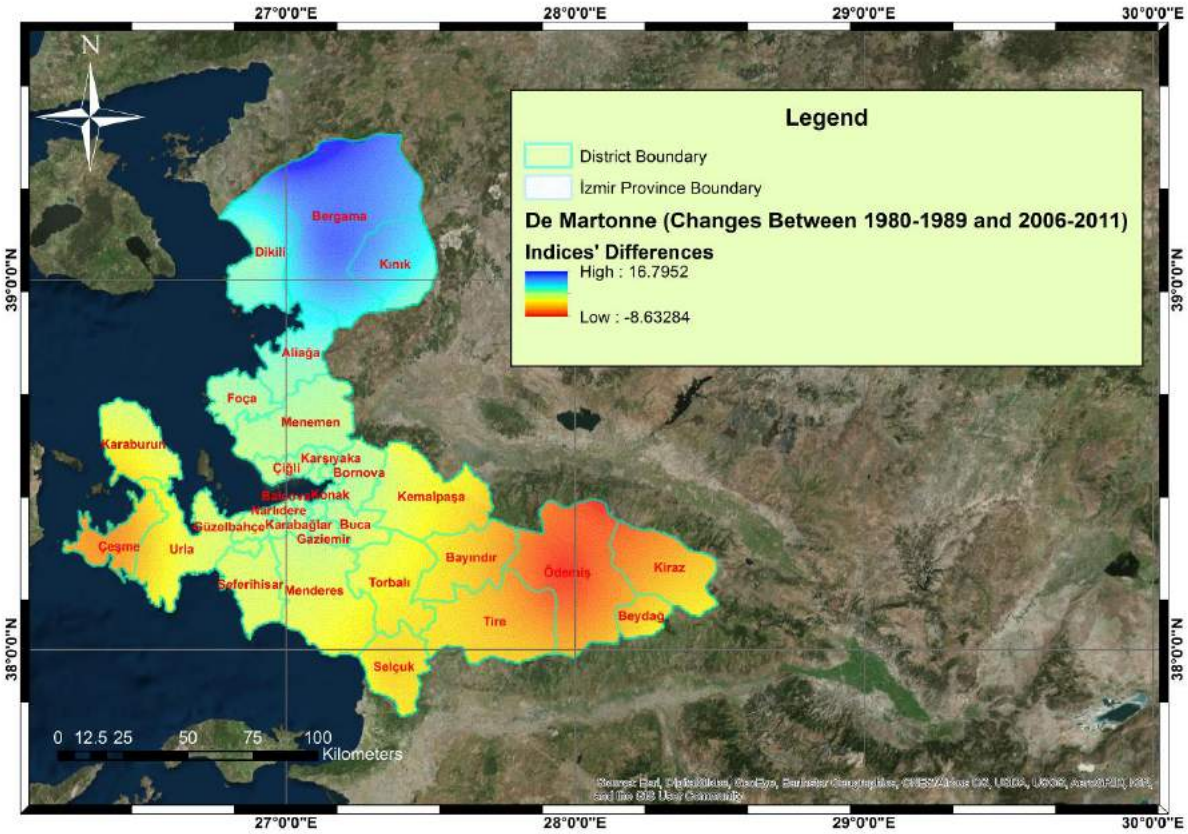

Figure 5: De Martonne (Changes between 1980-1989 and 2006-2011)

According to De Martonne, increasing changes between the two time series represent the movement towards humid class, whereas reductions represent the movement toward arid class. When the change map is examined, biggest change is defined in Bergama region (Figure 5).

4.2. Erinç Method

When examining the classifications prepared using 1980 and 1989 data and 2006 and 2011 data, there is a change towards humidity in Urla area. There is a tendency towards drought in the areas of Dikili, Ödemiş and Tire (Figure 6 and 7).

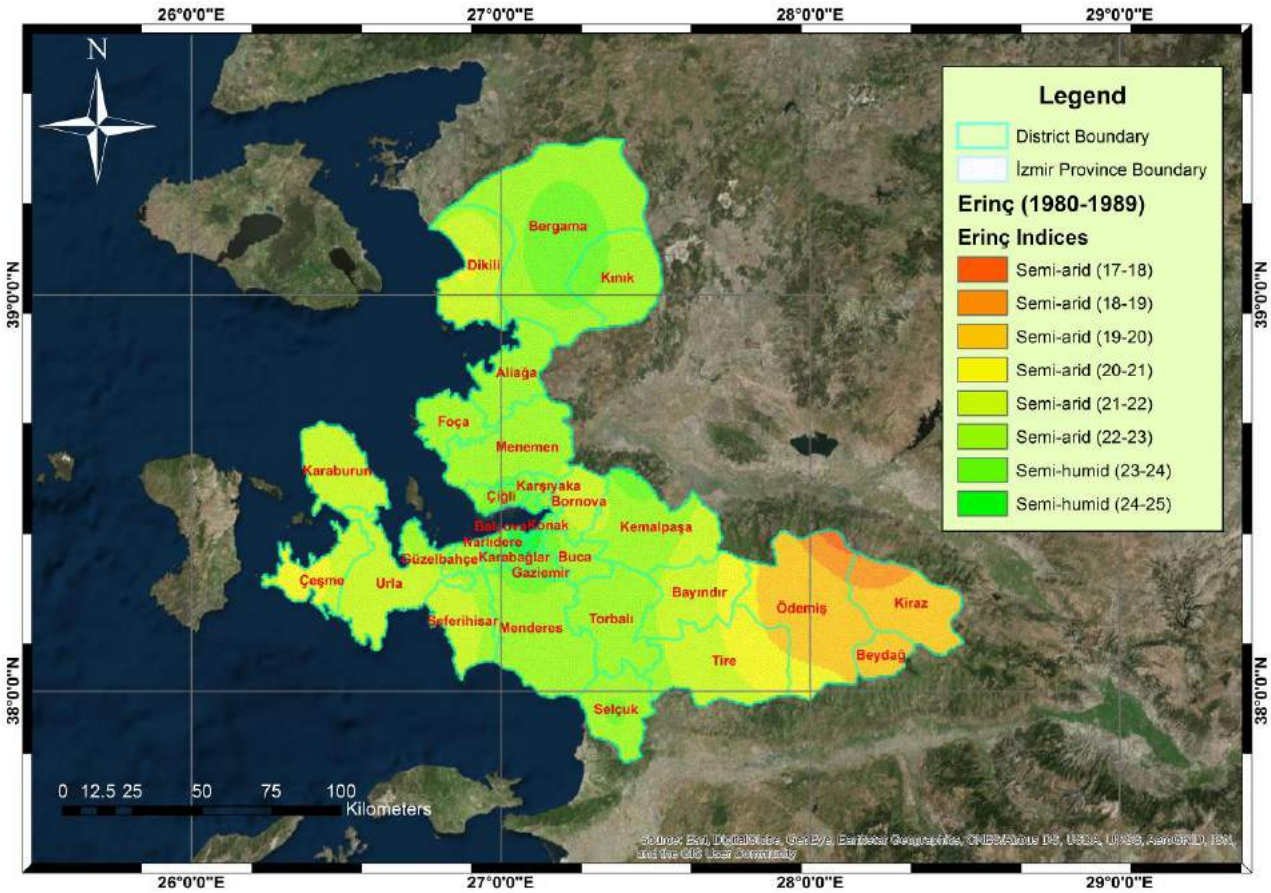

Figure 6: Erinç (1980-1989)

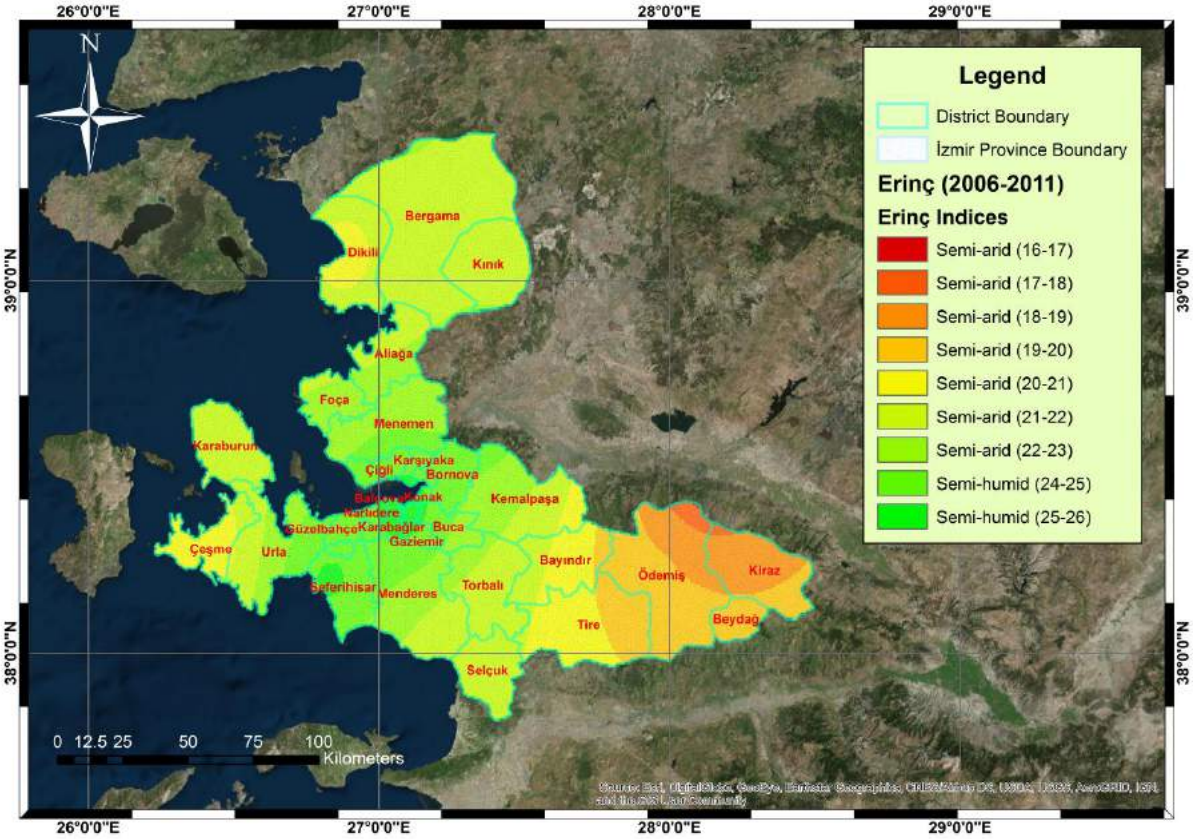

Figure 7: Erinç (2006-2011)

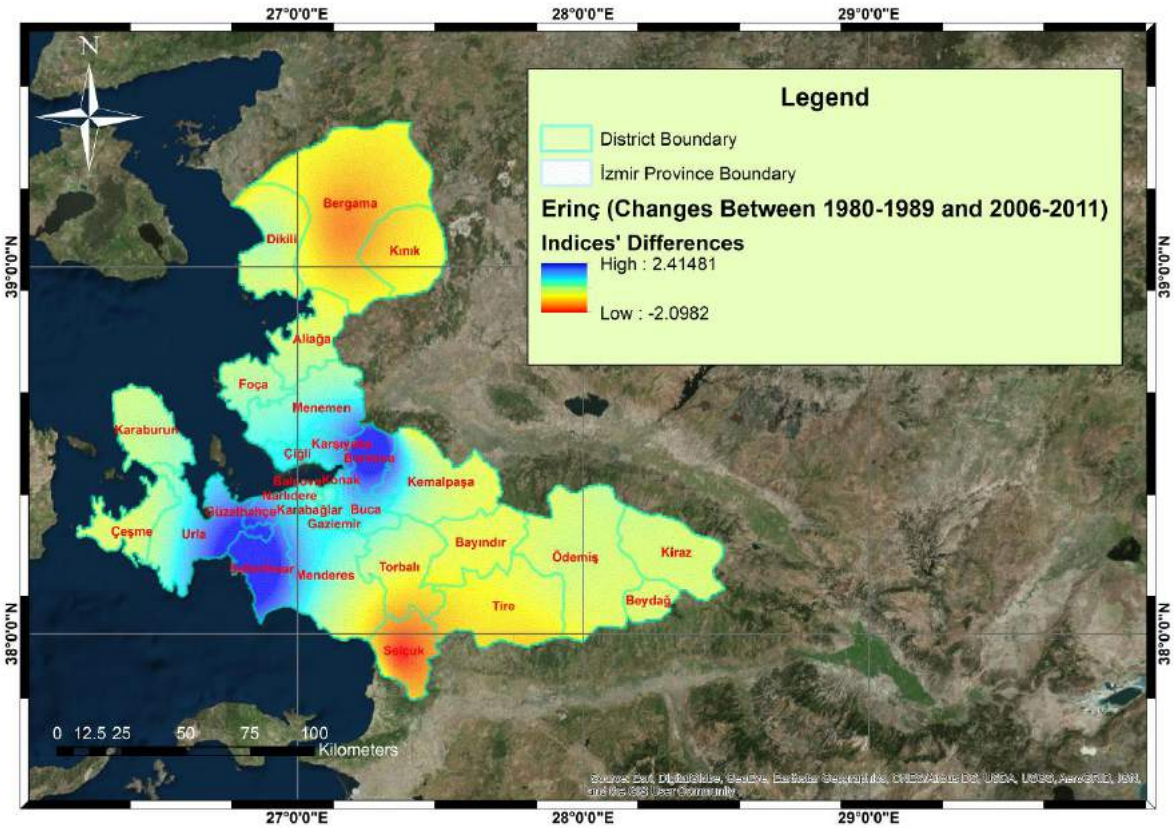

Figure 8: Erinç (Changes between 1980-1989 and 2006-2011)

When Figure 8 is examined, it is seen that there are increases in indices in Seferihisar, Karşıyaka, Bornova, Konak areas. According to the Erinc method, these increases indicate that they move towards humidity from drought. Unlike De Martonne climate classification, the Bergama region is still in the "Semi-humid" class, although it's indices value goes from "Semi-humid" class to "Semi-arid" class. In the Selçuk region, indices are decreasing like Bergama region. According to the Erinç method, large scale class changes did not occur on the basis of the districts.

5. Discussions and Conclusions

When the climatic types represented by indices raster generated by GIS using De Martonne and Erinç formulas are examined, it is found out that the changes seen according to both methods are quite different from each other. In the de Martonne classification, the northern parts of İzmir are advancing from semi-humid to humid class, and the southeast parts are moving towards less humid from semi-humid. In the method of Erinç, it is seen that there are not major changes on the basis of the districts but some transition to drought in the northern part. There are some differences between De Martonne and Erinc methods and also their results. The reason for this is that the classification properties of both methods are different. In addition, Erinc defined the equality he proposed by considering the climate of Turkey. For example, Erinç's indices with values less than 8 are regarded as deserts, while in De Martonne this value is 5 and below. According to the Erinç method, a very humid climate is defined as 55 and above, whereas in De Martonne this value is defined as between 35 and 55.

The TEMA Foundation has provided the following important findings in its report that it was prepared in 2015. According to this report, the main negative impact is defined as the change in crop yields due to climate change and the decrease in crop yield. The reduction of underground and surface water levels and negatively affecting agricultural land are also held in the foreground. The warmer and drier summers are due to the formation of indefinite seasons, and the colder days are beginning to occur in winters. With the increase in sea water temperature, the diversity of living creatures in the sea has begun to decrease. With the increase in temperature, the use of air conditioners has been increased for cooling and it is emphasized that there are also increases in respiratory diseases. It has been determined that erosion disasters have been accelerated and increased due to the heavy rainfall of soils, and agricultural lands and settlement areas have been found to be under water due to these rains. Extreme wind and tornado events have caused havoc in living spaces. Establishment of wind power plants for healthy energy production without feasibility studies creates social, economic and ecological problems. It is emphasized that wind energy plants that are produced without consideration of their environmental effects will cause problems and negative on areas like Bayındır and Tire, which are highly dependent on their livestock. It is stated that the same situation applies within Karaburun region. With the more efficient use of rain water, cleaning and water consumption can be reduced in house necessities. It is necessary to increase the amount of recycled paper. Importance and training of individuals involved in combating climate change should be emphasized (TEMA Vakfı, 2015).

Renewable energy sources are a strategic issue that has a very prevalent sense in terms of our country. It is very important to bring this reliable and beneficial source of energy to country level quickly. However, actions should be taken after the necessary feasibility studies have been carried out. Thus, the use of coal, one of the fossil fuels with high carbon emissions, can be avoided.

As a result of this study, the results of classification of the data obtained for many years show that İzmir province is one of the risky illnesses in which climate change can be experienced in Turkey. In particular, our country's southern and western regions, where the Mediterranean climate is visible, show that we are very sensitive to climate change. According to this situation, the climate region where the effects of drought will be felt the most in our country will be Mediterranean climate area. However, especially at this point, floods and overflowing events as well as landslide events are more likely to occur due to sudden and extreme fall of rainfall.

Given the benefits of working:

- With the results of the study, new reforms can be implemented taking into account changes that may occur in agricultural activities.
- Measures can be taken to ensure that the province of Izmir has the least harmful effect from the global warming effect which is effective on all over the world.
- The loss of life quality due to meteorological data changes in İzmir province can be prevented.
- Provincial climate classification studies have proven to be feasible.
- The subsequent climate classification studies will be a preliminary step.

References

Atalay İ., (1994), *Türkiye Coğrafyası*, Ege Üniversitesi Basımevi.
Dönmez, Y, (1984), *Umumi Klimatoloji ve İklim Çalışmaları İ.T.Ü.*, Yayın No: 2506, Coğrafya Enstitüsü Yayın No: 102
Gönençgil B., (2014), *Küresel İklim Değişiklikleri*, İstanbul Üniversitesi, Coğrafya Lisans Programı Ders kitabı

Klimatoloji Şube Müdürlüğü, (2014), *İklim Sınıflandırmaları*, Meteoroloji Genel Müdürlüğü, Klimatoloji Şube Müdürlüğü Kalaba, Ankara, Türkiye.
Erinç S., (1996), *Klimatoloji ve Metodlari (Climatology and Methods)*, Alfa Basim Yayim IV. Basim, Istanbul.
Sensoy S., (2012), *İklim Sınıflandırmaları*, MGM web sitesi
Url: http://www.mgm.gov.tr/FILES/iklim/iklim_siniflandirmalari.pdf.
TEMA Vakfı, (2015), *TEMA ve WWF-Türkiye Proje Ekibi İklim Değişikliklerinin Yerel Etkileri Raporu*, Omsan Ofset.

Landslide Susceptibility Mapping of Ilkadım (Samsun) District Using Frequency Ratio Method

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Abstract

Landslides cause heavy damage to property and infrastructure as well as loss of human lives in many parts of the Turkey. Samsun is one of the provinces in Turkey where landslides occur most frequently. There have been numerous landslides characterized as natural disaster recorded across the province. In this study, landslide susceptibility map of Ilkadım district of Samsun province has been produced. The lithology, altitude, slope, aspect, plan curvature, profile curvature, topographic wetness index (TWI), and proximity to roads and drainage network parameters have been used in the landslide susceptibility analysis. Frequency Ratio Method has been used in the study. The areas in the produced susceptibility map have been classified into five groups as "very low, low, moderate, high and very high susceptible". Landslide areas located in the landslide inventory map and the landslide susceptibility map have been compared to each other in order to test the reliability of the produced map. The verification results showed that the susceptibility map is consistent with the control landslides in a ratio of 74.80% on the basis of the very high and the high susceptible areas. This landslide susceptibility map can be used for preliminary land use planning and hazard mitigation purpose.

Keywords

GIS, Landslide, Landslide Susceptibility Mapping, Frequency Ratio Method, Ilkadım, Samsun

1. Introduction

Disaster is defined as "a situation or an event which overwhelms local capacity, necessitating a request at a national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction, and human suffering" (Vos et al. 2010). The Centre for Research on the Epidemiology of Disasters (CRED) has maintained EM-DAT—a worldwide database on disasters since 1988. EM-DAT considers two generic categories for disasters (natural and technological), the category of natural disasters is further divided into five subgroups, which in turn cover 12 disaster types and more than 30 sub-types. On the basis of this classification, natural disasters can be defined as the "results of biological, meteorological, hydrological, climatologic, and geophysical based events, which are unpredictable and cannot be prevented. In addition to earthquakes, floods, storms, and landslides are also one of the most commonly experienced natural disasters in the world. Landslides are the downward and outward movement of the slopes composed of natural rock, soils, artificial fills, or combinations of these materials (Varnes 1958).

As one of the most common natural disasters in the world, landslides cause a large-scale socio-economic devastation such as casualties, economic damage, and loss of cultural and natural heritage. Landslides are also known to be one of the leading natural disasters causing life and property losses in Turkey. When natural disasters between the years 1950–2000 in Turkey are analyzed, landslides are found to be the most frequent ones with 45% occurrence (Gökçe et al. 2008). One of the latest landslides, caused by heavy rains, with devastating effects in Turkey was recorded on August 26, 2010 in the town of Gündoğdu at the center of Rize, killing 13 people.

In Turkey, Samsun is one of the foremost provinces, wherein landslides occur at a higher frequency. In a past study, carried out in Samsun to find the distribution of damage and for microzonation of the landslides, the city center was grouped into three areas: 1) dangerous areas for construction (where the current buildings must be evacuated), 2) unfavorable areas for construction (where the current constructions must be discontinued), and 3) the favorable areas, where new construction facilities can be permitted under certain conditions (Doyuran et al. 1985). However, housing is denser in Atakum, İlkadım and Canik districts where landslides occur more frequently. Considering the fact that the landslides are the leading natural disasters causing loss of life and property in Turkey and high potential risk of landslides in Samsun, there is a great need for producing a landslide susceptibility map of Ilkadım district in order to prevent the possible loss of life.

In general, for landslide evaluation tasks, different types of maps that contain diverse information are prepared by conducting field and laboratory studies for the geological and the geotechnical purposes. These maps are used for various tasks such as choosing settlement areas, infrastructure works, the construction facilities of other engineering structures, etc. In this context, landslide susceptibility maps are one of the most significant geology-based maps (Yalçın 2007). Landslide susceptibility maps provide information about sensitive areas for landslides in the future and the tendency of an area towards possible landslides (Dağdelenler 2013).

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Although researchers have been using different parameters due to regional characteristics in landslide susceptibility analysis, in the studies that evaluated which methods and parameters should be used in the preparation of landslide susceptibility maps (Gökçeoğlu and Ercanoğlu 2001, Dağ et al. 2011), it has been observed that slope, aspect, lithology, and land cover are frequently used parameters. In parameter selection, one of the most important and effective factor is the fact that whether a reliable dataset related with any parameter can be easily obtained. In the literature, there is no consensus among the researchers on the methods and parameters used in the preparation of landslide susceptibility maps; and there are a large number of parameters and methods that are used. This is due to the fact that researchers mainly take into account the parameters related to their study area (Gökçeoğlu and Ercanoğlu 2001, Dağ et al. 2011). Dağ et al. (2011) pointed out that approximately 64% of all landslide susceptibility maps have been prepared by various statistical methods.

The main objective of this research was to produce landslide susceptibility map for Ilkadım, one of the districts of Samsun province, known as highly sensitive to landslide occurrence. In this study, the parameters of altitude, aspect, slope, topographic wetness index (TWI), profile curvature, plan curvature, lithology, and distance to drainage network and roads were used. Frequency ratio method was chosen for this study since it is widely used in the literature, consist of understandable and simple statistical model, provide accurate result, and can easily be applied.

2. Material and Method

2.1. Study Area

Ilkadım district is located in Samsun Metropolitan Municipality boundaries. It neighbors Canik district on the east, Atakum district on the west, Black Sea on the north, Kavak district on the south (Figure 1). According to the Address Based Population Registration System, population of Ilkadım was 325.666 in 2016. The district is between 41° 8’ 8.6” – 41° 19’ 32” north latitude and 36° 7’ 42” – 36° 21’ 11” east longitude and has an area of 157.19 km^2.

The slope ranges from 0° to 60° in the district. The average slope is about 14°. Approximately 42.4% of the study area, the slope is below 10°. The areas where the slope is between 10° and 20° cover 31.3% of the study area and the areas with the slope above 20° are about 26.3%. According to CORINE 2006 land cover data, 65% of the study area is composed of agricultural and 19% is forest area. In Samsun, the climate of the Black Sea is seen. This kind of climate is rainy every season, hot in summers and warm in winters. The long-term average annual rainfall in Samsun is 694mm. According to the average of 40 years between 1970 and 2010, the average annual temperature in Samsun is 14.4°C. The hottest months are July (23.3°C) and August (23.5°C), while the coldest months are January (7.0°C) and February (6.9°C) (Bahadır, 2013).

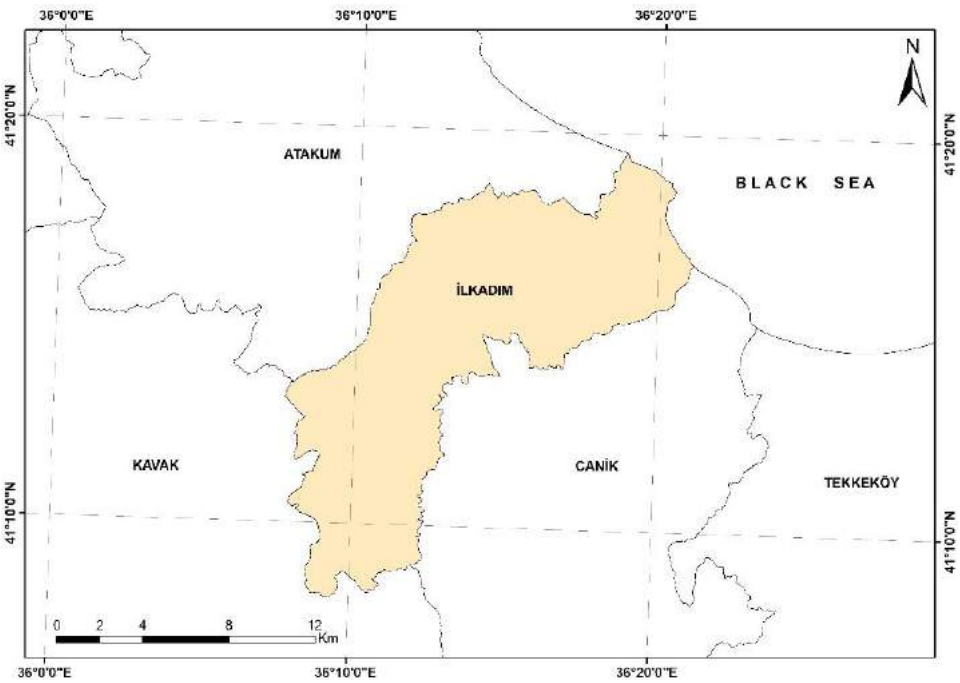

Figure 1: Location map of the study area

2.2. Lithology of the Study Area

As shown in Figure 2, ten different formations are seen from older to younger in the İlkadım district (Öztekeşin, 2008; Keskin, 2011; Temizel et al., 2014).

Cankurtaran formation (Kc): Cankurtaran formation consists of tuff-tuffite, sandy limestone, and marl intercalated with sandstone and shale alternations (Temizel et al., 2014).

Akveren formation (Kta): Akveren formation consists of sandstone, sandy limestone, limestone, and marl with siltstone and shale intercalations (Temizel et al., 2014).

Kusuri formation (Tk): Kusuri formation consist of marl, sandstone, siltstone, limestone and calcareous sandstone alternations (Keskin, 2011).

Tekkeköy formation (Tt): Tekkeköy formation consist of sandstone, marl and tuffite alternations, basalt and anglomera (Keskin, 2011).

Mahmurdağ volcanics (Tmv): Mahmurdağ volcanics consist of basaltic lava, dike and sills (Keskin, 2011).

Ilyas member (Tsi): The unit is formed in the lagoonal marine medium and consists of grey-blue marls, clay, sandstone, siltstone, pebblestone and gypsum. The thickness of the member is about 130 m.

Karasamsun member (Tsk): This unit consists of sandstone, siltstone and marl with lenses, in places mid-tight attached and also well-cemented conglomerates. The conglomerate is mainly formed by andesite-basalt type volcanic, small amounts of limestone, sandstone and marl.

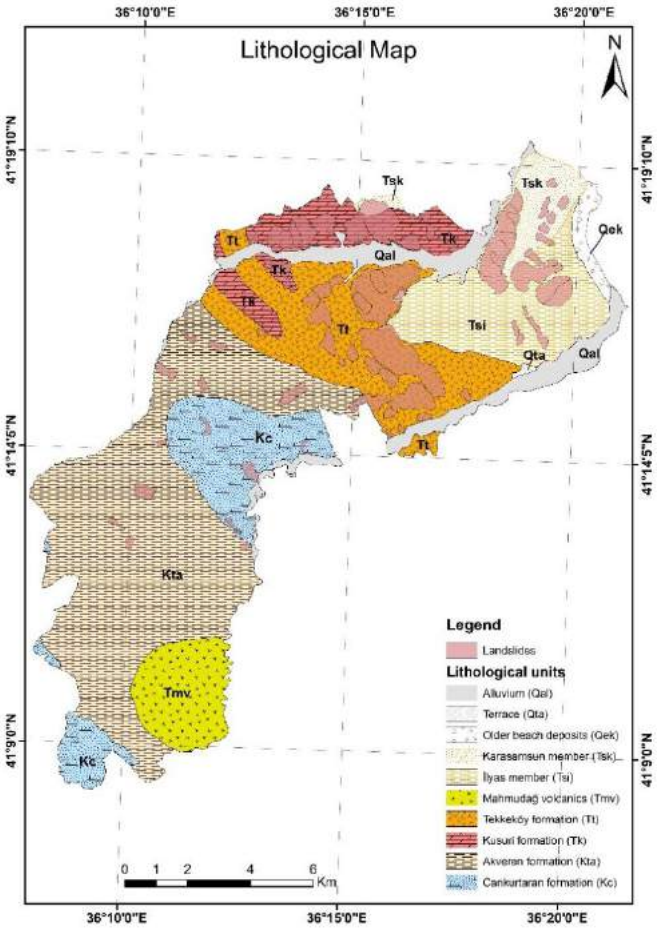

Figure 2: Lithological map of the study area

2.3. Data Handling and Data Preparation

In this study, the parameters, such as altitude, aspect, slope, profile and plan curvatures, TWI, lithology, proximity to the drainage networks and roads were used. Descriptive statistical data of the environmental parameters used in the study was presented in Table 1. The basic data required to produce the landslide susceptibility maps of the study area were obtained from 1/25.000 scale Standard Topographic Maps. At first, the digital elevation model (DEM) of the study area was created by using contour lines in the topographic maps in ArcGIS 10.2. The DEM was converted into 10×10 m cell size raster format and then altitude, aspect, slope, TWI, profile and plan curvature maps of the study area were produced. 1/25.000 scale digital geology and landslide inventory maps of the study area were procured from the MREI (General Directorate of Mineral Research and Exploration Institute). These maps were also converted into 10×10 m cell size raster format. In order to produce the landslide susceptibility map, the produced parameters maps were compared one by one with the landslide inventory map, and thus the relations of each layer to landslides were found.

Table 1: Descriptive statistical data of the environmental parameters used in the study

Parameter	Min.	Max.	Mean	Std. Deviation	Data Type	Scale
Elevation (m)	0	980	337.43	239.14	GRID	10x10 m
Slope (°)	0	60.36	13.71	9.49	GRID	10x10 m
Plan curvature	-12.702	11.423	0.004	0.63	GRID	10x10 m
Profile curvature	-15.976	18.586	0.007	0.95	GRID	10x10 m
TWI	3.149	28.778	7.57	2.07	GRID	10x10 m
Proximity to road	0	1000	94.53	88.41	GRID	10x10 m
Proximity to drainage	0	2060	472.60	319.09	GRID	10x10 m

The first step in assessing landslide susceptibility is to learn about the past landslides occurred within the research area. This is based on the assumption that future landslides can occur under similar conditions, wherein the past landslides occurred (Lee and Talip, 2005; Kumtepe et al., 2009; Erener and Düzgün, 2010; Kavzoglu et al., 2015). Therefore, one of the most important datasets required for studying landslide susceptibility is "landslide inventory maps", as these maps show the existing landslide areas on land (Çevik and Topal, 2003; Yalçın 2007). In this study, 1/25000 scale digital landslide inventory maps produced by MREI were used. There are 76 landslides with a total area of 2080.26 ha on the landslide inventory map. In the 1/25.000 scale landslide inventory maps produced by the MREI, classification of landslides was based on Varnes (1978) classification (Çan et al., 2013). However, in the digital landslide inventory map provided from MREI within the scope of the study, landslides were classified as active and inactive according to their activities only. 47.56% of the landslides were in the Tekkeköy formation (Table 2). Approximately 67% of the landslide areas were analyzed and 33% were used as validation data sets.

Lithology is one of the most important parameters affecting the formation of landslides (Kumtepe et al., 2009) and is an important parameter considered in the susceptibility studies, owing to the fact that different lithological units have different levels of sensitivity to active geomorphological processes including landslides. Geomorphological processes are partly based on the lithology and the dissociation properties of the basic materials constituting to the lithology (Dai et al., 2001, Çevik and Topal, 2003). Lithological units in the study area were obtained from the 1/25.000 scale geological maps produced by MREI (Figure 2).

Slope angle is considered as the most important parameter of the landslide susceptibility analysis (Lee and Min, 2001; Dai et al., 2001). In several studies, this parameter was given the first priority for producing landslide susceptibility maps (Yalçın, 2008; Yılmaz, 2009; Erener and Düzgün, 2010). Previous studies and field observations have indicated that susceptibility to landslide increases with the rising slope (Yalçın, 2007). Therefore, the DEM of the study area was produced by using the contour lines in ArcGIS 10.2 GIS software. Generated DEM was converted into 10 m × 10 m cell size ESRI GRID format and the slope of the study area map was determined. The produced slope map was reclassified with 5^0 increments and the distribution of the landslides corresponding to each slope group was identified by comparing it to the landslide inventory maps (Table 2). The maximum slope in the study area was found to be 60.36^0 and the most of the landslides according to the slope map were in $5–10^0$ slope group with 56.27% occurrence.

Like slope, aspect is also used as an important parameter in the generation of landslide susceptibility maps (Çevik and Topal, 2003; Ercanoğlu et al., 2004). An increase in the frequency of landslides in certain aspects can generally be associated with both the morphology of the study area and the meteorological conditions such as general rainfall direction or solar radiation intake. The soil infiltration capacity depends on many factors such as soil type, slope, permeability, porosity, soil moisture, organic matter contents, vegetation cover, and the season of precipitation. The slopes receiving more rainfall will reach saturation more quickly than the other slopes. Accordingly, this leads to the development of pore water pressure in such slopes (Gökçeoğlu and Ercanoğlu, 2001). In order to reveal the relationship between the aspect and landslides, aspect map of the study area was produced with DEM. The aspect map was divided into nine classes and the percentage presence of landslides in each group was calculated (Tables 2). The aspect map revealed that 16.96% of the landslides in the study area occur on the slopes with south aspect, and 15.10% on the slopes with southeast aspect.

The altitude map of the area was produced using DEM to determine the landslide-altitude relations in the study area. The altitude of the study area varies between 0 and 980 m. The values of elevation were divided into nine categories with 100 m increments, and landslide-altitude relationship was identified. Using this map, it was identified that the most of the landslides with 47.48% frequency occurred in areas at altitudes ranging from 100 to 200 m in the study area (Tables 2).

Curvature shows the morphological structure of topography (Lee and Min, 2001; Erener and Düzgün, 2010). Curvature maps are obtained as second derivative of DEM, thus they show changes in the slope (Erener and Düzgün, 2010). A positive curvature indicates an upward convex surface, while a negative curvature is indicative of an upward concave surface, and zero represents a flat surface. Plan curvature refers to the tendency of the surface for the water flow to converge (where the flow is collected) or diverge (where the flow is dispersed). The plan curvature with negative value indicates that the flow is collected, and a positive value indicates that the flow is dispersed. Streams and ridges can be removed from these values.

Table 2: Spatial relationship between litology, elevation, slope, aspect, plan and profile curvature with landslides

Factor	Category	No. of landslide cells	PoL	No. of cells in category	PoC	FR
Litology	Qal	0	0.00	112895	7.18	0.00000
	Qta	0	0.00	1613	0.10	0.00000
	Qek	0	0.00	17607	1.12	0.00000
	Tsk	7553	5.01	58646	3.73	1.34284
	Tsi	29278	19.43	198345	12.62	1.53909
	Tmv	0	0.00	90761	5.78	0.00000
	Tt	71674	47.56	268611	17.09	2.78216
	Tk	26072	17.30	110227	7.01	2.46622
	Kta	12507	8.30	550976	35.06	0.23668
	Kc	3622	2.40	161677	10.29	0.23358
		150706	**100.00**	**1571358**	**100.00**	
Elevation (m)	0-100	26931	17.87	275351	17.52	1.01979
	100-200	71550	47.48	330969	21.06	2.25407
	200-300	35841	23.78	205315	13.07	1.82014
	300-400	10714	7.11	179133	11.40	0.62362
	400-500	3520	2.34	144858	9.22	0.25336
	500-600	1824	1.21	130898	8.33	0.14529
	600-700	326	0.22	148671	9.46	0.02286
	700-800	0	0.00	116510	7.41	0.00000
	800-980	0	0.00	39653	2.52	0.00000
		150706	**100.00**	**1571358**	**100.00**	
Slope (º)	0-5	19550	12.97	295834	18.83	0.68904
	5-10	84800	56.27	370994	23.61	2.38327
	10-15	28110	18.65	262734	16.72	1.11555
	15-20	8963	5.95	229572	14.61	0.40708
	20-25	4602	3.05	188798	12.01	0.25415
	25-30	2856	1.90	127151	8.09	0.23420
	30-35	1263	0.84	64656	4.11	0.20368
	35-40	369	0.24	23827	1.52	0.16147
	40-45	121	0.08	6375	0.41	0.19790
	45-60	72	0.05	1417	0.09	0.52979
		150706	**100.00**	**1571358**	**100.00**	
Aspect	Flat	4195	2.78	67868	4.32	0.64448
	North	21654	14.37	206160	13.12	1.09516
	Northeast	14910	9.89	189732	12.07	0.81937
	East	14672	9.74	262159	16.68	0.58354
	Southeast	22754	15.10	280397	17.84	0.84611
	South	25561	16.96	171535	10.92	1.55371
	Southwest	18007	11.95	92545	5.89	2.02877
	West	10656	7.07	110688	7.04	1.00378
	Northwest	18297	12.14	190274	12.11	1.00264
		150706	**100.00**	**1571358**	**100.00**	
Plan Curvature	Concave (< 0)	66313	44.00	646851	41.17	1.06890
	Flat (0)	10218	6.78	139103	8.85	0.76590
	Convex (> 0)	74175	49.22	785404	49.98	0.98471
		150706	**100.00**	**1571358**	**100.00**	
Profile Curvature	Concave (< 0)	72211	47.92	753261	47.94	0.99955
	Flat (0)	7942	5.27	118943	7.57	0.69620
	Convex (> 0)	70553	46.81	699154	44.49	1.05217
		150706	**100.00**	**1571358**	**100.00**	
TWI	3.15-6.36	28341	18.81	430484	27.40	0.68644
	6.36-8.07	61144	40.57	635223	40.43	1.00363
	8.07-10.28	49114	32.59	359175	22.86	1.42575
	10.28-13.70	10587	7.02	123884	7.88	0.89105
	13.70-28.78	1520	1.01	22592	1.44	0.70151
		150706	**100.00**	**1571358**	**100.00**	

FR: Frequency Ratio, PoL: percentage of landslide occurrence in each sub-category, PoC: percentage of each sub-category

Table 3: Spatial relationship between distance to roads and drainage with landslides

Factor	Category	No. of landslide cells	PoL	No. of cells in category	PoC	FR
Distance to roads (m)	0-100	82532	54.76	1007178	64.10	0.85440
	100-200	39091	25.94	377377	24.02	1.08006
	200-300	19756	13.11	136524	8.69	1.50881
	300-400	7289	4.84	36458	2.32	2.08459
	400-500	1833	1.22	10097	0.64	1.89284
	500-600	205	0.14	2602	0.17	0.82147
	600-700	0	0.00	434	0.03	0.00000
	700-800	0	0.00	351	0.02	0.00000
	800-900	0	0.00	236	0.02	0.00000
	900-1000	0	0.00	101	0.01	0.00000
		150706	**100.00**	**1571358**	**100.00**	
Distance to drainage (m)	0-150	20674	13.72	281686	17.93	0.76525
	150-300	24219	16.07	271481	17.28	0.93017
	300-450	26993	17.91	257325	16.38	1.09374
	450-600	24337	16.15	238340	15.17	1.06467
	600-750	20054	13.31	212145	13.50	0.98563
	750-1000	24381	16.18	222150	14.14	1.14433
	1000-1530	9825	6.52	79216	5.04	1.29320
	1530-2060	223	0.15	9015	0.57	0.25792
		150706	**100.00**	**1571358**	**100.00**	

FR: Frequency Ratio, PoL: percentage of landslide occurrence in each sub-category, PoC: percentage of each sub-category

Profile curvature indicates flow speed of the water on the surface and convection of sediments along the slope of the curvature and erosion by expressing the slope change. Negative profile component shows concave (hollow) and positive values show convex (top) structure (Kılıç and Gökaşan, 2009). The plan and profile curvature maps of the study area were produced from DEM.

One of the indicators used while evaluating the saturation of geological material in a field is topographic wetness index (TWI). This index provides information about the aerial dimension of the study area in respect to its water saturation. The infiltration of water into the material increases pore water pressure in the material as well as reduces the strength of the material (Gökçeoğlu et al., 2005). Therefore, the direction and density of flow in the study area were calculated using the DEM; and the relative TWI map of the area was prepared. The relationship between landslides with TWI is shown in Table 2.

Another important variable controlling the stability of the slope is the degree of saturation of the material on the slopes. The proximity of slopes to drainage network is another important factor in terms of stability. Running waters such as rivers or creeks disrupt the stability by eroding the filling and toe of slopes or by saturating the material constituting the slope to the level of the stream or in both ways (Yalçın, 2008). The drainage network in the study area was produced from DEM and the proximity map of the drainage using related GIS analysis routines. The relationship between distance to drainage networks and landslides is shown in Table 3. Approximately 48% of the landslides in the study area were in the first 450 m distance to drainage networks.

The stability problems can also be seen in slopes that are affected by the construction of roads (Yalçın, 2008). The roads opened on the slopes cause load reduction both at the toe of slopes and in the topography, leading to an increase in the tension behind the slope and the development of tension cracks. Instability might be caused as the negative effects of road constructions, as water entering the roads from outside may disturb the equilibrium on slope. The road network in the study area was obtained digitally from Samsun Metropolitan Municipality. The map showing the proximity of the road was produced using the corresponding GIS analysis routines. In order to determine the relationship between the proximity to roads and the landslides, the road map and the landslide map were overlaid and it was found that 54.76% of the landslides in the study area were occurred within 100 m of the roads (Table 3).

2.4. Frequency Ratio Method

The frequency ratio method was used to determine the correlation between past landslide locations and each factor affecting landslides (Lee and Min, 2001; Lee et al., 2004; Erener and Düzgün, 2010). As defined by the Lee and Talib (2005), the frequency ratio is the "ratio of the area where landslides occurred in the total study area, and also, is the ratio of the probabilities of a landslide occurrence to a non-occurrence for a given attribute". In order to find the frequency ratio of each factor that affects landslides in the study area, each factor was assigned to a subcategory and the number of cells where a landslide has occurred in each subcategory of each factor was determined. The following equation was used to calculate the frequency ratio.

$$FR = \frac{PoL}{PoC} \tag{1}$$

Here, *PoL* is the percentage of landslide occurrence in each subcategory of a factor that affects landslide and *PoC* is the percentage of each subcategory of a factor that affects landslide. *PoL* is determined as *A/B* and *PoC* as *C/D*, where *A* refers to the number of landslide cells in each subcategory, *B* refers to the total number of landslide cells, *C* refers to the number of cells in each subcategory and *D* refers to the total number of cells in the study area (Erener and Lacasse, 2007).

The frequency ratios greater than 1 indicate high correlations with the landslides, while smaller than 1 indicate low correlations (Lee and Pradhan, 2007). The frequency ratios computed for each category were assigned to the relevant layer in the ArcGIS 10.2 software and afterwards the Landslide Susceptibility Index (LSI) were calculated by overlapping all layers over each other. The frequency ratios of each subcategory were summed to calculate the LSI, as shown in equation 2.

$$LSI = \sum Fr \tag{2}$$

The LSI value varied between 5.04 and 16.06 in our case study. If the LSI value is high, it means a higher susceptibility to landslide; a lower value means a lower susceptibility to landslides (Lee and Evangelista, 2005). Subsequently, the LSI was divided into five classes with natural break classification, each representing "very low, low, moderate, high and very high susceptible" areas. The susceptibility map with the five risk areas is shown in Figure 3.

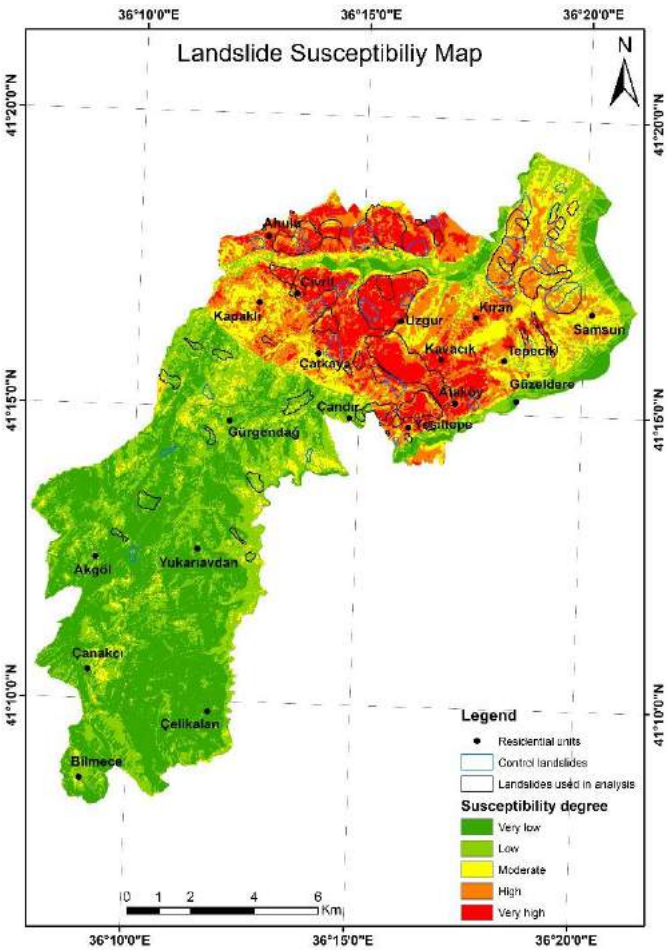

Figure 3: Landslide susceptibility map produced by frequency ratio method

3. Results

In this study, we focused on two issues according to the findings. The first one is the prediction (estimation) capabilities of method used in the production of landslide susceptibility map, and the second one is the determination of the principal factors causing landslides in the study area. In this study, frequency ratio method was used in the production of landslide susceptibility map. Correct classification approach was primarily used to test the reliability of the landslide susceptibility map. The correct classification approach showed the estimated accuracy of the landslide area in the control dataset in

landslide susceptibility maps. For this purpose, the landslides in the landslide inventory maps were not included in the analysis for controlling purpose; and the landslide susceptibility map were compared and distribution of landslide areas was determined according to the susceptibility class.

For the evaluation of the landslide susceptibility map produced by the frequency ratio method, it was identified that 35.39% of the control landslides occurred in an area with a very high degree of susceptibility, 39.41% in an area with a high degree of susceptibility, 17.30% in an area with a moderate degree of susceptibility (92.11% in total). According to these values, it was concluded that the produced landslide susceptibility map offers an acceptable level of accurate performance.

The factors that make up the mass movement are divided into four groups in general: ground conditions, geomorphological processes, physical processes, and the human effects. In the evaluations, it was determined that the mass movements in İlkadım district were caused by ground conditions. When the relationship between the factors used in landslide susceptibility analysis (and sub-categories) and the landslide areas found in the landslide inventory maps was considered, it is observed that landslides occur at a frequency of 47.56% in the fields with Tekkeköy formation, 19.43% in the fields with İlyas member, and 17.30% in the fields with Kusuri formation as per the characteristics of lithologic unit (Table 2). The landslides in these three formations account a total of 84.29% of the landslides occurring in the study area.

4. Conclusion

In this study, the landslide susceptibility map of the area of the İlkadım district of Samsun province was produced using frequency ratio method. Nine different factors affecting landslides were used in the susceptibility analysis. The landslide susceptibility map produced was classified into five types as “very low, low, moderate, high and very high susceptible” areas. In order to test the reliability of the landslide susceptibility map, control landslides found in the landslide inventory maps, which were not included in the analysis for control purpose, were analyzed; and landslides susceptibility map was compared and distribution of landslide areas was determined according to the susceptibility class. The verification results showed that 35.39% of the control landslides occurred in an area with a very high degree of susceptibility and 39.41% in an area with a high degree of susceptibility, 17.30% in an area with a moderate degree of susceptibility. As a result, it can be ascertained that the landslide susceptibility map produced by using frequency ratio method is consistent with the control landslides occurring in very high and high susceptible areas with 74.80% frequency. This landslide susceptibility map can be used for preliminary land use planning and hazard mitigation purpose.

References

Bahadır M., (2013), *Samsun İli İklim Özelliklerinin Enterpolasyon Teknikleri ile Analizi*, Anadolu Doğa Bilimleri Dergisi, 4(1), 28-46.

Çan T., Duman T.Y., Olgun Ş., Çörekçioğlu Ş., Gülmez F.K., Elmacı H., Hamzaçebi S., Emre Ö., (2013), *Türkiye Heyelan Veri Tabanı*, TMMOB Coğrafi Bilgi Sistemleri Kongresi 2013, Ankara, 11-13 Kasım 2013.

Çevik E., Topal T., (2003), *GIS-Based Landslide Susceptibility Mapping for a Problematic Segment of the Natural Gas Pipeline, Hendek (Turkey)*, Environmental Geology, 44, 949–962.

Dağ S., Bulut F., Alemdağ S., Kaya A., (2011), *Heyelan Duyarlılık Haritalarının Üretilmesinde Kullanılan Yöntem ve Parametrelere İlişkin Genel Bir Değerlendirme*, Gümüşhane Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 1(2), 151–176.

Dağdelenler G., (2013), *Heyelan Duyarlılık Haritalarının Üretilmesinde Örneklem ve Doğrulama Stratejilerinin Değerlendirilmesi (Gelibolu Yarımadası'nın Doğu Kesimi)*, Doktora Tezi, Hacettepe Üniversitesi, Ankara.

Dai F.C., Lee C.F., Li J., Xu Z.W., (2001), *Assessment of Landslide Susceptibility on The Natural Terrain of Lantau Island, Hong Kong*, Environmental Geology, 40(3), 381–391.

Doyuran V., Lünel T., Altıner D., Koçyiğit A., (1985), *Samsun Yerleşim Sahası Mikrobölgelendirme Çalışmaları*, Türkiye Jeoloji Kurumu Bülteni, 28, 93-103.

Ercanoğlu M., Gökçeoğlu C., Van Asch Th. W.J., (2004), *Landslide Susceptibility Zoning North of Yenice (NW Turkey) by Multivariate Statistical Techniques*, Natural Hazards, 32(1), 1–23.

Erener A., Lacasse S., (2007), *Landslide Susceptibility Mapping Using GIS*, The Union of Chambers of Turkish Engineers and Architects (UCTEA) Geographical Information Systems Congress, Trabzon, KTU, October 30 – November 02.

Erener A., Düzgün H.S.B., (2010), *Improvement of Statistical Landslide Susceptibility Mapping by Using Spatial and Global Regression Methods in the case of More and Romsdal (Norway)*, Landslides, 7(1), 55–68.

Gokce O., Ozden S., Demir, A., (2008), *Türkiye'de Afetlerin Mekânsal ve İstatistiksel Dağılımı Afet Bilgileri Envanteri*, Bayındırlık ve İskân Bakanlığı Afet İşleri Genel Müdürlüğü, Afet Etüt ve Hasar Tespit Daire Başkanlığı, Ankara.

Gökçeoğlu C., Duman T.Y., Sönmez H., Nefeslioğlu H.A., (2005), *17 Mart 2005 Kuzulu (Koyulhisar, Sivas) Heyelanı*, Mühendislik Jeolojisi Bülteni, 20, 17–28.

Gökçeoğlu C., Ercanoğlu M., (2001), *Heyelan Duyarlılık Haritalarının Hazırlanmasında Kullanılan Parametrelere Ilişkin Belirsizlikler*, Hacettepe Üniversitesi Yerbilimleri Uygulama ve Araştırma Merkezi Bülteni, 23, 189–206.

Kavzoglu T., Sahin E.K., Colkesen I., (2015), *Selecting Optimal Conditioning Factors in Shallow Translational Landslide Susceptibility Mapping Using Genetic Algorithm*, Engineering Geology, 192 (2015), 101-112.

Keskin İ., (2011), *1:100.000 Ölçekli Türkiye Jeoloji Haritaları, SAMSUN E-36 ve F-36 Paftaları*, Maden Tetkik ve Arama Genel Müdürlüğü, No:149, Ankara.

Kılıç F., Gökaşan E., (2009), *Yeryüzü Şekillerinin SYM ile CBS Ortamında Değerlendirilmesi (Ders Notu)*, YTÜ Fen Bilimleri Enstitüsü, http://www.yildiz.edu.tr/~fkilic/CBSYeryuzuV4.pdf, [Acccessed August 6, 2014].

Kumtepe P., Nurlu Y., Cengiz T., Sütçü E., (2009), *Bolu Çevresinin Heyelan Duyarlılık Analizi*, TMMOB Coğrafi Bilgi Sistemleri Kongresi, 02-06 Kasım İzmir.

Lee S., Min K., (2001), *Statistical Analyses of Landslide Susceptibility at Yongin, Korea*, Environmental Geology, 40(9), 1095–1113.

Lee S., Choi J., Min K., (2004), *Probabilistic Landslide Hazard Mapping Using GIS and Remote Sensing Data at Boun, Korea*, Int. J. Remote Sensing, 25(11), 2037-2052.

Lee S., Evangelista D.G., (2005), *Landslide Susceptibility Mapping using Probability and Statistics Models in Baguio City, Philippines*, ISPRS 31st International Symposium on Remote Sensing of Environment, Saint Petersburg, Russia, 20-24 May 2005.

Lee S., Talip J.A., (2005), *Probabilistic Landslide Susceptibility and Factor Effect Analysis*, Environmental Geology, 47(7), 982-990.

Lee S., Pradhan B., (2007), *Landslide hazard mapping at Selangor, Malaysia using frequency ratio and logistic regression models*, Landslides, 4, 33-41.

Öztekeşin K., (2008), *Samsun Kenti (Büyükşehir Belediyesi) İçmesuyu Potansiyeli*, TMMOB Samsun Kent Sempozyumu, Samsun, 27-29 Kasım 2008.

Temizel İ., Arslan M., Abdioğlu E., Yücel C., (2014), *Mineral Chemistry and Thermobarometry of Eocene Monzogabbroic Stocks from the Bafra (Samsun) area in Turkey: Implications for Disequilibrium Crystallization and Emplacement Conditions*, International Geology Review, 56 (10), 1226-1245.

Varnes D.J., (1958), *Landslide Types and Processes*, in Eckel E.B., ed., Landslides and Engineering Practice, Highway Research Board Special Report 29 (pp.20-47). NAS-NRC Publication 544, Washington, D.C.

Varnes D.J., (1978), *Slope Movement Types and Processes*, in Schuster, R.L., and Krizek, R.J., eds., Landslides—Analysis and control: National Research Council, Washington, D.C., Transportation Research Board, Special Report 176, 11–33.

Vos F., Rodriguez J., Below R., Guha-Sapir D., (2010), *Annual Disaster Statistical Review 2009: The Numbers and Trends*, Centre for Research on the Epidemiology of Disasters (CRED), Université catholique de Louvain, Brussels, Belgium.

Yalçın A., (2007), *Heyelan Duyarlılık Haritalarının Üretilmesinde Analitik Hiyerarşi Yönteminin ve CBS'nin Kullanımı*, Selçuk Üniversitesi Mühendislik-Mimarlık Fakültesi Dergisi, 22(3), 1–14.

Yalçın A., (2008), *GIS-based Landslide Susceptibility Mapping Using Analytical Hierarchy Process and Bivariate Statistics in Ardesen (Turkey): Comparisons of Results and Confirmations*, Catena, 72(1), 1–12.

Yılmaz I., (2009), *Landslide Susceptibility Mapping Using Frequency Ratio, Logistic Regression, Artificial Neural Networks and Their Comparison: A Case Study from Kat landslides (Tokat-Turkey)*, Computers & Geosciences, 35(6), 125–1138.

Integration of Bayesian Networks and GIS for Dynamic Avalanche Assessment: NSDI Perspective

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Abstract

Natural hazard assessments are core to risk definition and early warning systems and play a fundamental role in the prevention of major accidents. Traditional hazard identification methods are static. For this reason, new information and conditions cannot easily be included in the pre-defined hazard assessments. The Bayesian Networks can be used effectively for dynamic hazard identification. In this study, a methodology based on the Bayesian Networks model is presented for dynamic avalanche hazard assessment, in which changed and renewed data can be included in the system. In the proposed methodology, the integration of the Bayesian Networks and Geographical Information Systems (GIS) is modeled in the National Spatial Data Infrastructure (NSDI) perspective. In this structure, it is possible to combine and analyze the data obtained from different sources and factors for avalanche hazard can be dynamically updated with real-time updated data and temporal hazard mapping can be performed. The proposed methodology provides a generic structure and can be expanded for dynamic mapping for other disasters.

Keywords

Dynamic hazard assessment, avalanche, Bayesian Networks, GIS, NSDI

1. Introduction

Hazard assessment plays a fundamental role in the prevention/reduction of the losses of life and property and this assessment is a first step in the realization of risk analysis of natural disasters (Anderson-Berry and King 2005; Pine 2008; Jonkman et al. 2012; Villa et al. 2015; Xin et al. 2017). Many of the hazard assessment approaches used today are static (Xin et al. 2017) and do not have a dynamic dimension that can integrate the changing conditions and new warnings into the system (Villa et al. 2015). Until now, dynamic systems have generally been regarded as only part of early warning systems, and time-dependency has not been an important factor in the hazard and risk assessment (Narasimhan 2003; Villa et al. 2015; Xin et al. 2017). In the static approach, the updating of the hazard maps is often carried out after many years due to the difficulty of the revision of hazard maps with information updates. Therefore, these maps are often misleading. This problem becomes even more critical when the process and operational parameters continue to change. For this reason, a dynamic and flexible approach is needed in order to adapt to ever-changing data and information (Xin et al. 2017).

The accuracy of hazard maps is a very critical issue. Because all the information declared for disasters has a direct effect on issues such as creating panic on citizens and decreases in the real estate values. For this reason, it is necessary to be very careful in the production of hazard maps. The issue becomes particularly critical when maps are produced within the framework of specific legislation governing the matter and are therefore accepted as legally approved documents (Annoni et al. 2010). Because early warning systems require higher hardware, higher resolution data, and advanced modeling techniques, they are very costly. Therefore, early warning systems are implemented only in the hazardous and risky areas, rather than in every area (Pulwarty and Sivakumar 2014). For this reason, new hazardous areas emerging under changing conditions must be identified. Therefore, the creation of dynamic hazard maps is a prerequisite for the early warning systems to function properly.

Major disasters have caused the need to overcome the limitations of conventional static methods for hazard and risk assessment, and researches have begun on dynamic systems with emerging information and communication technologies (Villa et al. 2015). Over time, the process parameters change, so the hazards and hazard formation routes also change (Xin et al. 2017). Dynamic approaches for hazard and risk enable the identification and evaluation of risks that change over time or that arise and increase during the process. Dynamic methods aim to deal with uncertainties, system complexity, real-time changing conditions and real-time information from different resources and provide a more flexible structure than conventional static approaches. With this dynamic mapping, dynamic changes of the internal and external conditions of the system are achieved and the hazard or risk situation is updated (Villa et al. 2015). However, in order to achieve dynamic character, computer-assisted estimation techniques must be used as a part of the process. Avalanche event, which is caused by numerous factors, is also a dynamic process due to rapidly changing conditions over time (McClung and Schaerer 2006). Avalanche formation is mainly related to the conditions of the land, snow cover and weather (Kadıoğlu 2008), and the causative factors can be handled as meteorological (precipitation, wind intensity and direction, air temperature, humidity, etc.), and land and topographical (vegetation cover, slope, aspect, and other topographic formations) (Turkish General Directorate of Disaster Affairs 1999). Meteorological factors can cause an avalanche under suitable topographic and terrain conditions. In general, the effects of precipitation (snow, rain, precipitation intensity), wind (speed, direction, high altitude winds, local wind conditions), temperature

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(current and previous temperature conditions), and relative humidity are important meteorological factors (Taştekin 2003).

The snow conditions vary according to the land and time. Because meteorological factors vary considerably (Taştekin 2003). In addition, vegetation cover and artificial effects are other factors that show dynamic characteristics (Rawat and Kumar 2015). It is possible to determine the avalanche hazard by acting on the factors affecting the formation of an avalanche (Kadıoğlu 2008). Rapid changes in the instability of snow accumulation give a dynamic character to the avalanche prediction. For this reason, an avalanche prediction in any avalanche path can ideally be carried out by starting with the first snowfall in winter and then revising this prediction with new information (McClung and Schaerer 2006). However, new information or changing conditions cannot be easily included in existing hazard maps (Xin et al. 2017).

The dynamic process in which the results are updated with the integration of new information is similar to the Bayesian revision with the use of updated information as time progresses (McClung and Schaerer 2006). In this context; the Bayesian Networks can be used to add dynamics to the hazard assessment process by adding new information (Grêt-Regamey and Straub 2006; Straub and Grêt-Regamey 2006; Eckert et al. 2010; Landuyt et al. 2015; Villa et al. 2015; Xin et al. 2017).

In this study, we focus on the assessment of avalanche hazard by dynamic mapping approach. In this context, a methodology based on the Bayesian Networks has been proposed in the integration of data from different sources and/or sensors and dynamic avalanche hazard mapping. The proposed approach is based on the integration of Geographical Information Systems (GIS) and Bayesian Networks in the National Spatial Data Infrastructure (NSDI) perspective.

2. Bayesian Networks

Bayes' theorem was developed by Thomas Bayes (1702-1761). Essentially, the Bayes' theorem is an extended form of the concept of conditional probability (Bajpai 2009). Bayes' theorem is a probability model that allows the prediction of the posterior probabilities of an event by changing and updating the prior probabilistic expectations of that event as a result of newly added information (Bajpai 2009; Doğan et al. 2012; d'Acremont et al. 2013; Akıncı et al. 2014). In this context, if more data/information can be provided about the probability of a random variable being calculated, it can be updated and corrected with the Bayes' rule. In other words, the probabilities predicted based on previous observations can be corrected according to the results of new information and observations (Jebb 2017; URL 1). Bayes' theorem modifies a prior probability, yielding a posterior probability, via the Equation 1 (Kelly and Smith 2011).

$$P(H|D)P(D) = P(D|H)P(H) \tag{1}$$

As can be seen from Equation 1, there are 4 components of the Bayes' theorem. These components are explained in Table 1 (Kelly and Smith 2011).

Table 1: Components of Bayes' theorem

Term	Definition
$P(H \mid D)$	Posterior distribution, which is conditional upon data D that is known related to the hypothesis H
$P(H)$	Prior distribution, from knowledge of the hypothesis H that is independent of data D
$P(D \mid H)$	Likelihood, or aleatory model, representing the process or mechanism that provides data D
$P(D)$	Marginal distribution, which serves as normalization constant

A Bayesian Network is based on the Bayes' theorem (Stassopoulou et al. 1998) and is a graphical-mathematical construct (Ames and Anselmo 2008) as a directed acyclic graph and covers nodes, edges and Conditional Probability Tables (CPT). Nodes are variables, directed edges between nodes represent dependencies and causal relationships between variables, and CPT is the conditional probabilities of linked variables (Stassopoulou et al. 1998; Qiu et al. 2015; Jebb 2017). Bayesian Networks are used to probabilistically model the processes and to graphically configure the information (Stassopoulou et al. 1998; Ames and Anselmo 2008; Çinicioğlu 2015). Bayesian Networks provide a flexible structure because they provide a causal relationship (Stassopoulou et al. 1998).

Bayesian Networks allow explicit modeling of related parameters, causal relationships, and associated uncertainties. Probabilities can be obtained from observations, expert knowledge, and literature (Papakosta and Straub 2015).

A Dynamic Bayesian Network is an extended form of the standard Bayesian Network (static). The general structure of a Dynamic Bayesian Network (Hwang et al. 2011) is presented in Figure 1. If there is a link going from node A to node C, then A is said to be a 'parent node' of C, and C is said to be a 'child node' of A (Kragt 2009).

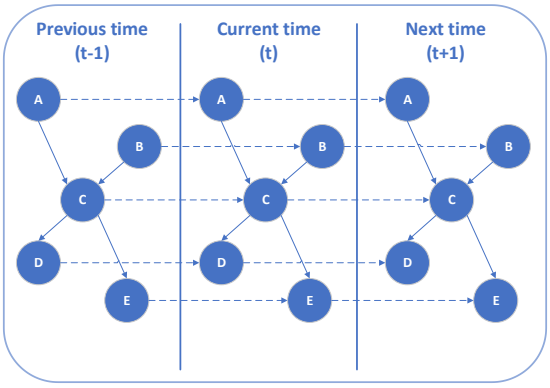

Figure 1: A structure of Dynamic Bayesian Network

3. A Framework for Dynamic Avalanche Assessment

The classical methods used in the production of hazard maps are inadequate because of the need for higher dynamism in the maps for disaster management. In order to be able to get effective results, these maps should be based on update and real-time data as much as possible (Annoni et al. 2010). With the integration of GIS and Bayesian Networks, dynamic hazard maps can be created by updating the hazard map with changing parameters.

3.1. Determination and definition of variables

In this study, a comprehensive literature review was carried out to determine the variables. Some practical studies utilized in this study are given in Table 2. In this study a number of variables not included in Table 2 were added based on theoretical literature studies (Osterhuber 1999; McClung and Schaerer 2006). Depending on these studies, the variables for dynamic avalanche assessment were determined as land cover, elevation, slope, aspect, plan curvature, profile curvature, terrain roughness, air temperature, rainfall, relative humidity, wind speed, wind direction, radiation, sunshine duration, and snowpack depth.

Following the identification of the variables, the definitions/intervals of the variables were specified to calculate conditional probabilities for the Bayesian Network. The definitions/intervals of the variables are provided in Table 3. As in the specification of the variables, the definitions/intervals of the variables required for conditional probabilities were determined based on the literature survey.

Table 2: Variables used for avalanche hazard assessment in some practical studies

	Elevation	*Slope*	*Aspect*	*Plan Curvature*	*Profile Curvature*	*Tangential Curvature*	*Terrain Roughness*	*Vegetation*	*Land Cover*	*Air Temperature*	*Wind Speed*	*Wind Direction*	*Cloudiness*	*Radiation*	*Sunshine Duration*	*Snow Temperature*	*Snowpack Depth*
Naresh and Pant 1999										x	x	x				x	x
Srinivasan et al. 1999										x	x		x		x	x	x
Cookler and Orton 2004		x	x								x						x
McCollister and Birkeland 2006	x	x	x					x									
Cordy et al. 2009										x	x						x
Covăsnianu et al. 2011	x	x	x		x		x		x								
Elmastaş and Özcanlı 2011		x															
Suk and Klimánek 2011		x	x		x	x		x									
Simea 2012	x	x		x	x				x								
Nefeslioglu et al. 2013		x	x		x		x	x				x					x
Selçuk 2013	x	x	x				x		x								
Jaedicke et al. 2014		x	x									x					
A.S. Mohammed et al. 2015		x	x		x				x								
Helbig et al. 2015		x								x				x			
Omirzhanova et al. 2015		x									x					x	
Germain 2016		x									x						x
Yilmaz 2016	x	x	x	x	x			x									
Aydın and Eker 2017	x	x			x		x										
Kumar et al. 2017	x	x	x		x		x		x								

Table 3: States of the variables for calculation conditional probabilities

Variable	Number of states	States	References
Land cover	8	Artificial surfaces	Turkish General Directorate of Geographic Information Systems 2012
		Agricultural areas	
		Forests (Broad-leaved)	
		Forests (Coniferous)	
		Forests (Mixed)	
		Scrub and/or herbaceous vegetation associations	
		Open spaces with little or no vegetation	
		Other areas	
Elevation	6	<1000 m	Elibüyük and Yılmaz, 2010; Selçuk 2013
		1000-1500 m	
		1500-2000 m	
		2000-2500 m	
		2500-3000 m	
		>3000 m	
Slope	5	< 10°	Kriz 2001; Brugnot 2008
		10-28°	
		28-45°	
		45-55°	
		>55°	
Aspect	9	N	A.S. Mohammed et al. 2015; Kumar et al. 2017
		S	
		E	
		W	
		NE	
		NW	
		SE	
		SW	
		Flat	
Plan curvature	3	Concave: curvature < -0.2	Maggioni and Gruber 2003
		Convex: curvature > +0.2	
		Flat: -0.2 < curvature < +0.2	
Profile curvature	3	Concave: curvature < -0.2	Maggioni and Gruber 2003; A.S. Mohammed et al. 2015
		Convex: curvature > +0.2	
		Flat: -0.2 < curvature < +0.2	
Terrain roughness	6	<0.001	Kumar et al. 2017
		0.001-0.005	
		0.005-0.01	
		0.01-0.05	
		0.05-0.1	
		>0.1	
Air temperature (long-term average can be assessed for winter/spring)	3	Min temperature longer than 24 hours < -10 C° or maximum temperature difference between day and night >8 C°	Woodmencey and Nalli 2010; Turkish Disaster and Emergency Management Presidency 2015
		-10 C° < Min temperature longer than 24 hours < -4 C°	
		Other conditions	
Rainfall (long-term average of maximum daily total rainfall can be assessed for winter/spring)	6	1-5 mm	Turkish General Directorate of Meteorology 2017
		5-20 mm	
		20-50 mm	
		50-75 mm	
		75-100 mm	
		>100 mm	
Relative humidity (long-term average of maximum daily relative humidity can be assessed for winter/spring)	4	95-100 %	McClung and Schaerer 2006
		90-95 %	
		85-90%	
		<85 %	
Wind speed (long-term average of maximum daily wind speed can be assessed for winter/spring)	5	<8 m/sec	Germain 2016
		8-15 m/sec	
		15-20 m/sec	
		20-25 m/sec	
		>25 m/sec	
Wind direction (Depending on the seasonal (winter/spring) dominant wind direction)	2	Leeward side	Nefeslioglu et al. 2013; Rudolf-Miklau et al. 2015
		Other	

Table 3: States of the variables for calculation conditional probabilities (continued)

Variable	Number of states	States	References
Radiation (long-term average of maximum daily radiation can be assessed for winter/spring)	6	<1 kWh/m^2-day	Şahan et al. 2015; Yiğit, 2015; U.S. Geological Survey 2016; Kıncay 2017
		1-2 kWh/m^2-day	
		2-3 kWh/m^2-day	
		3-4 kWh/m^2-day	
		4-5 kWh/m^2-day	
		>5 kWh/m^2-day	
Sunshine duration (long-term average of maximum daily sunshine duration can be assessed for winter/spring)	6	<1 hr	Turkish General Directorate of Meteorology 2017
		1-2 hr	
		2-3 hr	
		3-4 hr	
		4-5 hr	
		>5 hr	
Snowpack depth (long-term average of maximum snowpack depth can be assessed for winter/spring)	8	<15 cm	Liu 2009; Germain 2016
		15-50 cm	
		50-100 cm	
		100-150 cm	
		150-200 cm	
		200-250 cm	
		250-300 cm	
		>300 cm	

3.2. Dynamic Bayesian Network model development

Following the determination and definition of the variables, a Dynamic Bayesian Network was created. Figure 2 shows the Bayesian Network for the dynamic avalanche hazard assessment. The Bayesian Network includes the variables that correspond to avalanche hazard. Connecting lines show the causal relationships among the variables. This Bayesian Network models the joint probability distribution of a set of variables for avalanche hazard.

Dynamic Bayesian Network was proposed for continually integrating data and consequently for updating the avalanche hazard. This will be possible by continuously generating and updating spatial data in the GIS environment.

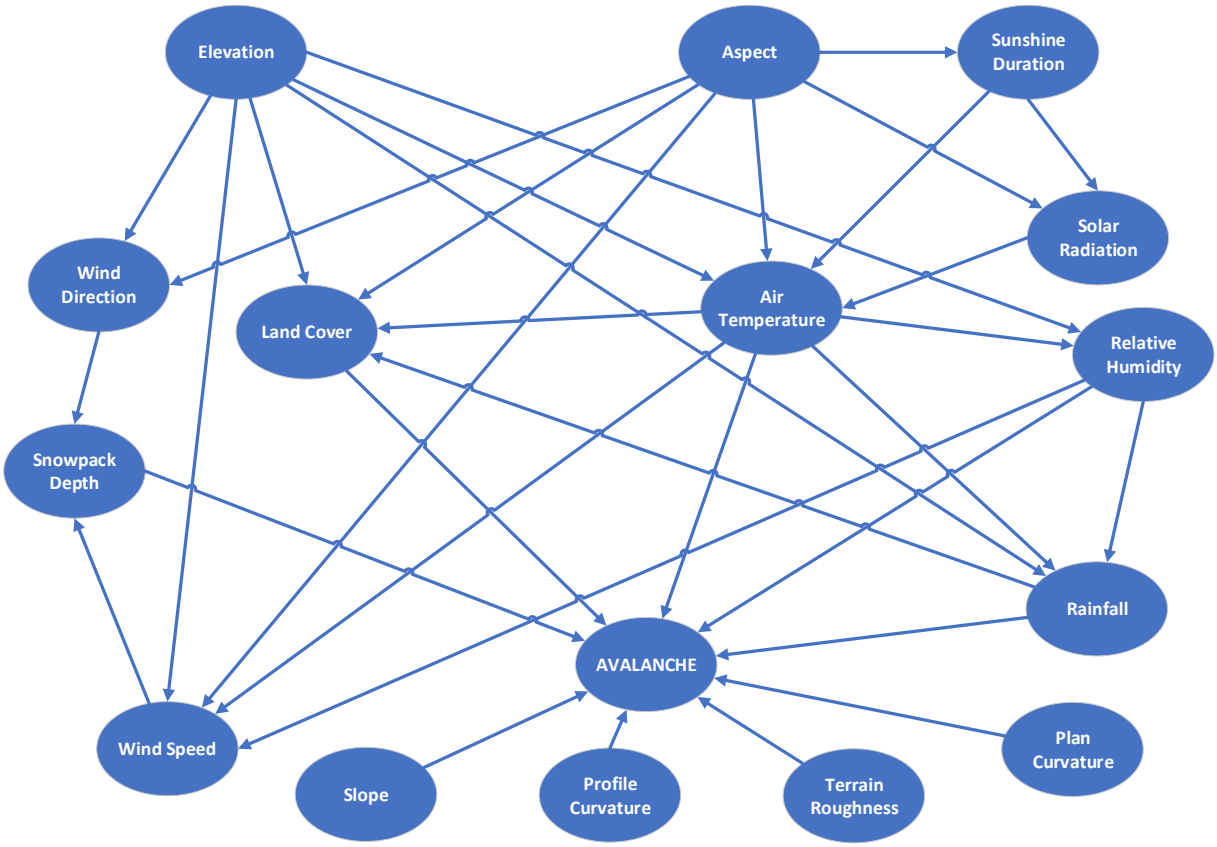

Figure 2: Dynamic Bayesian Network for the avalanche hazard assessment

3.3. NSDI perspective

In this study, an approach based on the integration of GIS and Bayesian Networks within the NSDI framework is presented for an avalanche hazard assessment (Figure 3). The proposed approach is dynamic and it is based on the principle of the transferring field observations on the system in real time and identifying changing hazards with inputs updated at specified or desired periods. Thus, for example, an avalanche hazard map can be updated annually for "winter" and "spring" season. For the approach of the dynamic avalanche hazard assessment considered in this study, it is necessary to have an infrastructure in which atmospheric data such as snow cover, direction and intensity of wind, air temperature can be accessed in real time. Thus, parameters to be used in avalanche hazard evaluation can be automatically updated with the data to be added in real time. In addition to this, current data access and system integration for vegetation cover and other dynamics should be provided. In this way, the renewed hazard situation under changing conditions will be able to be up-to-date. But at this point, it is necessary to seek an answer to the question of how to access real-time.

As known, many initiatives in the world, especially INSPIRE (Infrastructure for Spatial Information in Europe) aimed to improve the availability and accessibility of data by developing national spatial data infrastructures since the beginning of the 1990's. These typically involve the provision of core data sets within the framework of general user requirements, documentation of existing spatial data sets and services through metadata and catalogs, and access through distributed internet-based services within agreed rules and protocols (Cömert and Akıncı 2005; Bostancı et al. 2007; Annoni et al. 2010; Bossomaier and Hope 2015).

Today, as a result of changing conditions and technological developments, expectations from NSDI's are increasing. In this context; with the online transmission of data from geo-sensors and other data integration, it is possible to implement advanced applications in the framework of the NSDI (URL 2). Geo-sensors can be described as geographically referenced devices that take environmental stimuli (physical, chemical, or biological) and convert them into an electrical signal (Bröring et al. 2011). For this reason, satellite-based sensors providing a wide variety of information about the earth (image, land cover, vegetation cover indexes, etc.), aerial sensors for detailed images, laser scanners, fixed or moving sensors located near, above or below the ground surface that measure physical characteristics such as pressure, temperature, humidity, and events such as wind, rain, earthquake, and allows the tracking and monitoring of vehicles and living, are covered in this context (Annoni et al. 2010). A sensor is a basic unit, a sensor system is a group of different sensors that serve a common purpose connected to a single platform and sensor networks are based on a large number of interconnected sensors that are distributed over geographical areas and automatically generate useful information by combining different sensing capabilities (Bröring et al. 2011).

Sensor technology continues to evolve with smaller, cheaper, smarter and more energy efficient devices and is being used in more and more applications, especially in disaster management, environmental monitoring, precision agriculture, early warning systems (Bröring et al. 2011). As a result of technological advances, various international organizations and governments have recognized the need for sensor networks, standardized protocols, sensor communication methodologies and procedures that enable sensors to communicate over the web (URL 2). This issue has been the driving force for the Open Geospatial Consortium (OGC) to launch the SWE (Sensor Web Enablement) Initiative in 2003. The SWE Workgroup has developed a standard package that can be used as the building blocks of the Sensor Web. SWE defines the Sensor Web as web-accessible sensor networks and sensor data accessible with defined and standardized protocols and Application Programming Interfaces (APIs) (Bröring et al. 2011). In 2016, INSPIRE has released standards for sensor web access under the heading "Guidelines for the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE Annex II and III data specification development" (URL 3). In fact, large-scale sensor networks have already been used in science and technology since the 1990s. The new situation is that these sensors and sensor networks are activated by the web. Individual sensors can then be discovered, assigned and accessed via web standards, and networks can transfer information through interoperability regulations (Annoni et al. 2010), integration of sensor data with other spatial data can be achieved (URL 2).

In our country, there is a necessity to carry out the studies of NSDI, which is in the effort to be established for many years and called as the Turkish National Geographic Information System (TNGIS), in line with these technological developments and the increasing expectations as a result of changing circumstances. Therefore, sensor networks need to be constituted by establishing an infrastructure that will adapt to new technologies and the goals and priorities of TNGIS need to be renewed to provide access to real-time data.

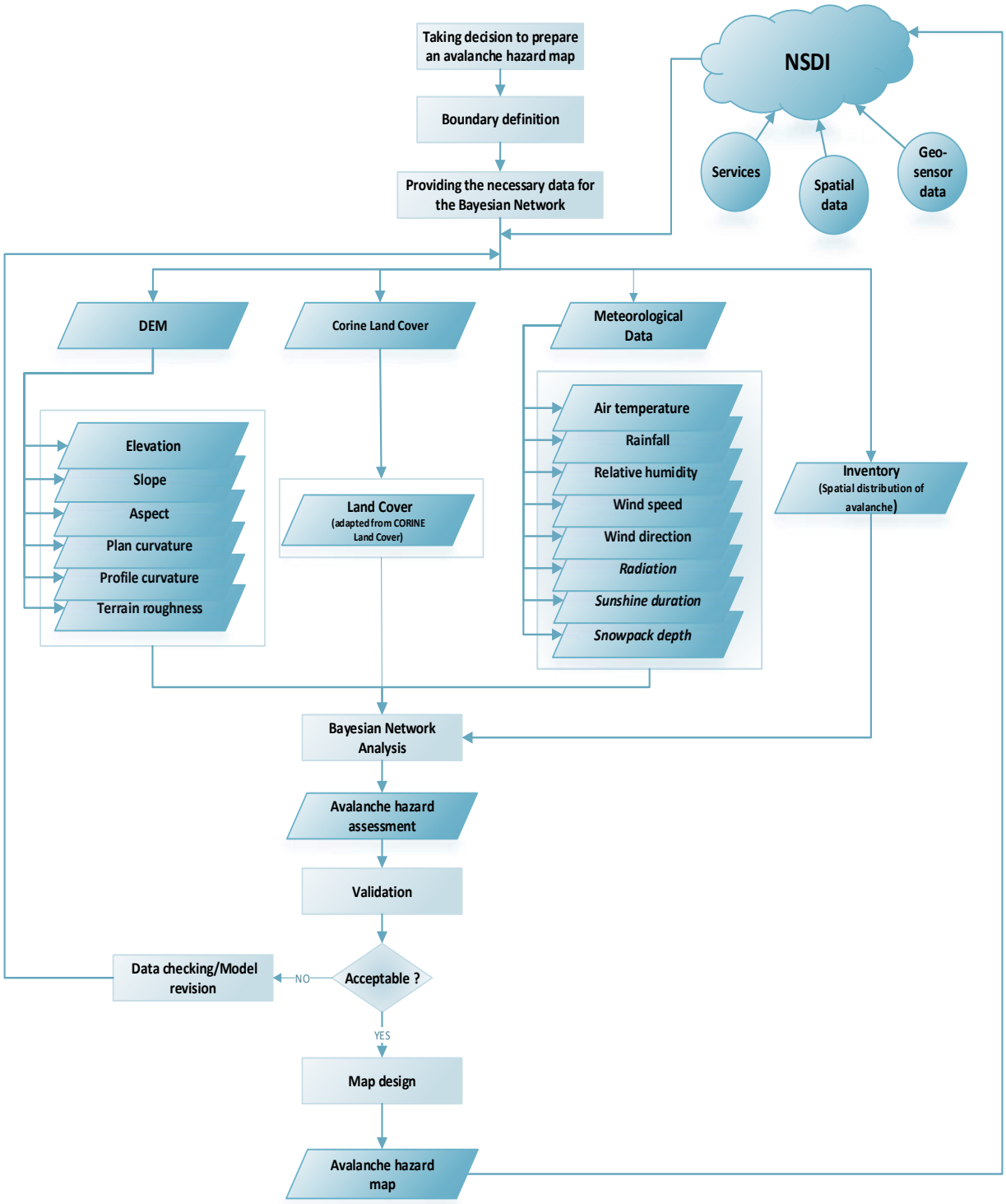

Figure 3: Integration of GIS and Bayesian Networks within the NSDI framework

4. Conclusion

This study deals with how to define probable avalanche hazard in response to update and real-time inputs by means of Bayesian Networks-based methodology. While the scope of the study is limited to dynamic avalanche hazard mapping, the same method can be applied to other fields by creating a similar Bayesian Network model.

Ensuring timely access to accurate information is crucial in planning and decision-making process. However, the accuracy and up-to-date of the data is much more critical in the management of emergencies such as disaster and accident. Therefore, real-time data obtained from the geo-sensors needs to be accessible within the scope of NSDI for natural disaster risk management and other environmental studies, including hazard identification.

References

A.S. Mohammed A.A., Naqvi H.R., Firdouse Z. J., (2015), *An assessment and identification of avalanche hazard sites in Uri sector and its surroundings on Himalayan mountain*, Journal of Mountain Science, 12(6), 1499-1510, doi: 10.1007/s11629-014-3274-z.

Akıncı H., Yavuz-Özalp A., Özalp M., Temuçin-Kılıçer S., Kılıçoğlu C., Everan E., (2014), *Bayes olasılık teoremi kullanılarak heyelan duyarlılık haritalarının üretilmesi*, 5. Uzaktan Algılama ve CBS Sempozyumu (UZAL-CBS 2014), 14-17 Ekim 2014, İstanbul.

Ames D.P., Anselmo A., (2008), *Bayesian Network Integration with GIS*, In: Encyclopedia of GIS, Springer US, pp. 39-45.

Anderson-Berry L., King D., (2005), *Mitigation of the impact of tropical cyclones in Northern Australia through community capacity enhancement*, Mitigation and Adaptation Strategies for Global Change, 10(3), 367-392.

Annoni A., Craglia M., de Roo A., San-Miguel J., (2010), *Earth observations and dynamic mapping: Key assets for risk management*, Geographic Information and Cartography fore Risk and Crisis Management, In: Lecture Notes in Geoinformation and Cartography, (Konecny M., Zlatanova S., Bandrova T.L., Eds.), Springer-Verlag, Berlin-Heidelberg, pp.3-22.

Aydın A., Eker R., (2017), *GIS-Based snow avalanche hazard mapping: Bayburt-Aşağı Dere catchment case*, Journal of Environmental Biology, 38, 937-943, doi: 10.22438/jeb/38/5(SI)/GM-10.

Bajpai N., (2009), *Business Statistics*, Pearson Education, 794 p.

Bossomaier T., Hope B.A., (2015), *Online GIS and spatial metadata*, CRC Press, United States, 438 p.

Bostancı H.T., Cömert Ç., Akıncı H., (2007), *UKVA için tapu ve kadastro web servislerinin tasarımı ve geliştirilmesi*, TMMOB Harita ve Kadastro Mühendisleri Odası 11. Türkiye Harita Bilimsel ve Teknik Kurultayı, 2-6 Nisan 2007, Ankara.

Bröring A., Echterhoff J., Jirka S., Simonis I., Everding T., Stasch C., Liang S., Lemmens R., (2011), *New generation sensor web enablement*, Sensors, 11, 2652-2699, doi:10.3390/s110302652.

Brugnot G. (2008), *Spatial Management of Risks*, ISTE Ltd and John Wiley & Sons Inc, London United Kingdom, 256 p.

Cookler L., Orton B., (2004), *Developing a GIS avalanche forecasting model using real-time weather telemetry information for the south side of MT. Hood*, Proceedings of the 2004 International Snow Science Workshop, Jackson Hole, Wyoming, pp. 145-152.

Cordy P., McClung D.M., Hawkins C.J., Tweedy J., Weick T., (2009), *Computer assisted avalanche prediction using electronic weather sensor data*, Cold Regions Science and Technology, 59, 227-233, doi: 10.1016/j.coldregions.2009.07.006.

Covăsnianu A., Grigoras I.R., State L.E., Balin I., Balin D., Hogas S., (2011), *Mapping snow avalanche risk using GIS technique and 3D modeling: Case study Ceahlau National Park*, Romanian Journal of Physics, 56(3-4), 476-483,doi: 10.2139/ssrn.1884082.

Cömert Ç., Akıncı H., (2005), *Ulusal konumsal veri altyapısı ve e-Türkiye için önemi*, TMMOB Harita ve Kadastro Mühendisleri Odası 10. Türkiye Harita Bilimsel ve Teknik Kurultayı, 28 Mart-1 Nisan 2005, Ankara.

Çinicioğlu E.N., Ekici Ş.E., Ülengin F., (2015), *Bayes ağ yapısının oluşturulmasında farklı yaklaşımlar: Nedensel Bayes ağları ve veriden ağ öğrenme*, In: Sn. Prof. Dr. Halil Sarıaslan'a Armağan Kitabı, Siyasal Kitabevi, Ankara, pp.267-284.

d'Acremont M., Schultz W., Bossaerts P., (2013), The *human brain encodes event frequencies while forming subjective belief*, Journal of Neuroscience, 33(26), 10887-10897, doi: 10.1523/JNEUROSCI.5829-12.2013.

Doğan S., Akıncı H., Kılıçoğlu C., (2012), *Bayes olasılık teoremi kullanılarak Samsun il merkezinin heyelan duyarlılık haritasının üretilmesi*, 65. Türkiye Jeoloji Kurultayı, 2-6 Nisan 2012, Ankara.

Eckert N., Naaim M., Parent E., (2010), *Long-term avalanche hazard assessment with a Bayesian depth-averaged propagation model*, Journal of Glaciology, 56(198), 563-586, doi:10.3189/002214310793146331.

Elibüyük M., Yılmaz E., (2010), Türkiye'nin *coğrafi bölge ve bölümlerine göre yükselti basamakları ve eğim grupları*, Coğrafi Bilimler Dergisi, 8(1), 27-55.

Elmastaş N., Özcanlı M., (2011), *Bitlis ilinde çığ afet alanlarının tespiti ve çığ risk analizi*, VI.Ulusal Coğrafya Sempozyumu, 3-5 Kasım 2010, Ankara, Bildiriler Kitabı, pp. 303-314.

Germain D., (2016), *Snow avalanche hazard assessment and risk management in northern Quebec, eastern Canada*, Natural Hazards, 80, 1303-1321, doi: 10.1007/s11069-015-2024-z.

Grêt-Regamey A., Straub D., (2006), *Spatially explicit avalanche risk assessment linking Bayesian networks to a GIS*, Natural Hazards and Earth System Sciences, 6(6), 911-926, doi:10.5194/nhess-6-911-2006.

Helbig N., van Herwijnen A., Jonas T., (2015), *Forecasting wet-snow avalanche probability in mountainous terrain*, Cold Regions Science and Technology, 120, 219-226, doi: 10.1016/j.coldregions.2015.07.001.

Hwang J.W., Lee Y.S., Cho S.B., (2011), *Structure evolution of dynamic Bayesian network for traffic accident detection*. In Evolutionary Computation (CEC), 2011 IEEE Congress on (pp. 1655-1671), IEEE (2011, June).

Jaedicke C., Syre E., Sverdrup-Thygeson K., (2014), *GIS-aided avalanche warning in Norway*, Computers & Geosciences, 66, 31-39, doi: 10.1016/j.cageo.2014.01.004.

Jebb A.T., (2017), *Bayesian statistics*, In: The SAGE Encyclopedia of Industrial and Organizational Psychology, (Rogelberg S.G., Ed.), SAGE Publications, Inc.

Jonkman N.S., Gerritsen H., Marchand M., (2012), *Coastal storm*, In: Handbook of Hazards and Disaster Risk Reduction and Management, (Wisner B., Gaillard J.C., Kelman I., Eds.), Taylor & Francis, New York, pp. 220-231.

Kadıoğlu M., (2008), *Sel, heyelan ve çığ için risk yönetimi*, TMMOB İnşaat Mühendisleri Odası Samsun Şubesi Sel-Heyelan-Çığ Sempozyumu, 28-29 Mayıs 2008, Samsun.

Kelly D., Smith C., (2011), *Bayesian Inference for Probabilistic Risk Assessment: A Practitioner's Guidebook, Springer-Verlag, 225p.*

Kıncay O. (2017), Güneş Enerjisi, http://www.solar-academy.com/menuis/Gunes-Enerjisi.021720.pdf, [Accessed 29 September 2017].

Kragt M.E., (2009), *A beginners guide to Bayesian network modelling for integrated catchment management. Landscape Logic, Technical Report No. 9, 22 p.*

Kriz K., (2001), *Using GIS and 3D Modeling for avalanche hazard mapping*. ICA-CMC session of mountain cartography, Beijing, China.http://www.mountaincartography.org/publications/papers/ica_cmc_sessions/2_Beijing_Session_Mountain_Carto/5_Beijing_Kriz.pdf, [Accessed 23 October 2017].

Kumar S., Srivastava K.P., Snehmani, (2017), *GIS-based MCDA–AHP modelling for avalanche susceptibility mapping of Nubra valley region, Indian Himalaya*, Geocarto International, 32(11), 1254-1267, doi: 10.1080/10106049.2016.1206626.

Landuyt D., Van der Biest K., Broekx S., Staes J., Meire P., Goethals P.L.M.A., (2015), *GIS plug-in for Bayesian belief networks: Towards a transparent software framework to assess and visualise uncertainties in ecosystem service mapping*, Environmental Modelling and Software, 71, 30-38, doi:10.1016/J.ENVSOFT.2015.05.002.

Liu X., Liu Y., Li L., Ren Y., (2009), *Disaster monitoring and early-warning system for snow avalanche along Tianshan Highway*, IGARSS 2009 - 2009 IEEE International Geoscience and Remote Sensing Symposium, 12-17 July 2009, Cape Town, South Africa.

Maggioni M., Gruber U., (2003), *The influence of topographic parameters on avalanche release dimension and frequency*, Cold Regions Science and Technology, 37, 407-419 , doi: 10.1016/S0165-232X(03)00080-6.

McClung D., Schaerer P.A., (2006), The avalanche handbook, Mountaineers Books, 342p.

McCollister C., Birkeland K. W., (2006), *Using Geographic Information Systems for Avalanche Work*, Published in The Avalanche Review, 24(4) .

Narasimhan B.V.A., (2003), *Early and dynamic warning: An integrated approach to drought management*, In: Early Warning Systems for Natural Disaster Reduction, (Zschau J., Küppers A., Eds.), Springer, Berlin-Heidelberg, Berlin, pp.357-365.

Naresh P., Pant L.M., (1999), *Knowledge-Based system for forecasting snow avalanches of Chowkibal-Tangdhar Axis (J&K)*, Defence Science Journal, 49(5), 381-391.

Nefeslioglu H.A., Sezer E.A., Gokceoglu C., Ayas Z., (2013), *A modified analytical hierarchy process (M-AHP) approach for decision support systems in natural hazard* assessments, Computers & Geosciences, 59, 1-8, doi: 10.1016/j.cageo.2013.05.010.

Omirzhanova Zh. T., Urazaliev A.S., Aimenov A.T., (2015), *GIS for Predicting The Avalanche Zones In The Mountain Regions of Kazakhstan*, International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XL-2/W4, 2015, 39-44, doi: 10.5194/isprsarchives-XL-2-W4-39-2015.

Osterhuber R. J. (1999), *Precipitation intensity during rain-on-snow*, 67th Annual Western Snow Conference, April 1999, South Lake Tahoe, California

Papakosta P., Straub D., (2015), A Bayesian Network Approach to Assessing Wildfire Consequences, Proceedings ICOSSAR 2013: 11th International Conference on Structural Safety & Reliability, 16-20 June 2013, New York, United States.

Pine J.C., (2008), *Natural hazard analysis: Reducing the impact of disasters*, CRC Press, Taylor & Francis Group, Boca Raton, 304 p.

Pulwarty R.S., Sivakumar MV.K., (2014), *Information systems in a changing climate: Early warnings and drought risk management*, Weather and Climate Extremes, 3, 14-21, doi: 10.1016/j.wace.2014.03.005.

Qiu G.Q., Huang S., .Zhu L.L , Su X.H., Chen Y., (2015), *Risk assessment of multi-state Bayesian Network in an oil gathering and transferring system*, Procedia Engineering, 130, 1514-1523, doi: 10.1016/j.proeng.2015.12.320.

Rawat J.S., Kumar M., (2015), *Monitoring land use/cover change using remote sensing and GIS techniques: A case study of Hawalbagh block, district Almora, Uttarakhand, India*, Egyptian Journal of Remote Sensing and Space Science, 18(1), 77-84, doi:10.1016/j.ejrs.2015.02.002.

Rudolf-Miklau F., Sauermoser S., Mears A. (Eds), (2015), The Technical Avalanche Protection Handbook, Berlin, Germany, 430 p.

Selçuk L., (2013), *An avalanche hazard model for Bitlis Province, Turkey, using GIS based multicriteria decision analysis*, Turkish Journal of Earth Sciences, 22, 523-535, doi: 10.3906/yer-1201-10.

Simea I. M., (2012), *The Avalanches From Rodnei Mountains*, PhD Thesis, Babeş-Bolyai University, Cluj-Napoca.

Srinivasan K., Semwal G., Sunil T., (1999), *Statistical-Based Forecasting of Avalanche Prediction*, Defence Science Journal, 49(5), 447-455.

Stassopoulou A., Petrou M., Kittler J., (1998), *Application of a Bayesian network in a GIS based decision making system*, International Journal of Geographical Information Science, 12(1), 23-46, doi:10.1080/136588198241996.

Straub D., Grêt-Regamey A., (2006), *A Bayesian probabilistic framework for avalanche modelling based on observations*, Cold Regions Science and Technology, 46(3), 192-203, doi:10.1016/j.coldregions.2006.08.024.

Suk P., Klimánek M. (2011), *Creation of the snow avalanche susceptibility map of the Krkonoše Mountains using GIS,* Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 28(5), 237-245, doi: 10.11118/actaun201159050237.

Şahan M., Tokat Ö., Okur Y., (2015), *Osmaniye'de günlük toplam güneş ışınım ölçümleri*, SDU Journal of Science (E-Journal), 10(2), 97-105, http://dergipark.gov.tr/download/article-file/116445.

Taştekin A.T., (2003), *Meteoroloji ve çığ*, https://www.mgm.gov.tr/FILES/genel/makale/meteorolojivecig.pdf, [Accessed 11 August 2017].

Turkish Disaster and Emergency Management Presidency, (2015), *Çığ Temel Kılavuzu*, https://www.afad.gov.tr/upload/Node/3468/xfiles/cig_temel-kilavuz-tr_.pdf, [Accessed 23 July 2017].

Turkish General Directorate of Disaster Affairs, (1999), *Çığ el kitabı*, Bayındırlık ve İskan Bakanlığı, Ankara, Afet İşleri Genel Müdürlüğü Yayınları, 94 p.

Turkish General Directorate of Geographic Information Systems, (2012), *Türkiye Ulusal Coğrafi Bilgi Sistemleri Standartlarının Belirlenmesi Projesi: TUCBS.AO Arazi Örtüsü Veri Teması*, TUCBS Temel Veri Temaları Gereksinim Analizi, 98p.

Turkish General Directorate of Meteorology, (2017), https://www.mgm.gov.tr/FILES/resmi-istatistikler/Turkiye-Gunluk-Guneslenme-Suresi.pdf, [Accessed 30 October 2017].

U.S. Geological Survey, (2016), Data Series 284, https://pubs.usgs.gov/ds/2007/284/section7.html, [Accessed 28 October 2017].

Villa V., Paltrinieri N., Cozzani V., (2015), *Overview on dynamic approaches to risk management in process facilities*, Chemical Engineering Transactions, 43, 2497-2502, doi:10.3303/CET154341.

Woodmencey J. and Nalli B., (2010), Avalanche weather forecasting, http://nidm.gov.in/pdf/guidelines/new/landslidessnowavalanches.pdf, [Accessed 29 October 2017].

Xin P., Khan F., Ahmed S., (2017), *Dynamic hazard identification and scenario mapping using Bayesian network*, Process Safety and Environmental Protection, 105, 143-155, doi:10.1016/j.psep.2016.11.003.

Yiğit M., (2015), *Güneş enerjisi ölçümleri ve ölçüm tebliği*, Meteroloji Genel Müdürlüğü, Gözlem Sistemleri Dairesi Başkanlığı, http://www.gensed.org/CF/CD/15970af38a9b39767fffb6e9afa13fb18e8f1422437016.pdf, [Accessed 29 October 2017].

Yilmaz B. (2016), *Application of GIS-Based fuzzy logic and Analytical Hierarchy Process (AHP) to snow avalanche susceptibility mapping, North San Juan, Colorado*, Master of Arts Thesis, University of Colorado at Boulder, Colorado, USA.

URL 1: Olasılık teorisi, http://insaat.balikesir.edu.tr/dokumanlar/istatistik/ist2.pdf, [Accessed 12 August 2017].

URL 2: Development of a major R&D sub-programme on geo-spatial technologies: Sensor web enablement (SWE) and sensor networks, http://nrdms.gov.in/ogc.asp, [Accessed 12 August 2017].

URL 3: INSPIRE Infrastructure for Spatial Information in Europe, D2.9 Draft Guidelines for the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE Annex II and III data specification development, http://inspire.ec.europa.eu/documents/Data_Specifications/D2.9_O&M_Guidelines_v2.0rc3.pdf, [Accessed 13 August 2017].

A Research on Standard Address Usage in Turkey

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Abstract

Although various studies on the standardization of address system continues at a great speed, some existing problems on address descriptions (e.g. keeping the address information of public institutions and organizations in different standards, frequency of updating on the changed street names and building numbers) make the geocoding difficult. In this study, the similarity values of postal addresses used in a sample region in Turkey are calculated, and the success rates of global web services providing standard address conversation based on geocoding are presented. The addresses used as examples belong to 74 accommodation facilities located within the borders of Fatih district of Istanbul province. The addresses of the facilities are automatically collected by scraping method from five different websites. The address in Address Registration System (AKS – Adres Kayıt Sistemi) of each accommodation facility is taken from www.adres.nvi.gov.tr. In the first step, the similarity values between addresses obtained from six different web sites for a total of 74 facilities was calculated using the Levenshtein distance algorithm in binary. In the second stage, address information from six different websites was processed in the geocoding service of Google and Bing Maps and brought to the standard form provided by the services. Then, similarities between Google and Bing Maps standard addresses and raw addresses were calculated. Finally, it is necessary that the AKS used throughout the country be spatially supported and actively used by Spatial Address Registration System (MAKS – Mekansal Adres Kayıt Sistemi) everywhere. Supporting MAKS by map and geocoding services, and opening it to citizens will also make a significant contribution to the establishment of a national-based standard address system.

Keywords

Geocoding, Postal Address, Address Registration System, Levenshtein Distance, MAKS

1. Introduction

An address is a syntax used to describe a location in a geographical space. Local governments and public institutions around the world need postal addresses in many studies in line with their needs. Proper planning of public services and its coordinating by all public institutions and organizations, instantly access to basic information of living citizens can be obtained up-to-date as a result of the establishment of reliable population registration systems which include identification numbers of persons with their residence addresses. Since address information is considered to be fundamental information in many functions for the public, it can be used for many applications finding a location and determining transportation route to a place and integrated with Geographic Information Systems (Yıldız and Aydınoğlu, 2010).

The Address Registration System (AKS - Adres Kayıt Sistemi) in Turkey is being created and updated by the General Directorate of Registration and Citizenship Affairs (NVIGM - Nüfus ve Vatandaşlık İşleri Genel Müdürlüğü) under the Ministry of Interior. Address according to NVIGM is defined as a geographical location of a piece of land or a building defined by components such as province, district, quarter, road, street name and house number (URL-1). The address structure used in Turkey is composed of more than one qualifier. The geographical qualifiers such as zip codes, province, district, village names, neighborhood, square, boulevard, road, street names, building number, etc. constituting an address are named as address components.

In order for AKS to operate efficiently under the control of the Ministry of Interior within the scope of keeping address components together, Standardization of the current residence addresses information of the Turkish citizens and foreigners, and matching of identifying information to addresses must be required. In this direction, at the end of 2015, "Spatial Address Registration System Data Creation and Expansion Project" has been initiated with a contract signed between NVIGM and ASELSAN A.Ş. (URL-2). Within the scope of the project, it is aimed to create Spatial Address Registration System infrastructure by combining the textual data stored in AKS with the geographical coordinates and to integrate with other systems used by public institutions. In this process, all residential addresses within the borders of *Kocaeli*, *Yalova*, *Afyonkarahisar*, *Elazığ*, *Gaziantep*, *İzmir*, *Uşak*, *Denizli*, *Burdur*, *Isparta*, *Bilecik*, *Aksaray*, *Karaman*, *Trabzon* and *Erzurum* provinces have been integrated into the Spatial Address Registration System (MAKS – Mekansal Adres Kayıt Sistemi). Although the project is planned to be completed by the end of 2018, spatial address registration studies within the borders of Istanbul where the population is crowded are still at an initial stage.

The objective of this study is to calculate the similarity values of postal addresses used in Turkey for a sample region and to compare the success rates of global web services providing standard address conversion services based on geocoding. The addresses used as examples belong to 74 accommodation facilities located within the borders of Fatih district of Istanbul province. The addresses of the facilities are automatically collected by scraping from five different websites known as *Agoda.com*, *Booking.com*, *Hotels.com*, *Hotelscombined.com* and *Tripadvisor.com*. The address of each accommodation facility in AKS is taken from www.adres.nvi.gov.tr. In the first stage, similarities between postal addresses obtained from six different websites are calculated using the Levenshtein distance algorithm. At the second

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stage, the online geocoding process for Google and Bing is applied to examine the qualities of these services on these six websites and they are compared with the each other using the Levenshtein distance.

The rest of the full text is organized as follows. The next section gives a brief background on address studies. Section 3 describes the study area and generation of the data, and the address similarities are presented in section 4. The full text ends with conclusions in Section 5.

2. Studies on Address in the World and in Turkey

Integration with spatial components of address data and its reduction to a standard structure is provided by expressing clearly the components that make up the address. The use of standard address structures will improve the quality of analysis and work, as well as reduce economic and temporal losses. When studies on the world are examined, it is seen that many countries, especially South Africa, Australia, New Zealand, England, Denmark and the United States, have worked on address standardization. Organizations such as the International Postal Union (UPU), the International Organization for Standardization (ISO) and the Organization for the Advancement of Structured Information Standards (OASIS) also contribute to the establishment of address standards (Coetzee et al., 2008).

In 2007, the Infrastructure for Spatial Information in Europe (INSPIRE) Directive entered into force due to the establishment of spatial information infrastructures in Europe and the provision of easy access by institutions and organizations (INSPIRE, 2007). There are a large number of protocols and standards in the INSPIRE directive ranging from data themes to co-ordination of institutions. While developing INSPIRE address standards, it is trying to establish a common standard for all of Europe by taking advantage of ISO / TC211 standards and using object oriented data modeling.

When we examine the address structures used in Turkey, it is seen that there are more than one qualifier that defines the address. The street names and door numbers are generated by the numbering operations carried out by the local administrations, the zip codes that appear due to the work done by the postal organization and the neighborhood names are approved by the Ministry of Interior as defined a qualifying address component (Yıldırım, 2003). Within the scope of keeping these components together, in order for the ARS to operate efficiently, a standardized National Address Database (NAD) was created (Ural vd., 2015).

Just as in Europe, creation of spatial information infrastructures based on address in Turkey is important for the management of geographical information. TNGIS was generated to integrate seamlessly into the European Union Spatial Data Infrastructure and to be developed in accordance with the INSPIRE Directive and INSPIRE Implementation Rules (Akıncı and Cömert, 2009).

In 2012, Spatial Address Registration Systems project was initiated to combine the existing address records, which are kept in database of AKS implemented by Ministry of Interior General Directorate of Civil Registration and Nationality of Turkey, with geographic data and to integrate the upcoming infrastructure with other address based systems. By becoming an important base to e-government infrastructure and enabling to share information with national security, MAKS system is deliberated to be one of the most significant projects of Republic of Turkey's history. ASELSAN's effort in the MAKS Project's scope, enable all local authorities to provide address based services in an easy, fast and a secure way. This modernization of the address registration services will result in reducing bureaucracy and most importantly it will provide better location statistics and analysis for use by agencies, government organizations and for emergency situations (URL-3).

3. The Study Area and Preprocessing

In order to investigate the similarities of the use of standard addresses, Fatih district of Istanbul province was selected as the study area (Figure 1). The address and name information of 74 accommodation facilities in the Fatih were collected manually AKS website and automatically by a web scraping software from five different accommodation websites. Web scraping (web harvesting or web data extraction) is data scraping used for extracting data from websites (Boeing and Waddell, 2016). It is used for contact scraping, and as a component of applications used for web indexing, web mining and data mining, online price change monitoring and price comparison, product review scraping (to watch the competition), gathering real estate listings, weather data monitoring, website change detection, research, tracking online presence and reputation, web mashup and, web data integration (URL-4).

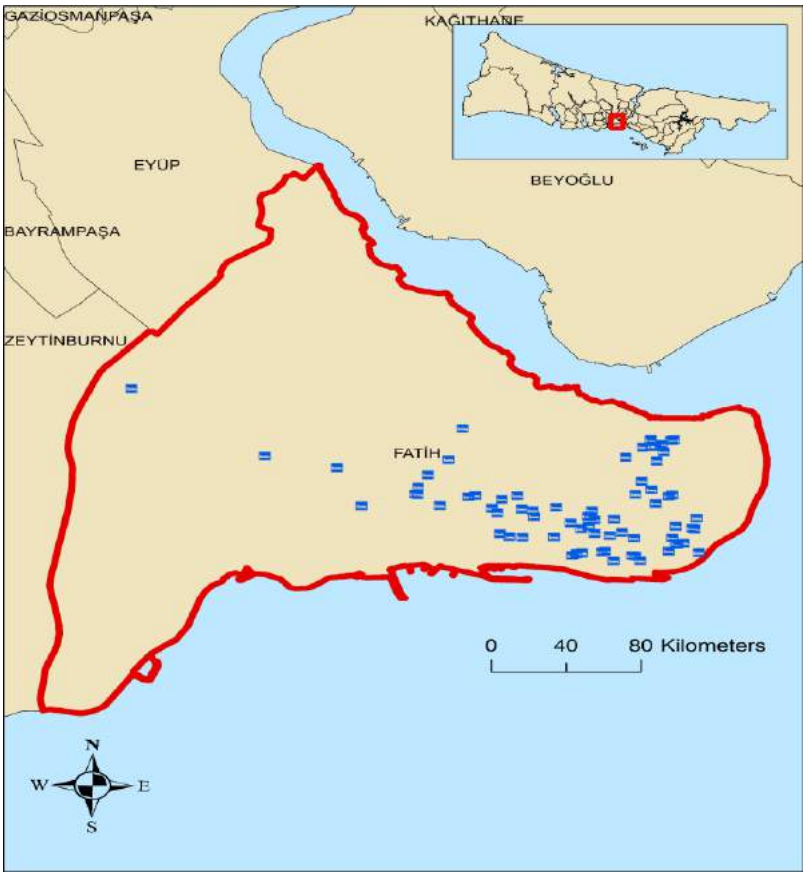

Figure 1: Study area

4. Methods

The application has been examined in Fatih region in two parts: similarities of collected addresses and similarities obtained after geocoding process. In first step, addresses obtained from six different websites are compared with the each other using the Levenshtein distance algorithm utilized by internet search engines. Levenshtein distance is a measure of the similarity between two strings, words, sentences (the source and the target). The distance is the number of deletions, insertions, or substitutions required to transform string into target. The greater the Levenshtein distance, the more different the similarity are (Haldar and Mukhopadhyay, 2011). The similarity between the six different addresses with each other is determined for Fatih region (Table 1).

Table 1: Address similarity between six different website

%	Agoda	AKS	Booking	Hotels	Hotelscomb	Tripadvisor
Agoda	100	**56.75**	**72.26**	**69.08**	**71.76**	**67.89**
AKS		100	**62**	**57.02**	**61.36**	**57.33**
Booking			100	**71.53**	**75.18**	**67.85**
Hotels				100	**72.35**	**70.62**
Hotelscomb					100	**70.94**
Tripadvisor						100

According to Table 1, while the similarity values between *Agoda.com* and *AKS* addresses is 56%, the similarity between *Hotelscombined.com* and *Booking.com* is 75%. These values are the lowest and highest similarities determined. Similarity in Fatih for AKS and other websites is obtained approximately between 56-62%. Due to the lack of harmonization between registered addresses for accommodation facilities in the Fatih district, the similarities between the addresses in the Address Registration System and the addresses in the other five websites are quite low. This situation negatively affects the use of standard address and reduces reliability.

In second step, geocoding process was performed for each of the six different websites, and addresses obtained from each site were converted into a standard form using online geocoding services. The simplest way to obtain spatial data is to interpret addresses since addresses are the fundamental means people use to describe locations (Roongpiboonsopit and Karimi, 2010). The process to convert addresses into geographic coordinates is known as geocoding, which is a main operation in Geographic Information Systems (Antenucci et al. 1991, Huxhold 1991, Longley et al. 2005). In this study, Google and Bing Maps were used as online geocoding services and in order to determine the quality of the services, the similarities between the addresses obtained from the services and the six websites were calculated individually (Table 2 and 3). Besides, similarities between Google and Bing Maps for each website was determined (Table 4).

Table 2: Address similarity between Google and other websites

%	**Agoda**	**AKS**	**Booking**	**Hotels**	**Hotelscomb**	**Tripadvisor**
Google Maps	53.33	**75.89**	65.96	62.29	63.34	56.06

Table 3: Address similarity between Bing and other websites

%	**Agoda**	**AKS**	**Booking**	**Hotels**	**Hotelscomb**	**Tripadvisor**
Bing Maps	52.42	55.6	64.9	58.15	52.13	52.61

Table 4: Address similarity between Google and Bing Maps

%	**Agoda**	**AKS**	**Booking**	**Hotels**	**Hotelscomb**	**Tripadvisor**
Google - Bing	60.90	67.56	63.94	64.25	62.78	61.7

When examining the table 2, 3 and 4, Google maps provides better quality results than Bing maps does. The highest similarity is calculated as about 76% between Google Maps standard address definitions and AKS addresses. On average, the similarity between Google and Bing Maps services is 63%. This value shows that the standard addresses of the two services do not match each other in Fatih region, resulting in lower results.

5. Conclusions

In this work, the address formats used in Turkey are examined for a sample region and the results are compared using the Levenshtein distance algorithm. When the addresses taken from the Web sites are examined, although they are in harmony with each other, their similarities with AKS are quite low. This is an indication that you are kept in different formats on each website of addresses and are away from standardization. On the other hand, the results obtained after the geocoding process in Fatih region show that both services return addresses in different standards and are incompatible. The use of standard address formats will improve the quality of the analysis and the work to be done, and will also reduce economic and time losses.

As a result, it is necessary that the AKS used throughout the country be spatially supported and it is imperative that the MAKS be actively used everywhere. The use and development of the MAKS by the public institutions and organizations, supporting by the geocoding services and opened for the use of the citizens, will make a significant contribution to the establishment of a national basic standard address system.

References

Akıncı, H., and Cömert, Ç. (2009), *TUCBS ve INSPIRE Teknik Mimarisi*, TMMOB Harita ve Kadastro Mühendisleri Odası 12. Türkiye Harita Bilimsel ve Teknik Kurultayı 11-15 Mayıs 2009, Ankara.

Antenucci, J.C., Brown, K., Croswell, P.L., Kevany, M.J. and Archer, H., (1991), *Geographic Information Systems: a guide to the technology*, Springer US, New York: Van Nostrand Reinhold.

Boeing, G., and Paul W., (2016), *New Insights into Rental Housing Markets across the United States: Web Scraping and Analyzing Craigslist Rental Listings.* Journal of Planning Education and Research: 0739456X16664789.

Coetzee, S., Cooper, A.K., Lind, M., Wells, M.M., Yurman, S.W., Wells, E., Griffiths, N. and Nicholson, M.J., (2008), *Towards an International Address Standard*, 10th International Conference for Spatial Data Infrastructure, St. Augustine, Trinidad & Tobago.

Haldar, R., and Mukhopadhyay, D. (2011), *Levenshtein distance technique in dictionary lookup methods: An improved* approach. arXiv preprint arXiv:1101.1232.

Huxhold, W.E., (1991), *An Introduction to Urban Geographic Information Systems*, Oxford University Press, Oxford.

INSPIRE Directive (2007), Directive 2007/2/EC of the EU Parliament and of the Council (14 March 2007) Establishing An Infrastructure for Spatial Information in the EU Community (INSPIRE), Official Journal of the European Union, 50.

Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W., (2001), *Geographic Information System and Science*, England: John Wiley & Sons, Ltd: 327-329.

Roongpiboonsopit, D. and Karimi, H.A., (2010), *Comparative evaluation and analysis of online geocoding services*, International Journal of Geographical Information Science, 24: 1081-1100.

Ural H., Bediroğlu Ş., Yıldırım V., Nişancı R., Çolak H.E., Erbaş Y.S. and Memişoğlu T., (2015), *Mekânsal Adres Kayıt Sistemine Geçişte Yaşanabilecek Numarataj ve Geokodlama Sorunları ve Çözüm Önerileri*, 7. Kentsel Altyapı Sempozyumu: TMMOB, 13-14 Kasım 2015, Trabzon.

URL-1, Nüfus ve Vatandaşlık İşleri Genel Müdürlüğü Adres Kayıt Sistemi, Adres Tanımları. https://www.nvi.gov.tr/hakkimizda/projeler/aks, [Accessed 10 August 2017].

URL-2, Nüfus ve Vatandaşlık İşleri Genel Müdürlüğü, Mekânsal Adres Kayıt Sistemi. https://maks.nvi.gov.tr/, [Accessed 10 August 2017].

URL-3, ASELSAN, MAKS Project, http://www.aselsan.com.tr/en-us/capabilities/cpb5/PublishingImages/maks/MAKS%20Project.pdf, [Accessed 05 October 2017].

URL-4, Web scraping, Wikipedia – The Free Encyclopedia, https://en.wikipedia.org/index.php?q=aHR0cHM6Ly9lbi53aWtpcGVkaWEub3JnL3dpa2kvV2ViX3NjcmFwaW5n, [Accessed 05 October 2017].

Yıldırım, V., (2003), *Adres Bilgi Sistemi Tasarımı ve Uygulaması: Trabzon kent örneği*, Yüksek Lisans Tezi, Karadeniz Teknik Üniversitesi, Trabzon.

Yıldız, G. and Aydınoğlu, A.Ç., (2010), *Altyapı Bilgi Sisteminde Adresin Önemi ve İstanbul Örneği*, III. Uzaktan Algılama ve Coğrafi Bilgi Sistemleri Sempozyumu, 11 – 13 Ekim 2010, Gebze – Kocaeli.

A XML Application Schema for the Real Estate Valuation Report

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Abstract

Real estate values are used in many areas today, including taxation. Real estate values are also found in the register of land titles. Work is underway to form a valuation report form by the Capital Markets Board (CMB), which sets the real estate appraisal standards. One of the geographic data layers used in Infrastructure for Spatial Information in the European Union (INSPIRE) is that of cadastre and land registry. It has recently become a common practice to use open source and interoperability technologies supported by Extensible Markup Language (XML), a creation of the World Wide Web Consortium (W3C). The Geography Markup Language (GML) is the XML grammar developed by the Open Geospatial Consortium (OGC) and supported by INSPIRE for encoding spatial and non-spatial data. In Turkey, XML-based archiving is also organized in the Large-Scale Map and Map Information Production Regulations (BÖHHÜY). In this study; an XML schema example of the existing housing report format used by Real Estate Appraisal Companies was prepared so that the current valuation reports can be digitized and the valuation reports can be integrated into the XML based Geographic Information Systems (GIS) in the future.

Keywords

XML application schema, immovable property, real estate valuation report

1. Introduction

There is a growing need in the world and in our country for a reliable immovable property valuation service based on a standard. Real estate valuation services are carried out through independent private organizations operating in the international arena, especially in the United Kingdom and the United States. The international valuation standards used in making this service have been developed by the International Valuation Standards Committee (IVSC).

CMB announced with the Communiqué (Serial:VIII, Number:45) that the appraisers are obliged to abide by the International Valuation Standards and apply them in valuation transactions made in accordance with the capital market. It is arranged with other communiqué (Serial:VIII, Number:58) of CMB that the valuation report made shall be prepared in writing in accordance with the form set by the Board with minimum elements. The CMB has announced that it will be published on the web page after the preparation of the "real estate appraisal report form" and the "housing appraisal report form" which will contain the minimum elements.

In the current situation, appraisal reports are prepared within the framework of the "minimum particulars that should be included in appraisal reports" for the real estate appraisal procedures to be carried out within the context of the capital market legislation until the results of the report formation work carried out by the CMB are finalized. The existing report format used by the “real estate appraisal companies” continues to be used in the housing appraisal reports that are prepared under the 4th paragraph of Article 38 / A of the Capital Markets Law.

On the other hand, data configuration studies of land registry and cadastre in a geographic information system are continuing. There is a need for this configuration in many areas especially in tax cadastre. One of the geographic data layers used in INSPIRE is that of cadaster or land registry. It has recently become a common practice to use open source and interoperability technologies supported by XML, a creation of the W3C. The GML is the XML grammar developed by the OGC and supported by INSPIRE for encoding spatial and non-spatial data (GML 3.2.1. 2007). In BÖHHÜY is organized declaring of the National Data Exchange Format (UVDF) in Turkey that encodes large-scale map data and archiving of data in XML format (BÖHHÜY, 2005).

In this study; an XML schema example of the existing housing report format used by Real Estate Appraisal Companies was prepared. By this means, it is aimed to be able to transfer the existing valuations to the virtual platform and to develop applications that can make various inquiries. The formats of the real estate appraisal reports to be created by the CMB will be easily combined with this prepared format for using in the virtual environment. It will also be easily integrated into the GIS that will be created with GML and CityGML implementation schemes that are likely to be implemented in the future.

2. Material and Method

In the study, "note pad" and "XML Copy editor" programs were used. First of all, the Unified Modeling Language (UML) class diagram of the valuation format was prepared taking into consideration possible queries. All the records in the valuation report are shown in the UML diagram (Fowler, Scott, 2003). The UML class diagram of the application schema is shown in Figure 1. The XSD scheme was created by considering the prepared UML class diagram (XSD 1.1., 2012; Alas, 2017). The XSD scheme was checked if the document was well-formed.

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An XML document of a sample valuation report was prepared and was checked if the document was well-formed and valid with respect to the XSD application schema (Stanek, 2003; XML 1.0., 2008; Alas, 2017). The prepared XSD scheme codes are given in Figure 2 and some of the codes of the XML document example used in the application is shown in Figure 3.

In the study, it has also been taken into consideration that the XML documents to be generated according to the prepared XSD scheme are converted into Hypertext Markup Language (HTML) format according to the necessity by using Extensible Stylesheet Language Transformation (XSLT) (Gardner, Rendon, 2002).

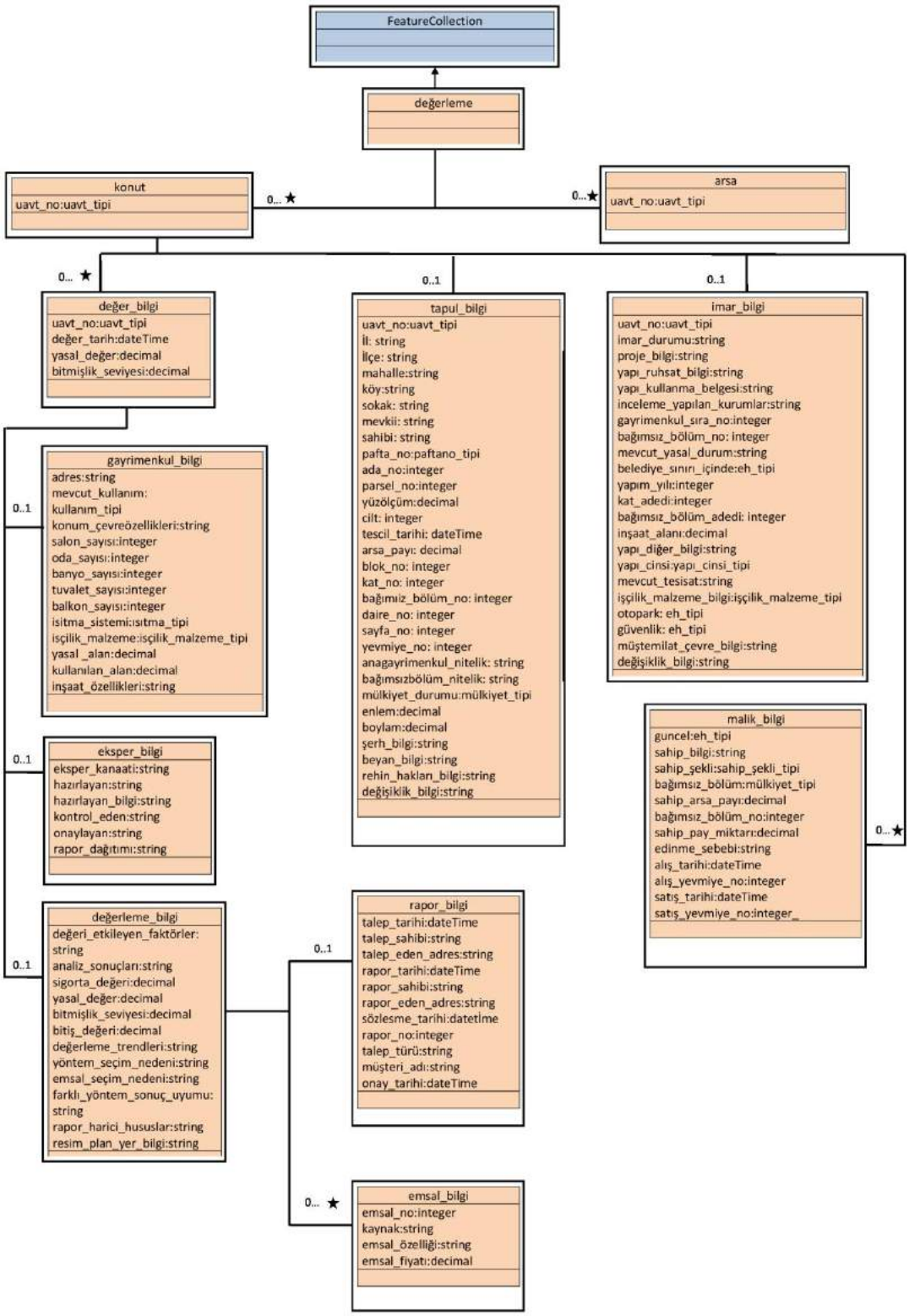

Figure 1: The UML class diagram of the application schema

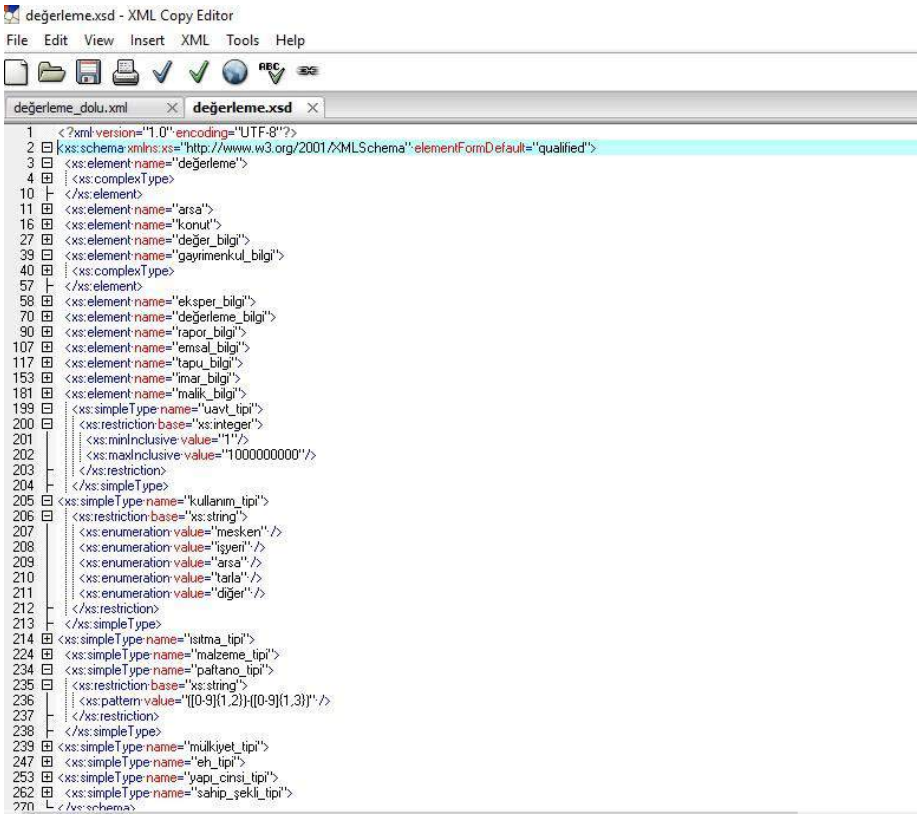

Figure 2: The XSD schema codes

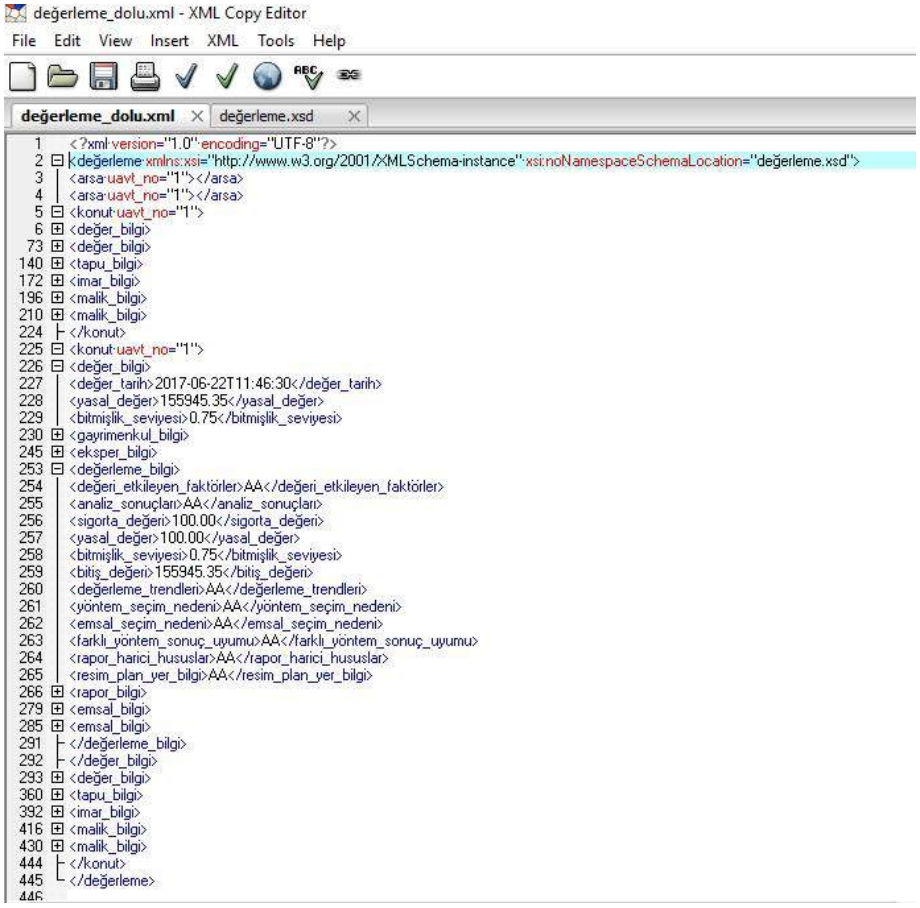

Figure 3: The XML document

3. Results and Discussion

The prepared XSD diagram will ensure transferring of the data of the valuations made to the digital environment. This data may be input into software that will enable various interrogations to be made. When the real estate appraisal form that will be prepared by the CMB is finalized, it is necessary to develop this schema. If the land register and cadastral data are created in GML format, the data collected by the prepared schema can be integrated into this form. As a result of the integration, it will be possible to store and query the property values together with the land registry data in GIS or on the internet environment.

4. Conclusions

The preparation of real estate appraisal reports in accordance with the schema format presented in the declaration will ensure that the data of report is transmitted in a certain standard on the internet together with the storage. In addition, there will be the possibility to develop applications to question these data. If the Land Registry and Cadastre data are stored according to a GML application scheme to be prepared, the real estate appraisal reports can be combined with this data on the basis of parcel and independent section. Various queries can be made from the database that will be created with GML for different purposes such as tax collection, mass valuation and index creation.

References

Alas, B., (2017). XML Technologies and GML, Okan Publishing, Istanbul, Turkey, 310ss.
Fowler, M., Scott, K., (2003), Refined UML, Alfa Publishing, Istanbul, Turkey, 318ss.
Gardner, J.R., Rendon, Z.L., (2002), XSLT and XPATH, Alfa Publishing, Istanbul, Turkey, 381ss.
Stanek, W.R., (2003), XML, Arkadas Publishing, Ankara, Turkey, 389ss.
XML 1.0. (2008), Extensible Markup Language, World Wide Web Consortium (W3C) Recommendation, Fifth Edition.
XSD 1.1. (2012), XML Schema Definition Language, World Wide Web Consortium (W3C) Recommendation.
GML 3.2.1. (2007), Geography Markup Language, OpenGIS Consortium (OGC) Implementation Specification, OGC Document Number: OGC 07-036.
BÖHHÜY (2005), Large-Scale Map and Map Information Production Regulations, O.J..No: 25876, Ankara, Turkey.

Automatic Extraction of Building Boundaries from High Resolution Images with Active Contour Segmentation

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Abstract

Building extraction from remotely sensed images plays an important role in many applications such as updating geographical information system, change detection, urban planning, disaster management and 3D building modeling. Automatic extraction of buildings from aerial images is not an easy task because of background complexity, lighting conditions and vegetation cover that reduces separability or visibility of buildings. As a result, automatic building extraction can be a complex process for computer vision and image processing techniques. In order to overcome this difficulty region-based active contour model was used to automatically detect the boundary of buildings for this study. To extract object boundaries, the model grows or shrinks the initial contour in the image. The main objective of this paper is making active contours algorithm perform without user interaction and to detect automatically initial contours to segment buildings with a software coded in Matlab. This task carried out by morphological operations, band ratio and thresholding methods. In this study, high resolution aerial images with 8 cm ground sampling distance (GSD) were used. Three separate test zones were selected with varying building level of detail on these images. Finally, it was assessed the accuracy of segmented buildings using Correctness, Completeness and Quality metrics by comparing the results images and manually digitized reference image. The proposed approach for building extraction from images was shown to be 98% accurate on buildings with simple geometry and homogeneous roof textures. However, accuracy of extracted buildings with heterogeneous roof textures and lighting, and complex geometry is 89%. The results clearly show that automatically calculated initial contour positions work in accordance with the active contour algorithm and easily extraction of the buildings boundaries.

Keywords

Active Contour, Automatic, Building Extraction, High Resolution Image.

1. Introduction

The accurate segmentation of buildings from high resolution aerial images enables many useful applications such as change detection, disaster management, urban planning, updating geographic information system (GIS) databases. According to Wang (2016), extracting of buildings automatically from digital images has been an active research area in both photogrammetry and computer vision communities for decades. However, the automatic extraction of buildings from remotely sensed data is one of the challenging tasks faced by the computer vision and remote sensing communities (Siddiqui, et. al., 2016). This task is challenging due to many reasons such as complexity in the building structures, surrounding environment (highly-dense vegetation, occluded building and hilly scene), poor acquisition of data and registration error between data sources (Siddiqui, et. al., 2016). Also, this is because the remote sensing images are usually characterized by complex data in the form of heterogeneous regions with large intra-class variations and often lower inter-class variations (Alshehhi, et. al., 2017). Thereby automatic building boundary extraction with high accuracy is not a simple task because of background complexity, lighting conditions and vegetation cover that reduces separability or visibility of buildings.

Many researchers have presented methods for the segmentation of buildings from high resolution images. According to Attarzadeh and Momeni (2012), these algorithms have mainly considered radiometric, geometric, edge detection and shadow criteria approaches. Alshehhi et al. (2017) proposed a single patch-based Convolutional Neural Network (CNN) architecture for extraction of roads and buildings from high-resolution remote sensing data. Gilani et al. (2016) developed a methodology to extract and regularize buildings using features from point cloud and ortho-imagery. Wang (2016), developed an approach uses both geometric properties and radiometric properties of building to recognize buildings and delineate their boundaries. Wang's (2016) method consists of automatic generation of high quality point cloud from the imagery, building detection from point cloud, classification of building roof and generation of building outline. Turker and Koc-San (2015), developed an integrated approach for the automatic extraction of rectangular and circular shape buildings from high-resolution optical space borne images using the integration of support vector machine (SVM) classification, Hough transformation and perceptual grouping. Song et al. (2015) developed a method to extract buildings using LiDAR data. They based their method on distinct topological relationship and characteristics of contour lines and acquired promising results. Ghaffarian (2015) used active contours to segment buildings using automatically extracted initial contour positions based on shadow areas with region growing algorithm. However, the proposed method is incapable of detecting the buildings with no shadows. Kodors et al. (2015) used energy minimization approach to recognize buildings from LiDAR point cloud.

The extraction of 2D images from buildings in a dense urban area is an intricate problem due to the variety of shapes, sizes, colours, and textures (Ghanea et al., 2014). To overcome the problem, they proposed an algorithm which

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the core components are multispectral binary filtering, sub-clustering and single binary filtering, multi-conditional region growing and post-processing. Awrangjeb et al., (2013), proposed a method for automatic 3D roof extraction through an effective integration of LiDAR (Light Detection And Ranging) data and multispectral ortho-imagery. Fazan and Poz (2013) used a method utilizing an energy function based on snakes that represents building roof contours in digital images and is optimized with a dynamic programming algorithm. Their results showed that the proposed method satisfactorily performed the task of extracting different building roof contours from digital images. However their method suffered from shadow and another roof nearby. Niveetha and Vidhya (2012) used mathematical morphologic operator to close and eliminate the undesired objects over the building roofs and extracted buildings based on the texture parameters from satellite imagery. Huang and Zuang (2012) proposed a systematic framework for building extraction from high-resolution imagery and aimed to enhance original morphological building index (MBI) algorithm. For this purpose they used a morphological shadow index (MSI) to detect shadows then geometrical index and a vegetation index are used to remove noise from narrow roads and bright vegetation. Ahmadi et al., (2010), proposed a modified active contour model to automatically extract building boundaries on aerial images. All building boundaries are detected by introducing certain points in the buildings' vicinity. They generated the initial curves automatically as a series of regular circles all over the image.

The main objective of this paper is making active contours algorithm perform without user interaction and to detect automatically initial contours to segment buildings with the aid of centroids. This task carried out by morphological operations, band ratio and thresholding methods.

2. Methodology

The proposed approach to automate the active contour algorithm consists of three major steps. These steps are image pre-processing, initial contour creation and building extraction using active contours. Also it was created a Graphical User Interface (GUI) in Matlab software to evaluate all processes in a single frame, to find the optimum initial contour positions and maximum number of iterations, and to obtain the most accurate segmentation results for input image. The flowchart of the methodology for this study is shown in Figure 1 and Figure 2 represents the Matlab interface for the proposed algorithm.

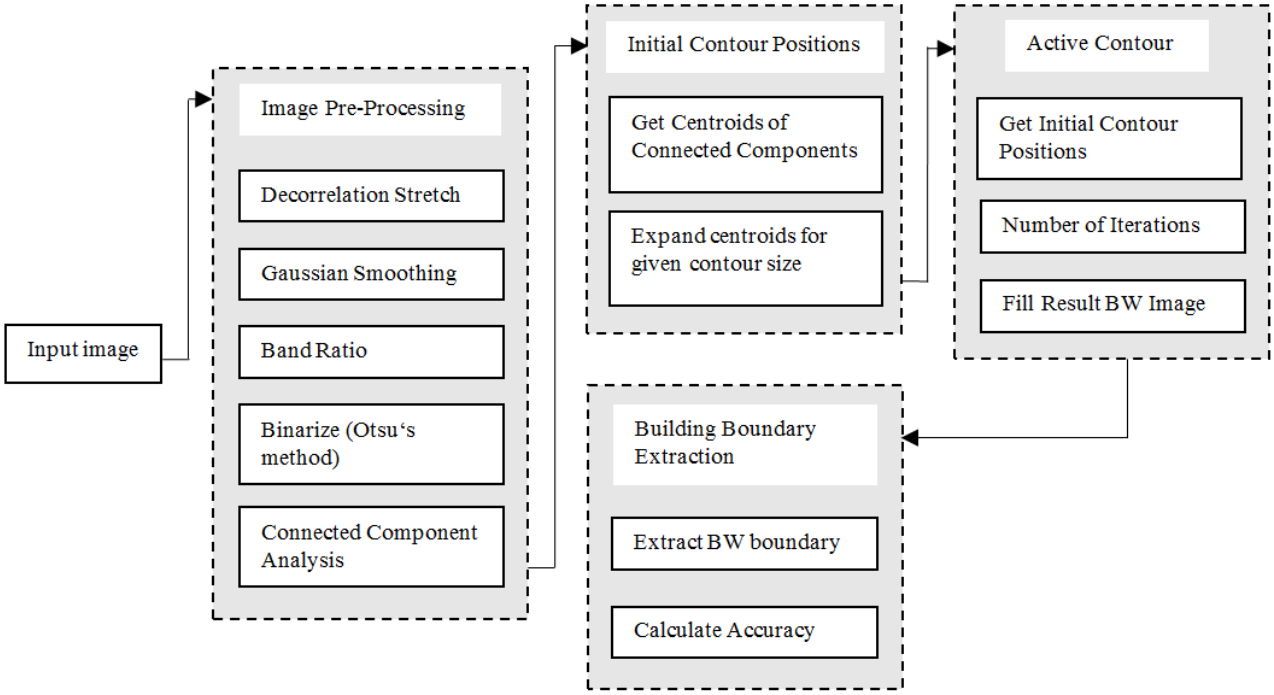

Figure 1: Workflow of automatic building extraction with active contour segmentation

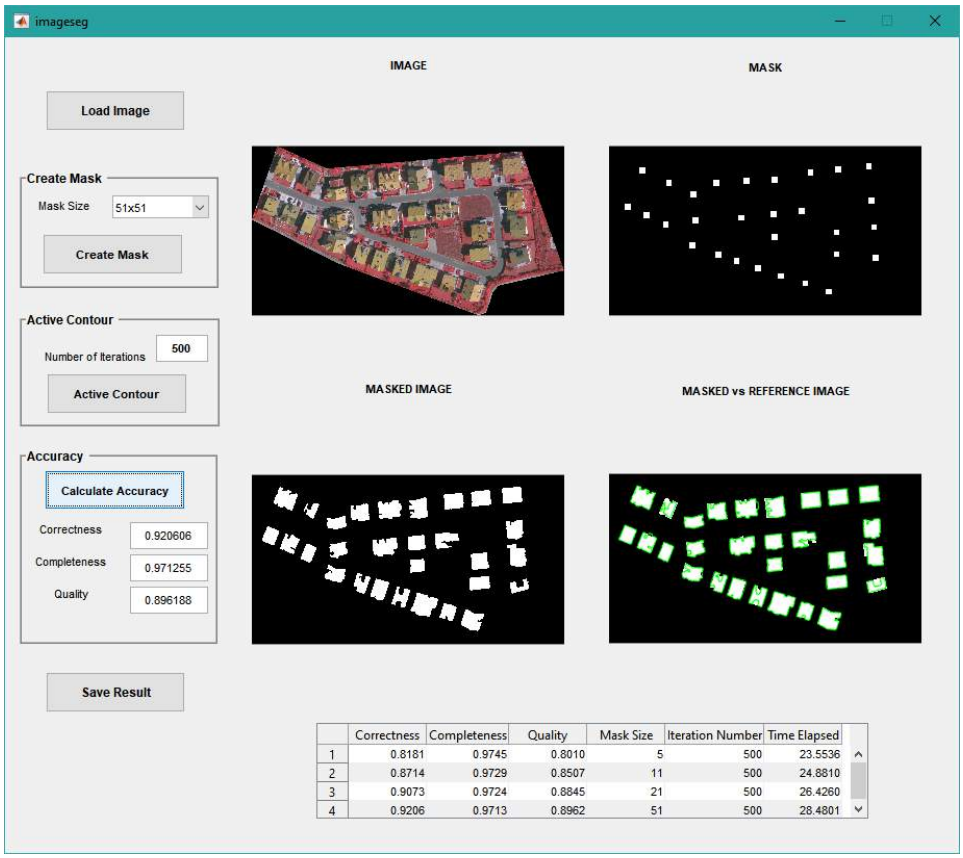

Figure 2: GUI created in Matlab

2.1. Active Contour Segmentation Algorithm

Active contours also called snakes was first proposed by Kass et al., (1988). The basic idea in active contour models or snakes is to evolve a curve, subject to constraints from a given image, in order to detect objects in that image. For instance, starting with a curve around the object to be detected, the curve moves toward its interior normal under some constraints from the image, and has to stop on the boundary of the object (Chan and Vese, 2001).

Active contour models can be classified into two categories: parametric snakes and geometrical snakes (Ahmadi et al., 2010). According to Ghaffarian (2015), there are three difficulties with the parametric model. First, the initial contour must, in general, be close to the true boundary, or else it will probably converge to the wrong result. Second, Snake active contours do not progress into boundary concavities. Third, parametric snake active contours are non-convex. Geometrical active contour models consist of two methods: edge based and region based. Region-based geometrical active contours rely on the homogeneity of spatially localized features such as gray level intensity, texture, and other pixel statistics (Ahmadi et al., 2010). Region based active contour models can detect details without significant edges and independent from object boundary waviness. Due to this advantages region based active contour model which also depends on Chan Vese Method is used.

Chan and Vese's (2001) method is a region based geometrical active contour model. The curve's motion is driven by a combination of internal and external forces, which achieve a minimal energy state when the curve/surface reaches the targeted image boundaries (Ahmadi et al., 2010). In Chan and Vese's method they added regularizing terms to the classical active contours to stop the evolving curve on the desired boundary. Energy function for active contour is shown in Equation (1).

$$F_1(C) + F_2(C) = \int_{inside(C)} |u(x,y) - c_1|^2 \, dx \, dy + \int_{outside(C)} |u(x,y) - c_2|^2 \, dx \, dy \tag{1}$$

where C is the active contour curve, $u(x,y)$ is the pixel values of input image, c_1 and c_2 are illustrate the average of pixel values inside and outside of C, respectively (Chan and Vese, 2001; Ahmadi et al., 2010).

$$F_1(C) = \int_{inside(C)} |u(x,y) - c_1|^2 \, dx \, dy \tag{2}$$

$$F_2(C) = \int_{outside(C)} |u(x,y) - c_2|^2 \, dx \, dy \tag{3}$$

Equations (2) is internal energy of curve C and (3) is external energy of curve C. Chan and Vese (2001) noted that the boundary of the object C is the minimizer of the fitting energy:

$$\inf_{C} \{F_1(C) + F_2(C)\} \approx 0 \approx F_1(C) + F_2(C) \tag{4}$$

To explain this if the curve C is outside the object, then $F_1(C)$>0 and $F_2(C)$≈0. If the curve C is inside the object, then $F_1(C)$≈0 but $F_2(C)$>0. If the curve C is both inside and outside the object, then $F_1(C)$>0 and $F_2(C)$>0. Finally, the fitting energy will be minimized if the $C = C$, i.e. if the curve C is on the boundary of the object (Chan and Vese 2001).

In their active contour model Chan and Vese (2001), minimized fitting energy and added some regularizing terms as shown in equation (5);

$$F(C, c_1, c_2) = \mu \times length(C) + \nu \times area(insideC) + \lambda_1 \int_{inside(C)} |u(x,y) - c_1|^2 \, dx\, dy + \lambda_2 \int_{outside(C)} |u(x,y) - c_2|^2 \, dx\, dy \tag{5}$$

Regularizing terms include the length of curve C and/or the area inside C. In equation (5) μ, ν, $\lambda_1$and λ_2 are fixed parameters and their values are $\mu \geq 0$, $\nu \geq 0$, $\lambda_1 > 0$ and $\lambda_2 > 0$. Finally, the minimizing problem can be expressed as follows;

$$\inf_{C} F(C, c_1, c_2) \tag{6}$$

2.2. Image Pre-processing

The proposed automatic building extraction approach was tested on high resolution color infrared aerial images. Spatial and radiometric resolution of these images is 8 cm and 12 bits, respectively. Test images include three different urban residential areas. First area contains 5 buildings with simple geometry and similar roof textures (Figure 3), second area includes 29 buildings with both relatively complex and simple geometry, and also with inhomogeneous roof textures and lighting. The other contains 27 buildings with complex geometry, texture and lighting with respect to second test area. One of the test areas was depicted in Figure 3.

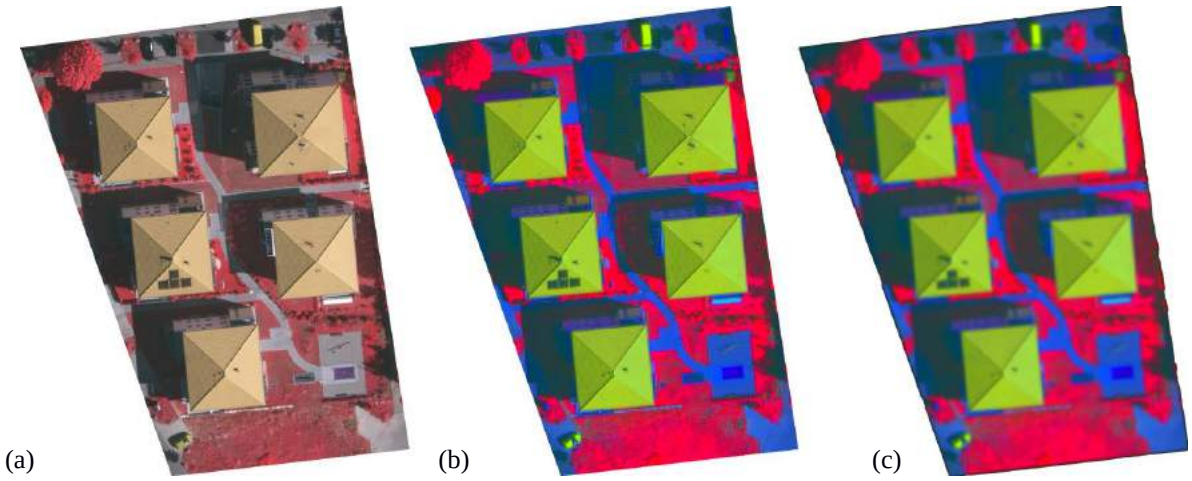

Figure 3: Test area containing 5 buildings with similar geometric shapes. (a) real image, (b) decorrelation stretched image, (c) Gaussian smoothed image.

Before creating initial contour positions, images were required to be enhanced in order to achieve good results. First, the decorrelation stretch method was used to make the bands of the images more separable. After decorrelation stretching; vegetation, buildings and roads became more distinguished from each other. Images were smoothed to reduce textural details and color transitions. With these enhancements images can be processed with morphological operations more efficiently. After the enhancement operations a band ratio calculated in order to detect approximate building locations. Ratio image then converted to a binary image with Otsu's method. Binarized ratio results contained some undesirable pixel groups that could impair the mask creation process. These pixel groups were removed with a series of morphological operations such as opening and closing.

2.3. Automatic Creation of Initial Contour Position

Automatic extraction of buildings based on active contour algorithm was required automatic generation of initial contour positions using centers of points (x, y) which are candidate building pixels. The segmentation process starts at that initial contour positions. To create initial contour positions, firstly, some morphological operations were applied on binary images to separate background from foreground object and so candidate pixels correspondence with buildings were found. Then, pixels were labeled by scanning the imagery pixel by pixel with connected component analysis. After this operation, pixels were grouped by their unique label which is assigned to each class. The centroids (x, y) were calculated for each approximately detected building pixels group. Finally, all of the centroids were used as initial contour input for active contour segmentation by varying kernel (mask) sizes such as 5×5, 11×11, 21×21, and 51×51 pixels. Optimal kernel size can be selected by users for image segmentation on GUI. Figure 4 shows an example of scene for automatically detected centroids and initial contour positions in a test image.

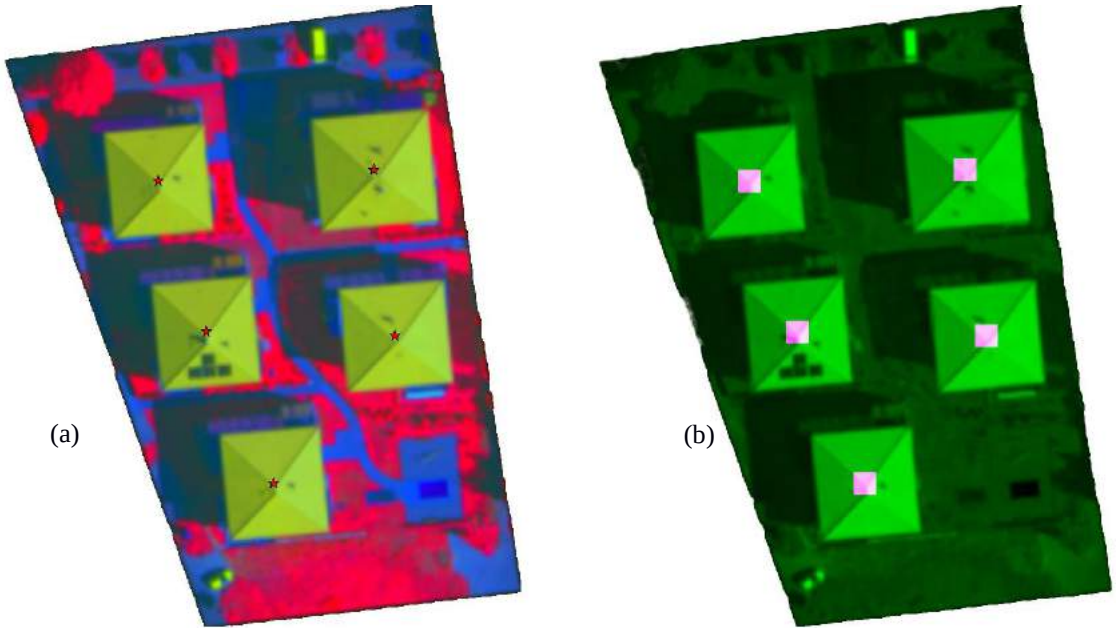

Figure 4: (a) automatically detected centroids (b) initial contour positions

2.4. Building Extraction with Active Contours

Active contour algorithm in Matlab requires the input arguments that are image to be segmented, initial contour positions (mask), maximum number of iterations and method. Input image is smoothed image as explain in section 2.2. Second input is initial contour mask mention in section 2.3. Third input is maximum number of iterations to perform in evolution of the segmentation, specified as a numeric scalar (URL-1, 2017). Active contour stops the evolution of the active contour when it reaches the maximum number of iterations (URL-1, 2017). Final input is region based Chan-Vese method that is describe in section 2.1. After preparing initial contours and recognize maximum iteration number image was segmented into two parts as background and foreground.

To accurately recognize boundaries of buildings is depend on well identified mask and maximum iteration number. Active contour also stops the evolution if the contour position in the current iteration is the same as the contour position in one of the most recent five iterations (URL-1, 2017). Optimum mask size and maximum number of iterations for input images were found by trial and error method on graphical user interface. Results images were filled with morphological operations.

Optional parameters for active contour algorithm in Matlab software are Smooth Factor and Contraction Bias. Smooth Factor is degree of smoothness or regularity of the boundaries of the segmented regions (URL-1, 2017). Contraction Bias is tendency of the contour to grow outwards or shrink inwards and this parameter does not guarantee that the contour contracts (or expands) (URL-1, 2017). For this reason, the default values of Contraction Bias and Smooth Factor were used in applying Chan-Vese method. Finally, output segmented binary image was obtained.

3. Results and Discussion

The accuracy assessment of proposed approach were carried out by comparing automatically extracted buildings with manually digitized reference images using Completeness, Correctness and Quality metrics as shown in equation (7), (8) and (9).

$$Completeness = \frac{||TP||}{||TP||+||FN||} \tag{7}$$

$$Correctness = \frac{||TP||}{||TP||+||FP||} \tag{8}$$

$$Quality = \frac{||TP||}{||TP||+||FN||+||FP||} \tag{9}$$

In Equations (7), (8), and (9), an entity classified as an object that also corresponds to an object in the reference is classified as a true positive (TP). A false negative (FN) is an entity corresponding to an object in the reference that is classified as background, and a false positive (FP) is an entity classified as an object that does not correspond to an object in the reference. A true negative (TN) is an entity belonging to the background both in the classification and in the reference data (Rutzinger et al. 2009; Shufelt 1999; Karsli et al. 2016).

The results of automatically extracted building boundaries were shown in Fig. (5), (6) and (7). Quantitative results for each test area were depicted in Table (1), (2) and (3).

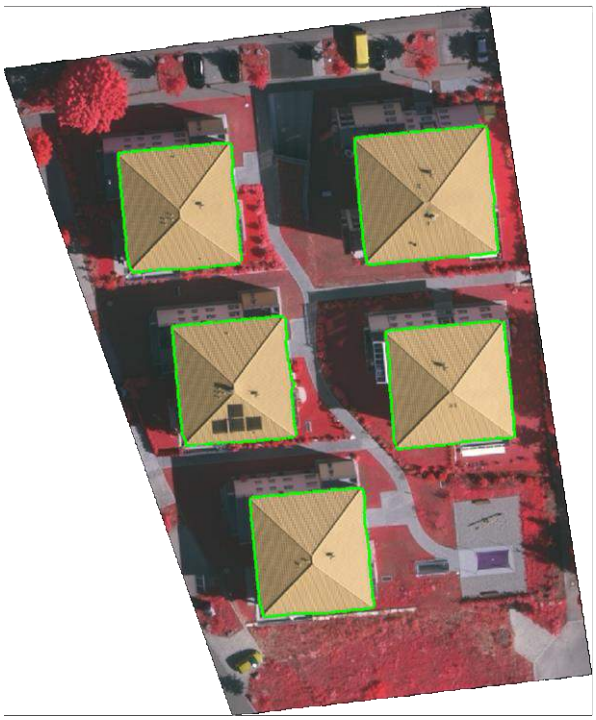

Figure 5: Results of first test area

Table 1: Accuracy assessment of first region with 5 buildings

Correctness	Completeness	Quality	Mask size	Iteration	Elapsed time (seconds)
0,872	0,995	0,868	5×5	200	2,53
0,889	0,994	0,884	11×11	200	2,32
0,918	0,993	0,912	21×21	200	2,43
0,981	0,990	0,971	51×51	200	2,69
0,970	0,990	0,960	5×5	250	3,06
0,975	0,990	0,966	11×11	250	3,10
0,984	0,989	0,973	21×21	250	3,21
0,989	0,987	0,977	51×51	250	3,52
0,989	0,987	0,977	5×5	300	3,86

Figure 6: Results of second test area

Table 2: Accuracy assessment of second region with 29 buildings

Correctness	Completeness	Quality	Mask size	Iteration	Elapsed time (seconds)
0.818	0.974	0.801	5×5	500	23.55
0.871	0.973	0.851	11×11	500	24.88
0.907	0.972	0.885	21×21	500	26.43
0.921	0.971	0.896	51×51	500	28.48
0.922	0.971	0.897	51×51	750	44.85
0.922	0.971	0.898	51×51	1000	61.22

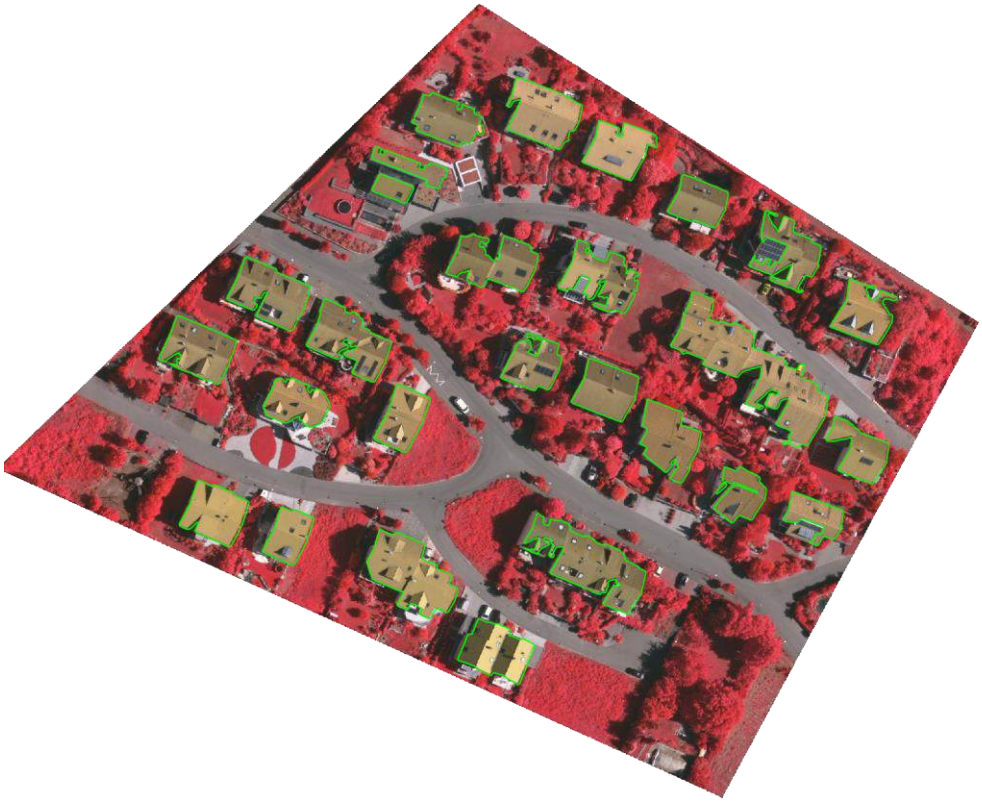

Figure 7: Results of third test area

Table 3: Accuracy assessment of third region with 27 buildings

Correctness	Completeness	Quality	Mask size	Iteration	Elapsed time (seconds)
0.871	0.966	0.845	5×5	500	33.69
0.883	0.965	0.856	11×11	500	35.38
0.892	0.965	0.864	21×21	500	35.57
0.915	0.963	0.884	51×51	500	39.30
0.923	0.961	0.890	11×11	750	57.11
0.923	0.961	0.890	51×51	750	61.14
0.923	0.961	0.890	21×21	1000	86.56
0.923	0.961	0.890	11×11	1000	83.80
0.923	0.961	0.890	51×51	1000	84.94

According to the results, optimum parameter values were determined with various combinations of maximum number of iterations and initial contour size for each test area to increase the accuracy of automatic building extraction. The trials were terminated when there is no improvement over optimum values. For instance, after performing active contour segmentation with 11×11 initial contour size and 750 iterations, results compared to other segmentations which carried out with greater values for iteration number and initial contour size showed no significant improvement as shown in Table 3. Moreover in Table 1, same results were acquired both 51×51 initial contour size with 250 iterations and 5×5 initial contour size with 300 iterations. As a result, selecting small initial contour size with a suitable iteration number can give the same results with a bigger initial contour size and lower iteration number.

To get desired segmentation results, there is no need to initial contour positions be close the object boundaries. Therefore, an initial contour selected at the center of the object to be segmented can be sufficient. Thus, high segmentation accuracy can be acquired with small initial contour created near the object center and a greater number of iteration. Accuracy for each test area was shown in Table 4.

Table 4: The best results for each test area

Test areas	Correctness	Completeness	Quality
First	0,989	0,987	0,977
Second	0.922	0.971	0.898
Third	0.923	0.961	0.890

While spectrally inhomogeneous and geometrically complex buildings were extracted with lower accuracy (Fig. 8 and 9), but buildings with spectrally homogeneous roof were extracted with higher accuracy (fig. 10). The reason for low extraction accuracy depends on the objects like solar panels or windows locating near the roof edges and in such situation active contour algorithm.

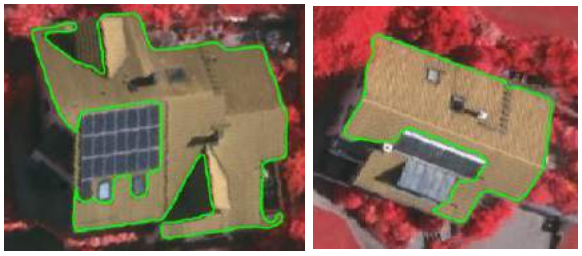

Figure 8: Objects on roofs such as sun panels affect the accuracy of active contours

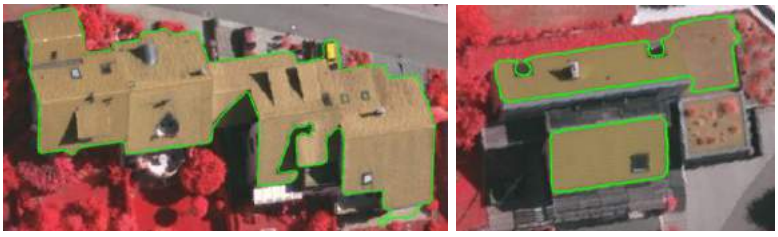

Figure 9: Shadowed zones on roofs especially near the edge also impair active contours, spectrally indistinctive pixels mixed with roof pixels

Figure 10: Decently illuminated roofs without prominent shadow areas can be accurately extracted by active contours, simple roof shapes can be extracted easily

4. Conclusion and Future Works

This study presents to create automatic initial contour positions for the extraction of buildings from high resolution aerial images instead of manually defining the initial contour positions in region based active contour algorithm**.** To do so, first the building candidate pixels were determined with morphological operations and labeled as the regions of building from binary images. Then, each building candidate pixel group's centroids were calculated. These centroids were used as initial contour positions by upsizing their dimensions with predetermined values such as 5×5, 11×11, 21×21, and 51×51 to run active contour model. To obtain desirable segmentation results, trial and error approach were implemented to find optimum initial contour size and iteration number in GUI.

With the proposed approach, all of the buildings were extracted from images. However, shadow effects and mixed pixels couldn't be avoided due to spectral characteristics of the environment such as roads and vegetation. As a result of previously mentioned issues, some of the detected buildings have jagged boundaries because of shadow effects and some of the building boundaries expanded to non-building areas with spectrally similar characteristics. Also, if the initial curve overlaps with a chimney, window or a solar panel then the curve created by active contour algorithm retracts inward and disappear. To overcome this problem, initial curve size must be large enough to surround such objects. Nevertheless, for homogeneous surfaced building roofs, overall segmentation quality does not affected by the size of initial contour.

Because of the fact that the main contribution in this study is to automatically create initial contour positions, it was not taken into consideration of the shadow regions and smoothness of the boundaries. Thus, as a future work we are going to smooth jagged boundaries and remove shadows effects on building roofs. Also, it is consider that Digital Elevation Model (DEM) covering the images will be included into dataset as a one layer to extract building boundaries with different roof textures and colors with active contour algorithm.

References

Ahmadi S., Zoej M. J. V., Ebadi H., Moghaddam H. A., Mohammadzadeh A., (2010), *Automatic urban building boundary extraction from high resolution aerial images using an innovative model of active contours*, International Journal of Applied Earth Observation and Geoinformation 12 (2010) 150–157.

Alshehhi R., Marpu P. R., Woon W. L., Mura M. D., (2017), *Simultaneous extraction of roads and buildings in remote sensing imagery with convolutional neural networks*, ISPRS Journal of Photogrammetry and Remote Sensing, 130 (2017) 139–149.

Attarzadeh R., Momeni M., (2012), *Object-Based Building Extraction from High Resolution Satellite Imagery*, International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XXXIX-B4, 2012 XXII ISPRS Congress, 25 August – 01 September 2012, Melbourne, Australia.

Awrangjeb M., Fraser C. S., Lua G., (2013), *Integration of Lidar Data And Orthoimage For Automatic 3D Building Roof Plane Extraction*, Multimedia and Expo (ICME), 2013 IEEE International Conference on, doi: 10.1109/ICME.2013.6607612.

Chan T. F., Vese L. A., (2001), *Active contours without edges*, IEEE Transactions on Image Processing, Volume 10, Issue 2, pp. 266-277.

Fazan A. J., Poz A. P. D., (2013), *Rectilinear building roof contour extraction based on snakes and dynamic programming*, International Journal of Applied Earth Observation and Geoinformation, doi: 10.1016/j.jag.2013.03.003.

Ghaffarian S., (2015), *An Approach For Automatic Building Extraction From High Resolution Satellite Images Using Shadow Analysis And Active Contours Model*, Master Thesis, Hacettepe University, Ankara, Turkey.

Ghanea M., Moallem P., Momeni M., (2014), *Automatic Building Extraction in Dense Urban Areas through GeoEye Multi-Spectral Imagery*, International Journal of Remote Sensing 35 (13): 5094–5119. doi:10.1080/01431161.2014.933278.

Gilani S. A. N., Awrangjeb M., Guojun L., 2016, *An Automatic Building Extraction and Regularisation Technique Using LiDAR Point Cloud Data and Orthoimage*, Remote Sensing 2016, 8(3), 258, doi: 10.3390/rs8030258.

Huang X., Zhang L., (2012), *Morphological Building/Shadow Index for Building Extraction From High-Resolution Imagery Over Urban Areas*, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, Volume: 5, Issue: 1, Feb. 2012, doi: 10.1109/JSTARS.2011.2168195.

Karsli F., Dihkan M., Acar H., Ozturk A., (2016), *Automatic building extraction from very high-resolution image and LiDAR data with SVM algorithm*, Arabian Journal of Geosciences, *doi:* 10.1007/s12517-016-2664-7.

Kass M., Witkin A., Terzopoulos, D., (1988), *Snakes: Active contour models*, International Journal of Computer Vision, 321-331.

Kodors S., Ratkevics A., Rausis A., Buls J.,(2015), *Building Recognition Using LiDAR and Energy Minimization Approach*, Procedia Computer Science, Volume 43, 2015, Pages 109-117.

Niveetha M. A., Vidhya R., (2012), *Automatic Building Extraction Using Advanced Morphological Operations and Texture Enhancing*, Procedia Engineering 38:3573-3578.

Rutzinger M, Rottensteiner F, Pfeifer N., (2009), *A comparison of evaluation techniques for building extraction from airborne laser scanning*, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 2(1):11–20.

Siddiqui F. U., Teng S. W., Awrangjeb M., Lu G., (2016), *A Robust Gradient Based Method for Building Extraction from LiDAR and Photogrammetric Imagery*, Sensors 2016, 16(7), 1110; doi:10.3390/s16071110.

Song J., Wu J., Jiang Y., (2015), *Extraction and reconstruction of curved surface buildings by contour clustering using airborne LiDAR data*, Optik 126 (2015), 513–521.

Shufelt J. A., (1999), *Performance evaluation and analysis of monocular building extraction from aerial imagery. Pattern Analysis and Machine Intelligence*, IEEE Transactions on 21(4):311–326.

Turker M., Koc-San D., (2015), *Building extraction from high-resolution optical spaceborne images using the integration of support vector machine (SVM) classification, Hough transformation and perceptual grouping*, International Journal of Applied Earth Observation and Geoinformation, 34 (2015) 58–69.

URL-1, (2017), https://www.mathworks.com/help/images/ref/activecontour.html, [12 November 2017].

Wang Y., (2016), *Automatic Extraction of Building Outline From High Resolution Aerial Imagery*, The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLI-B3, 2016 XXIII ISPRS Congress, 12–19 July 2016, Prague, Czech Republic.

Fractal Analysis of Coastal Pattern of the Kızılırmak Delta and Lagoons

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Abstract

The definition of features/shapes on the earth by various parameters facilitates the examination and understanding of these structures. Fractal geometry is used to describe the shapes and phenomena that are irregular and complex, and many problems, that cannot be understood and solved by Euclidean geometry, can be expressed mathematically by fractal geometry. Today, by means of the combining with remote sensing and Geographical Information Systems (GIS), fractal analysis based on fractal geometry has begun to be used effectively in the earth studies. In this study, the coastal pattern of the right and left section of the Kızılırmak Delta and the Karaboğaz, Balık, Uzun, Cernek, Liman, Gıcı and Tatlı lagoons in the delta were examined by fractal analysis. The study was supported by remote sensing and GIS, and the fractal dimension of the delta and lagoons was calculated by the box-counting method. Fractal analysis results were used as a data set that is thought to be related to environmental characteristics, and the relationship between fractal dimension and environmental characteristics-vegetation conditions and the relationship between fractal dimension and shoreline development index was examined and the results were interpreted. As a result of the study, it has been determined that the right section shoreline has a more complex structure than the left section shoreline in the Kızılırmak Delta, and the most complex lagoon is the Karaboğaz Lagoon while the most simple lagoon is the Cernek Lagoon. In addition, results show that the fractal dimension values can be used as mathematical data in the studies related to the earth and it can be effectively used in the evaluations of environmental research by including them in the problem-solving processes.

Keywords

Fractal analysis, fractal dimension, box-counting method, GIS, remote sensing, Kızılırmak Delta, lagoon

1. Introduction

Until now, Euclidean geometry has been commonly used in the research about spatial modeling of the features/shapes on the earth. However, traditional geometric methods in the modeling and visualization of the objects in nature are not efficient in fact. Because the shapes of objects in nature have not specific formulas, they cannot be fully visualized by known geometric algorithms (Köse 1990; Korvin 1992; Avasthi 2000; Dimri and Srivastava 2005; Değirmenci 2009). Euclidean geometry represents objects on the earth as a point, line, circle, triangle, polygon, cone, cylinder, etc. But the shapes of the natural objects on the earth are much more complex than points or lines used in Euclidean geometry (Değirmenci 2009; Koçak 2015).

The structures and formations of natural systems and finding unknowns about these structures, the answers to these questions constitute the basis of the research carried out by scientists to discover the formation of the universe and earth. The complexity and irregularity of these unknowns became understandable with the help of a new branch of science called "chaos" that emerged in the 20th century. Chaos also refers to a system within the irregularity or complexity and the complex forms called "fractals" are also used as one of the chaotic expression forms (Mandelbrot 1967; Gözübüyük 2007).

According to the fractal concept, complex objects with irregular, fractured, and/or infinite detail cannot be exactly defined by Euclidean geometry but can be defined by fractal geometry. A new concept introduced by fractal geometry is the "fractal dimension". According to this dimension concept, the fractal dimension is expressed by a real number larger than its topological dimension (Köse 1990).

The box-counting method, also called a grid method, is the most preferred approach for the fractal dimension calculation because it is simple and practical. In this method, the object is covered with grid cells of different sizes in order to calculate the fractal dimension. Grid sizes and the number of grids containing at least a part of the object are computed. The fractal dimension is calculated by a logarithmic ratio of the change in the number of grids to the change in the grid size (Eq.1). As the fractal value increases, the complexity of the object increases (Ediz 2003; Ceylan 2008; Wahl 2016).

$$D_B = \frac{\log N_2 - \log N_1}{\log S_2 - \log S_1} \tag{1}$$

where D_B is the fractal dimension based on the box-counting method, N is the box number, and S refers to the box size.

The rapid progress of technology increases the expectations of the modeling of the objects on the earth. The modeling of systems with complex structures is evolving with the facility of technology. New techniques, methods, and algorithms have been continuously developed to provide this improvement.

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In recent years, the use of fractal analysis in assessing spatial features on the earth have been continually increasing with the development of remote sensing and Geographical Information Systems (GIS) technologies. In the studies on the urban growth pattern, the fractal dimension is used for investigation of urban sprawl (Mcadams 2007; Kaya et al. 2009; Terzi and Kaya 2011; Li 2012). In many researches on architectural texture, the fractal dimension is handled in terms of detail richness of building facade (Ediz 2003; Gözübüyük 2007). In researches about shoreline, rivers, natural lakes, lagoons and artificial lakes, the relationships between fractal dimension and environmental conditions are investigated (Hamilton et al. 1992; Tarboton 1996; Zhou 2004; Shaikh et al. 2010; Shen et al. 2011; Shaohui and Zhongping 2013; Karle and Kolwankar 2015). However, these studies are limited in number and not common at the desired level.

Within the context of this study, the fractal dimension of the Kızılırmak Delta and delta's lagoons (Karaboğaz, Balık, Uzun, Cernek, Liman, Gıcı and Tatlı lagoons) was calculated with the help of remote sensing and GIS technologies by considering the phenomenon of nature and fractal geometry, which has an increasing importance, and the relationship between the lagoon fractal dimension and the environmental characteristics-vegetation conditions/shoreline development index was investigated.

2. Study Area: Kızılırmak Delta

The Kızılırmak Delta is located in the Black Sea region (Figure 1). The Kızılırmak Delta is one of the wetlands in Turkey that are protected by the Ramsar Convention.

In the selection of the study area, the presence of an increasing number of studies, as a result of the understanding of the necessity of ensuring the sustainability of wetlands in our country and all over the world in recent years, has been an important factor (Janssen et al. 2005; Sertel et al. 2008; Çetin 2009; Kuleli et al. 2011; Liu et al. 2014; Beyazıt et al. 2014; Borin and Malagoli 2015; Ozturk et al. 2015; Ozturk and Sesli 2015).

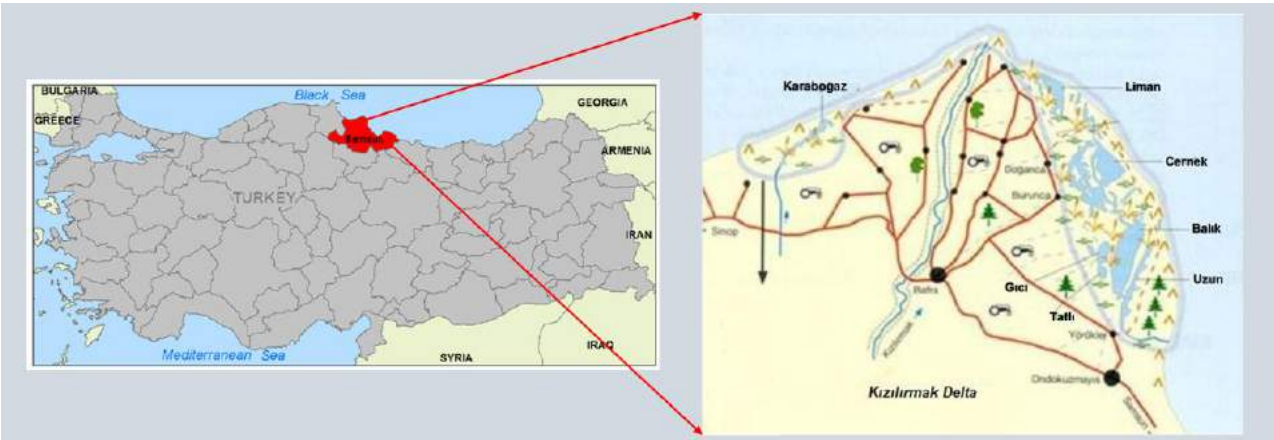

Figure 1: Kızılırmak Delta (Anonymous, 2017)

3. Data and Methodology

In order to achieve the fractal analysis of the Kızılırmak Delta and the lagoons (Karaboğaz, Balık, Uzun, Cernek, Liman, Gıcı and Tatlı lagoons), the coastal pattern of the delta and lagoons was obtained by using Landsat 8 OLI satellite images of June 4, 2017, covering the study area. Following radiometric calibration and correction, NDWI (Normalized Difference Water Index) and MNDWI (Modified Normalized Difference Water Index) water indexes were realized. Gram-Schmidt pan-sharpening was performed on NDWI and MNDWI index images, and 15-m pixel size index data was obtained from 30-m pixel size index images. These index images were classified by ISODATA (Iterative Self Organizing Data Analysis Technique) method and the shorelines of the delta and the lagoons were obtained. To perform fractal analysis, binary image for the delta and delta's lagoons was created from the classified image (Figure 2).

After the coastal pattern of the delta and the lagoons were obtained from the classified image, the fractal dimension was calculated for the right and the left section of the Kızılırmak Delta and each lagoon in the delta. In this study, fractal analysis performed by the box-counting method and the smallest grid size was selected as 75 m × 75 m (5 pixels) and the largest pixel size was selected as 450 m × 450 m (30 pixels) for the shorelines of delta and all lagoons by taking into account the similar studies in the literature (FracLac Advanced User's Manual 2004; Terzi and Kaya 2008; Ozturk, 2017). Because very large grid size may cause small changes, and thus, the measurement results can be misleading (Terzi and Kaya 2008) the maximum grid size was limited to 30 pixels, considering the size of the study area.

The most important disadvantage of the box-counting method is that the grid position affects the number of grids overlapped with the shape and accordingly the fractal dimension value. For this reason, in this study, fractal values were calculated using 10 different grid positions and the mean of the values obtained according to these grid positions was used as the main fractal dimension.

In addition, in order to investigate the relationship between fractal dimension and environmental conditions of the lagoons, the vegetation conditions surrounding the lagoons were determined using NDVI (Normalized Difference Vegetation Index) vegetation index algorithm. Furthermore, the existence of the relationship between the fractal dimension and the shoreline development index was also investigated.

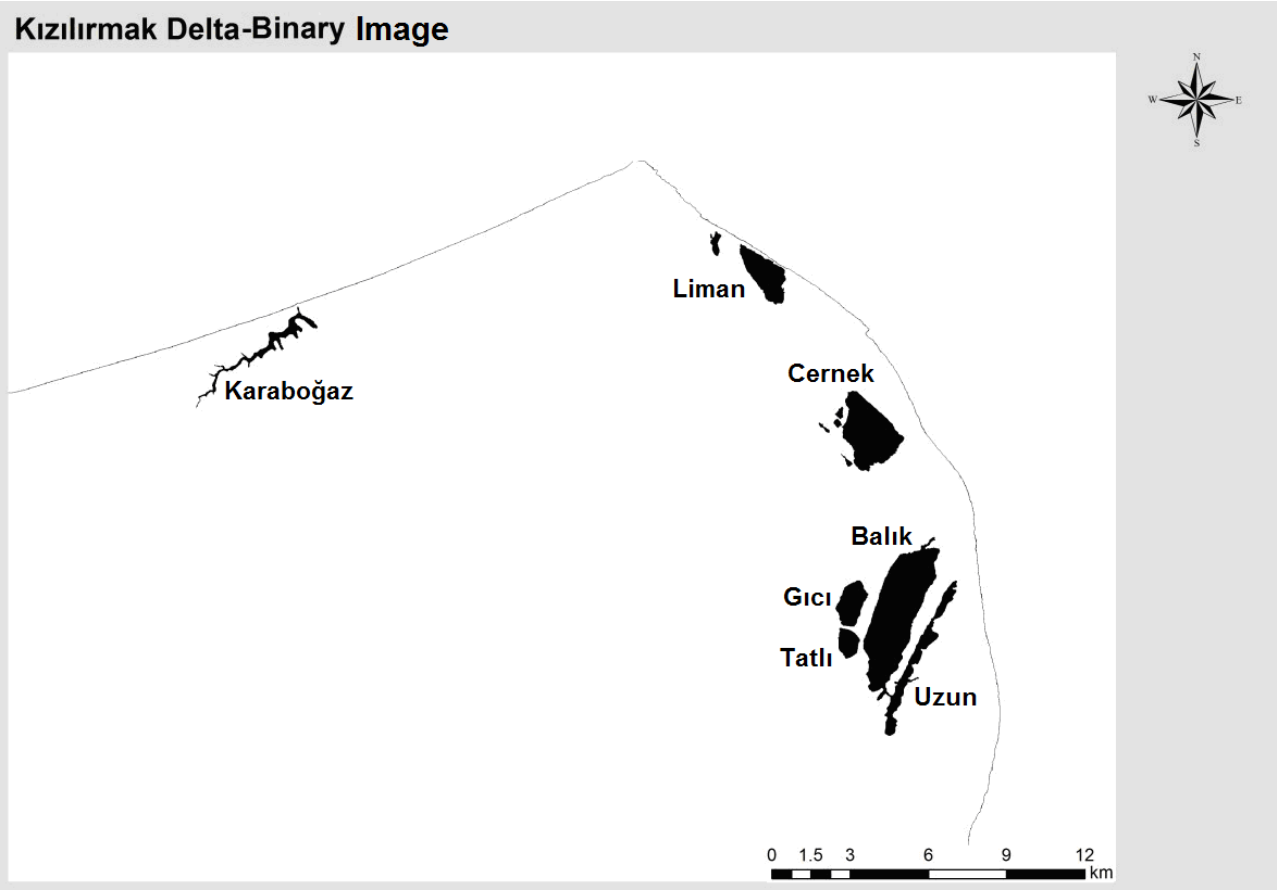

Figure 2: Binary image of the Kızılırmak Delta

4. Results

Results obtained by applying fractal analysis were discussed in two parts:

- Comparison of the complexity of the left and right section of the delta and lagoons
- Investigation of the relationship between 'fractal values and NDVI' and 'fractal values and shoreline development index'

When the fractal dimensions of the right and left section of the Kızılırmak Delta are compared (Table 1), it is seen that the fractal dimension is higher in the right section in terms of the mean value, maximum value and minimum value. The difference between the maximum and minimum values is greater in the left section. The higher fractal dimension of the right coastal section is thought to be due to the fact that coastal erosion is higher in this area and that the coastal area is more fragmented and complex due to interventions such as coastal structures as stated in the literature (Sertel et al. 2008; Kuleli et al. 2011; Ozturk et al. 2015; Ozturk and Sesli 2015).

When the fractal dimensions are examined to compare the complexity of the lagoon patterns, the highest fractal dimension in mean value is observed in the Karaboğaz Lagoon (1.3307) while the lowest fractal dimension is observed in the Cernek Lagoon (1.0503) (Table 2). The mean fractal dimension values are in the order of highest to lowest as Karaboğaz, Uzun, Tatlı, Balık, Gıcı, Liman and Cernek lagoons. When the fractal dimensions of the lagoons are ranked in terms of maximum values, it is understood that the highest value is in the Karaboğaz Lagoon (1.3500) and the lowest value is in the Cernek Lagoon (1.0767).

It is seen that ranking from highest to lowest is Karaboğaz, Uzun, Tatlı, Liman, Balık, Gıcı and Cernek lagoons. According to this sequence, it is seen that the results close to the order obtained in mean values. When the ranking is made according to the minimum fractal values, it is seen that the highest value is again in the Karaboğaz Lagoon (1.3137) while the lowest value is in the Gıcı Lagoon (1.0069). Ranking from highest to lowest is Karaboğaz, Uzun, Balık, Liman, Cernek, Tatlı and Gıcı lagoons. As the fractal value increases, the complexity of the lagoon increases.

Table 1: Maximum, minimum, and mean fractal dimension values of the left and right section of the delta for 10 different grid positions

FRACTAL DIMENSION	Left Section	Right Section
Mean	**1.1278**	**1.1296**
Maximum	1.1415	1.1430
Minimum	1.1141	1.1168
Maximum - Minimum	*0.0274*	*0.0262*

Table 2: Maximum, minimum and mean fractal dimension values of the lagoons for 10 different grid positions

FRACTAL DIMENSION	Karaboğaz Lagoon	Liman Lagoon	Cernek Lagoon	Balık Lagoon	Uzun Lagoon	Gıcı Lagoon	Tatlı Lagoon
Mean	**1.3307**	**1.0669**	**1.0503**	**1.0874**	**1.1957**	**1.0680**	**1.1014**
Maximum	1.3500	1.1099	1.0767	1.1090	1.2216	1.1054	1.1767
Minimum	1.3137	1.0276	1.0235	1.0542	1.1671	1.0069	1.0174
Maximum - Minimum	*0.0363*	*0.0823*	*0.0532*	*0.0548*	*0.0545*	*0.0985*	*0.1593*

The vegetation conditions surrounding the lagoons were determined using NDVI algorithm. The 100 m buffers were formed surrounding the lagoons and these buffers were overlapped with the NDVI layer and the mean, maximum and minimum NDVI values were calculated in the buffer area of each lagoon. When the mean NDVI values were compared with the fractal dimension values, it was found that NDVI values are higher around the lagoon which has the higher fractal dimension (Table 3). For example, the NDVI values around the Karaboğaz, Uzun and Tatlı lagoons with high fractal dimensions are much higher than the NDVI values around the Liman and Cernek lagoons with low fractal dimension. However, although there is a significant relationship between the fractal dimension values of lagoons and the NDVI values surrounding the lagoons, this is not absolute and monotonic.

Table 3: Maximum, minimum and mean NDVI values around the lagoons

NDVI	Karaboğaz Lagoon	Liman Lagoon	Cernek Lagoon	Balık Lagoon	Uzun Lagoon	Gıcı Lagoon	Tatlı Lagoon
Mean	**0.765**	**0.640**	**0.622**	**0.678**	**0.730**	**0.772**	**0.785**
Maximum	0.913	0.897	0.904	0.912	0.889	0.929	0.916
Minimum	-0.054	0.100	-0.148	-0.133	0.097	0.018	0.370

When the shoreline development index values were compared with the fractal dimension values, it was found that fractal dimension increased as the shoreline development index increased in general (Table 4). It can be seen that the highest value is in Karaboğaz and the lowest value is in Tatlı lagoon, according to the shoreline development index values. When the lagoon shoreline development index values are sorted from highest to lowest, the ranking is Karaboğaz, Uzun, Balık, Liman, Cernek, Gıcı and Tatlı lagoons. When this ranking was compared with the mean fractal dimension values, significant similarities were observed. For example, both the fractal values and the shoreline development index values of Karaboğaz, Uzun and Balık lagoons are significantly higher than the other lagoons. However, there are also some differences. The most important difference is that Tatlı Lagoon, which is in the 3rd order in terms of fractal dimension, takes the last order in terms of shoreline development index. At the end of the comparison, a relationship was found between the fractal dimension and the lagoon shoreline development index. However, this is not monotonic and absolute as it is in NDVI values.

Table 4: Shoreline development index of lagoons

Lagoon	Perimeter (m)	Area (m^2)	Shoreline development index
Karaboğaz	19492	1324480	4.7778
Liman	6955	2054570	1.3687
Cernek	9207	4236640	1.2618
Balık	17062	8289160	1.6718
Uzun	16456	2174770	3.1477
Gıcı	4980	1393620	1.1900
Tatlı	3369	719994	1.1200

This study also shows that the relationship between fractal dimension and NDVI is much stronger than the relationship between the shoreline development index and NDVI (Figure 3). In this context, if a comparison is made between the fractal dimension and shoreline development index, it is clear that the fractal dimension can provide much better information than the shoreline development index about vegetation conditions.

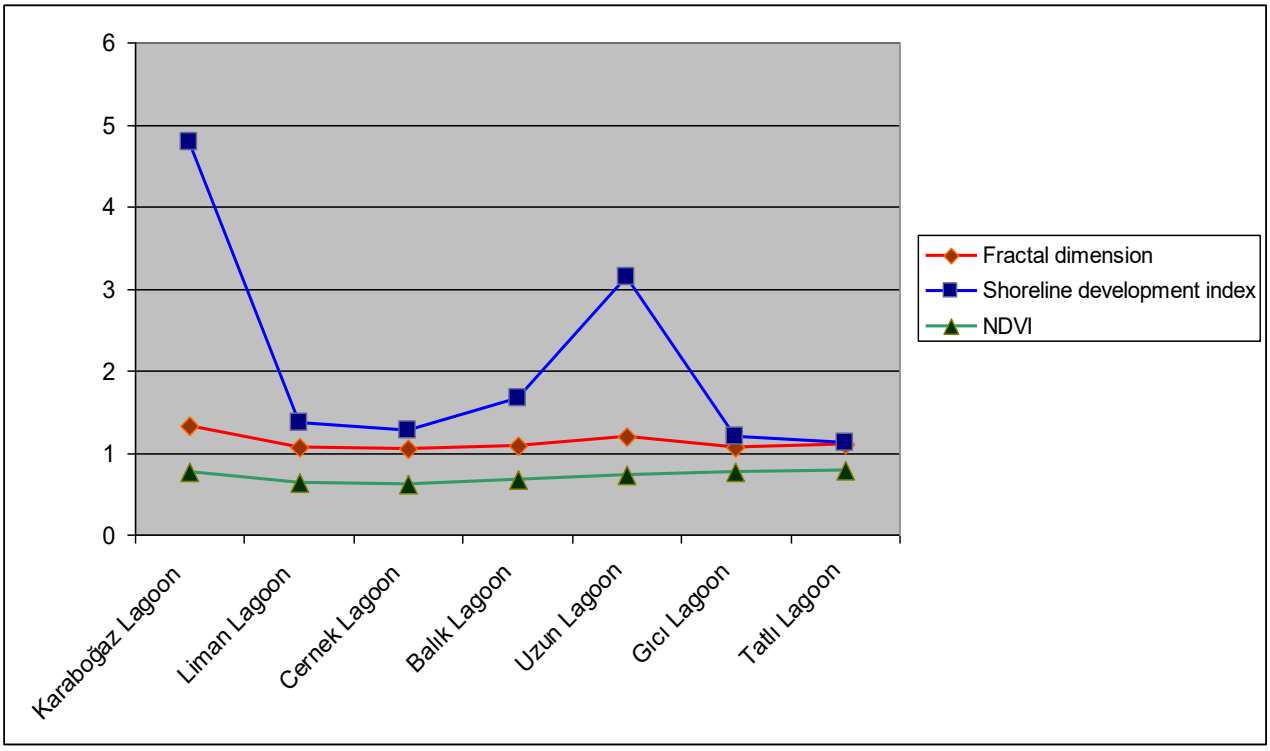

Figure 3: Comparison of the fractal dimension, shoreline development index and NDVI values for the lagoons

5. Conclusion

In this study, the right and left section of the coastal pattern of the Kızılırmak Delta and delta's lagoons were analyzed by fractal analysis and new mathematical data was provided in a different perspective. It has been concluded that the fractal dimension values can be used as mathematical data to measure the complexity of the delta's and lagoon's coastal patterns and to compare the morphology of coastal patterns. In relation to the NDVI index, the fractal analysis shows a stronger link than the shoreline development index. When the fractal dimension of the lagoons and the NDVI vegetation index of the field surrounding the lagoons are compared in terms of evaluating the contributions of coastal fractal dimension to environmental researches, it is seen in the most of lagoon that the NDVI index increases as the fractal dimension increases, and the NDVI index decreases as the fractal dimension decreases. However, these relationships are not absolute and monotonic. For this reason, fractal analysis can be supported by additional analysis techniques to investigate various environmental researches more effectively.

References

Anonymous (2017). Kızılırmak Deltası, http://www.kizilirmakdeltasi.net/2014/icerik/harita/delta.php, [Accessed 22 May 2017]. (in Turkish)

Avasthi D.N., (2000), *An introduction to fractals and their applications in the earth science*, In: Application of Fractals in Earth Sciences, (Dimri V.P., Ed.), CRC Press, Balkema, pp.1-6.

Beyazıt I., Öztürk D., Kılıç F., (2014), *Kızılırmak Deltası kıyı çizgisinin zamansal değişimi*, 5. Uzaktan Algılama-CBS Sempozyumu (UZAL-CBS 2014), 14-17 Ekim, İstanbul. (in Turkish)

Borin M., Malagoli M., (2015), *Ecology, functioning and management of wetland systems*, Environmental Science and Pollution Research, 22, 2357-2359, doi:10.1007/s11356-014-3771-1.

Ceylan S., (2008), *Marmara depremlerinin kaotik özellikleri ve fraktal analizi*, Master's Thesis, İstanbul Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul, Turkey. (in Turkish)

Çetin B., (2009), *Karataş (Bahçeözü) Gölü (Burdur-Karamanlı) sulak alanlarının kullanımı ve ortaya çıkan sorunlara coğrafi bir bakış*, e-Journal of New World Sciences Academy, 4(4), Article Number: 4A0011. (in Turkish)

Değirmenci F.B., (2009), *Fraktal geometri ve üretken sistemlerle mimari tasarım*, Master's Thesis, İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul, Turkey. (in Turkish)

Dimri V.P., Srivastava R.P., (2005), *Fractal modeling of complex subsurface geological structures*, In: Fractal Behaviour of the Earth System, (Dimri V.P., Ed.), Springer, Newyork, pp. 23-37.

Ediz Ö., (2003), *Mimari tasarımda fraktal kurguya dayalı üretken bir yaklaşım*, Ph.D. Thesis, İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul, Turkey. (in Turkish)

FracLac Advanced User's Manual, (2004), *FracLac for ImageJ-Using FracLac V2.0f for ImageJ*, 36p.

Gözübüyük G., (2007), *Farklı mimari dillerde fraktallere dayalı form üretimi*, Master's Thesis, İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul, Turkey. (in Turkish)

Hamilton S.K., Melack J.M., Goodchild M.F., Lewis W.M., (1992), *Estimation of the fractal dimension of terrain from lake size distributions*, In: Lowland Floodplain Rivers: Geomorphological Perspectives, (Carling P.A., Petts G.E., Eds.), Wiley, Chichester, pp.145-163.

Janssen R., Goosen H., Verhoeven M.L., Verhoeven J.T., Omtzigt A.Q.A., Maltby E., (2005), *Decision support for integrated wetland management*, Environmental Modelling & Software, 20(2), 215-229.

Karle N.N., Kolwankar K.M., (2015), *Characterization of the irregularity of a terrain using fractal dimension of lakes' boundaries*, Fractals, 23(2),1550002.

Kaya H.S., Terzi F., Bölen F., (2009), *Kentsel doku ile şehirsel büyüme biçimi arasındaki ilişkinin mekansal analizi: İstanbul örneği*, Dokuz Eylül Üniversitesi CBS Sempozyumu, 10-11 Aralık 2009, İzmir. (in Turkish)

Koçak K., (2015), Doğanın geometrisi: Fraktal geometri, http://web.itu.edu.tr/~kkocak/fraktal_yazi.htm, [Accessed 1 August 2015]. (in Turkish)

Korvin G., (1992), *Fractal models in the earth sciences*, Elsevier, Amsterdam, 424 p.

Köse C., (1990), *Yüzey dokusunun ve fraktal cisimlerin bilgisayarla üretimi*, Master's Thesis, Karadeniz Teknik Üniversitesi, Fen Bilimleri Enstitüsü, Trabzon, Turkey. (in Turkish)

Kuleli T., Güneroğlu A., Karslı F., Dihkan M., (2011), *Automatic detection of shoreline change on coastal RAMSAR wetlands of Turkey*, Ocean Engineering, 38, 1141-1149.

Li F., (2012), *Investigation of urban sprawl on the basis of remote sensing data: A case study in Jiangning, Nanjing City, China*, Ph.D. Thesis, University of Stuttgart, Germany.

Liu G., Zhang L., Zhang Q., Musyimi Z., Jiang Q., (2014), *Spatio-temporal dynamics of wetland landscape patterns based on remote sensing in Yellow River Delta, China*, Wetlands, 34(4), 787-801.

Mandelbrot B.B., (1967), *How long is the coast of Great Britain? Statistical self-similarity and fractional dimension*, Science, 156, 636-638.

Mcadams M.A., (2007), *Fractal analysis and the urban morphology of a city in a developing country: A case study of Istanbul*, Marmara Geographical Review, 15, 149-172.

Ozturk D., Beyazit I., Kilic F., (2015), *Spatiotemporal analysis of shoreline changes of the Kizilirmak Delta*, Journal of Coastal Research, 31(6), 1389-1402, doi:10.2112/JCOASTRES-D-14-00159.1.

Ozturk D., Sesli F.A., (2015). *Shoreline change analysis of the Kizilirmak Lagoon Series*, Ocean & Coastal Management, 118, 290-308, doi:10.1016/j.ocecoaman.2015.03.009.

Ozturk D., (2017), *Assessment of urban sprawl using Shannon's entropy and fractal analysis: a case study of Atakum, Ilkadim and Canik (Samsun, Turkey)*, Journal of Environmental Engineering and Landscape Management, 25(3), 264-276, doi:10.3846/16486897.2016.1233881.

Sertel E., Findik N., Kaya S., Seker D.Z., Samsunlu A., (2008), *Assessment of landscape changes in the Kizilirmak Delta, Turkey using remotely sensed data and GIS*, Environmental Engineering Science, 25(3), 353-362, doi:10.1089/ees.2006.0149.

Shaikh Y.H., Phathan J.M., Maqdoom F., Khan A.R., Behere S.H., (2010), *Application of fractal geometry to lakes*, Archives of Physics Research, 1(2), 147-170.

Shaohui Y., Zhongping Z., (2013), *Spatial-temporal changes of urban wetlands shape and driving force analysis using fractal dimension in Wuhan City, China*, International Conference on Remote Sensing, Environment and Transportation Engineering (RSETE 2013), July 26-28, 2013, Nanjing, China.

Shen X.H., Zou L.J., Zhang G.F., Sua N., Wu W.Y., Yang S.F., (2011), *Fractal characteristics of the main channel of Yellow River and its relation to regional tectonic evolution*, Geomorphology, 127, 64-70, doi:10.1016/j.geomorph.2010.12.007.

Tarboton D.G., (1996), *Fractal river networks, Horton's laws and Tokunaga cyclicity*, Journal of Hydrology, 187, 105-117.

Terzi F., Kaya H.S., (2008), *Analyzing urban sprawl patterns through fractal geometry: the case of Istanbul metropolitan area*, CASA Working Papers 144, Centre for Advanced Spatial Analysis (UCL), London.

Terzi F., Kaya H.S., (2011), *Dynamic spatial analysis of urban sprawl through fractal geometry: The case of Istanbul*, Environment and Planning B: Planning and Design, 38(1), 75-190, doi:10.1068/b35096.

Wahl B., (2016), Fractal Explorer, Dynamic Software, http://www.wahl.org/fe/HTML_version/link/FE4W/c4.htm#hausdorff, [Accessed 8 March 2017].

Zhou X., (2004), *Fractal and multifractal analysis of runoff time series and stream networks in agricultural watersheds*, Ph.D. Thesis, Virginia Polytechnic Institute and State University, USA.

Estimation of Monthly Sunshine Duration by Using Satellite Data and Geographic Parameters over Turkey

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Abstract

In this study, support vector machine (SVM) method was applied to estimate monthly sunshine duration (SD) over Turkey. Firstly, monthly dataset of atmospheric and geographical parameters, which were assumed to affect the SD, were constructed. The dataset was composed of 26 different monthly parameters which includes the thermal channels of the geostationary orbiting Meteosat SEVIRI sensor, the solar channels of the polar orbiting Suomi-NPP VIIRS sensor and extra-terrestrial solar radiation, day length, sun hour angle, declination angle, Julien day number, location (latitude, longitude, altitude) and time (year, month). Inputs of model were determined by using recursive feature elimination (RFE) algorithm which selects the most suitable parameters among the monthly dataset. Using the most appropriate function and its parameters of SVM model, SD estimations were performed for the considered pixels. Monthly SD maps of Turkey were created with a 600 meters spatial resolution. Errors were calculated for the training and test phases and results were analysed. Mean bias error (MBE), root mean square error (RMSE) and coefficient of determination (R^2) were found to be -0.1103h, 1.1842h and 0.8545 respectively for the test stage.

Keywords

Support vector machines, Sunshine duration, Meteosat SEVIRI, Suomi-NPP VIIRS, Turkey

1. Introduction

Sunshine duration (SD) is one of the most needed climatic data for many studies such as climate, agriculture, energy and hydrology (Suehrcke et al., 2013; Wild et al., 2005). For example, SD is the most used data for calculating solar energy at the earth's surface (Trnka et al., 2005). It is also widely used in yield estimation (Devanathan, 1975) and it has critical importance for observing climate changes (Sanchez-Lorenzo et al., 2009). Annual SD values are needed for the areas where photovoltaic panels are to be installed (Jain et al., 2011). Because of SD has great importance for such studies its temporal and spatial distribution over any area should be known or estimated precisely.

Classically SD is measured point-wise at meteorological ground stations and estimated using interpolation methods for non-station locations across the globe. The estimated values may include high error depending on geography and distance between stations (Kaba et al., 2016). In this reason, there is a need for estimating the SD more accurately.

Although exist different studies on the estimation of SD in the literature, these studies are extremely limited and can be divided into two main groups as satellite-based and ground-based (El-Metwally, 2005; Good, 2010; Kandirmaz, 2006; Mohandes and Rehman, 2013). Meteorological satellites provide valuable information about atmosphere, land surface, ocean, and glaciers in very short time intervals and these images are used in various studies as input data. This also means that the SD values over any area also can be estimated using satellite data. In recent years, many researchers have preferred to use of satellite data for this purpose (Bertrand et al., 2013; Erdi, 2015; Essa and Etman, 2004; Good, 2010; Kandirmaz, 2006; Kandirmaz and Kaba, 2014). While a lot of data produce from satellite images, SD product is unavailable and this lack must resolve.

Generally, the radiance data, first level satellite data, is distributed to users by satellite operators and other satellite products can be produced from this radiance data. For instance, products of reflectance (r) and brightness temperature (BT) are derived from the radiance data. In the present study, a new model which uses r and BT data was developed for the purpose of estimation of monthly SD. BT data were obtained from the SEVIRI (Spinning Enhanced Visible and Infrared Imager) sensor and r data were obtained from VIIRS (Visible Infrared Imaging Radiometer Suite) sensor.

In recent years, researchers are utilized machine learning algorithms in order to solve problems in various disciplines such as agriculture, hydrology, and meteorology (Ch et al., 2014; Chapelle et al., 1999; Ding and Sun, 2015; Sen, 1998; Tehrany et al., 2014; Unal et al., 2003; Zheng et al., 2015). For example, artificial neural networks (ANN) are used widely in solar energy and SD estimations and produced very satisfactory results (Al-Alawi and Al-Hinai, 1998; Eissa et al., 2013; Kandirmaz et al., 2014; Rahimikhoob, 2014; Yadav and Chandel, 2014). Some researchers have showed that the support vector machine (SVM) algorithm, which is relatively new method, produce much accurate results than the ANN algorithm for solving some type of problems (Ch et al., 2014; Javadi et al., 2015; Kaytez et al., 2015). In this study, monthly SD predicted using SVM approach using three years' satellite and geographic data between 2013 and 2015. It is shown that SVM approach can be successfully used for the estimation of monthly SD.

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2. Material and Method

2.1. Study Area and Data

This study was conducted for a period of three years from 2013 to 2015 in Turkey which is located at 35º-43º north latitude and 25 º-46 º east longitudes. Four different types of data as ground, geographic, geostationary orbiting satellite and polar orbiting satellite data were used in the study. The SD values (ground data) are recorded at observation stations of MGM. Geographic data consists of time (year and month), location (latitude, longitude and altitude), Julien day, declination angle, sun hour angle, day length and extra-terrestrial solar radiation. Geostationary orbiting satellite data were used seven thermal channels data from SEVIRI sensor on Meteosat satellites. Polar orbiting satellite data consists of nine solar channels from the Suomi-NPP VIIRS sensor. With the use of different satellite data, information that complements each other in a spectral sense is obtained and channel diversity is provided.

According to the definition of World Meteorological Organization (WMO, 2010) SD is the sum of the times when direct solar radiation reaching the unit area during a given period equal or exceed threshold value of 120 W/m^2.

Daily extra-terrestrial solar radiation (G) is calculated by using Equation 1.

$$G = \left(\frac{24*60}{\pi}\right) * G_{sc} * d * [\omega_s \sin\varphi \sin\delta + \cos\varphi \cos\delta \sin\omega_s] \quad (1)$$

where G_{sc} is solar constant (0.082MJ), d is inverse relative earth-sun distance, ω_s is sunset hour angle, φ, is the latitude and δ is the solar declination angle. ω_s, δ and d is given by following equations.

$$\omega_s = \cos^{-1}(-\tan\varphi * \tan\delta) \quad (2)$$

$$\delta = 0.409 * \sin[(2 * \pi * j/365) - 1.39] \quad (3)$$

$$d = 1 + 0.033\cos(2\pi j/365) \quad (4)$$

where j is Julien day number which is equal to 1 for the 1st January and 365 for the 31st December. And the time period between sunrise and sunset time is defined as day length (S_0) or the maximum sunshine duration and is calculated by Equation 5.

$$S_0 = 24 * \omega_s/\pi \quad (5)$$

The geostationary-orbit SEVIRI Level 1.5 data which is one of the major products of the MSG produced from the satellite raw data (Level 1.0). The Level 1.5 data is an image in which all undesired radiometric and geometric effects are corrected, a standardized projection is used and calibration and radiance linearization are performed. Different meteorological products are derived from this. The SDR (Level 1B) radiometric calibration algorithm converts the numerical values (Digital Number - DN) obtained from the records of the VIIRS sensor in RDR (Raw Data Records) to radiance and reflectance or brightness temperature. In addition to SDR radiation and reflectance or brightness temperature data, it also includes related geolocation data such as pixel geolocation, land elevation, satellite-to-ground spacing. Table 1 shows the channel properties of SEVIRI sensor and Table 2 shows the channel properties for the VIIRS sensor.

Table 1. SEVIRI sensor's bands

Channel Numbers	SEVIRI Channel Names	Centre Wavelength (µm)	Channel Numbers	SEVIRI Channel Names	Centre Wavelength (µm)
1	VIS0.6	0.63	**7**	IR8.7	8.70
2	VIS0.8	0.81	**8**	IR9.7	9.66
3	NIR1.6	1.64	**9**	IR10.8	10.80
4	IR3.9	3.90	**10**	IR12.0	12.00
5	WV6.2	6.25	**11**	IR13.4	13.40
6	WV7.3	7.35	**12**	HRV	0.75

Table 2. VIIRS sensor's bands

VIIRS Channel Names	Centre Wavelength (µm)	VIIRS Channel Names	Centre Wavelength (µm)
M01	0.412	**M12**	3.700
M02	0.445	**M13**	4.050
M03	0.488	**M14**	8.550
M04	0.555	**M15**	10.763
M05	0.672	**M16**	12.012
M06	0.746	**I01**	0.640
M07	0.865	**I02**	0.865
M08	1.240	**I03**	1.610
M09	1.378	**I04**	3.740
M10	1.610	**I05**	11.450
M11	2.250	**DNB**	0.700

2.2. Recursive Feature Elimination

The purpose of classification or regression in an application, all observations or measurement data considered to have high information value is taken as input. On the other hand, the complexity of the model to be developed depends on the number of inputs. The input number is an element that determines training of model time and space complexity and number of required learning examples. In most learning algorithms, complexity depends on the size of the data sample and the input size. If an input is known to be non-discriminatory, it can be cost-effectively saved to obtain or measure it. Simpler models in smaller data sets are more reliable. When the data set is explained with fewer variables, information extraction is easier and controllability is higher (Alpaydın, 2013).

In this study, Recursive Feature Elimination (RFE) method was used. RFE is a wrapper based feature selection algorithm developed by Guyon et al. (2002). It is aimed to find the best subset of r dimension with r < N in the N-dimensional data set. RFE is an algorithm that uses linear SVM. The algorithm uses regulation term of SVM $\frac{1}{2} \| \omega \|^2$ expression as a property sorting criterion. In each iteration, coefficients of the weight vector (ω) are used to calculate the ranking score of all the attributes. The feature with the smallest ranking score is eliminated.

2.3. Support Vector Machines

SVM is a machine learning algorithm developed by Vapnik based on supervised learning. Since its introduction, it has been widely used in pattern recognition, classification and regression problems. Firstly, the method developed for classification has been extended by Cortes and Vapnik to solve the regression problems. SVM learning is based on the principle of structural risk minimization that minimizes the upper limit of the overall error (Cortes and Vapnik, 1995; Vapnik et al., 1997). SVM can be applied to linear and nonlinear problems. In non-linear problems, the higher dimensional feature space is evaluated using a nonlinear kernel method (Ch et al., 2014; Vapnik and Mukherjee, 2000). The training data is directly mapped to the high dimensional feature space using quadratic programming. One or more hyperplanes are created in this space. These hyperplanes have the maximum range (margin) formed by considering the selected data, called support vectors. The solution in the high dimensional space is transformed into a convex optimization. For this reason, there are no local minimum problems (Kaba et al., 2016).

The SVM equations based on the Vapnik theory are expressed from equation 6 to equation 10 below (Ch et al., 2014; Kim et al., 2012; Smola and Schölkopf, 2004). Let us consider a data set of $\{x_i, d_i\}_i^l$ with the input space vector x_i, output values d_i and training data number l of the sample data. SVM aims to converge to the function given by equation 6. In the equation, ω denotes the normal vector and b denotes a scalar. The estimated quantity is measured by the loss function $L_\varepsilon(x_i, d_i)$. SVM uses a new ε-sensitive loss function proposed by Vapnik. Thus, errors of ε value are ignored, and the effect of larger errors is linear.

$$f(x) = \langle \omega, x \rangle + b \tag{6}$$

$$R_{SVMs}(C) = \frac{1}{2} \parallel \omega \parallel^2 + C\frac{1}{l}\sum_{i=1}^{l} L_\varepsilon(x_i, d_i) \tag{7}$$

$R_{SVMs}(C)$ refers to the regulated risk function, $\frac{1}{2} \parallel \omega \parallel^2$ regulation term and $C\frac{1}{l}\sum_{i=1}^{n} L_\varepsilon(x_i, d_i)$ empirical error in the equation 7. C is error penalty factor used to adjust the difference between the regulation term and the empirical error. In case the deviation from the hyperplane on both sides, $\xi_i, \xi_i^* \geq 0$ slack variables representing the deviation from the edge are defined. Equations 7 and 8 are obtained by the equation of the ξ_i, ξ_i^* variables representing the upper and lower additional deviation (Ch et al., 2014; Chen et al., 2011). Addition of Lagrange multipliers to Equation 8 and optimum constraints yield Equation 9 (Lagrange equation) (Basak et al., 2007; Smola and Schölkopf, 2004).

$$Minimize\ R_{SVMs}(\omega, \xi_i, \xi_i^*) = \frac{1}{2} \parallel \omega \parallel^2 + C \sum_{i=1}^{l}(\xi_i + \xi_i^*) \tag{8}$$

$$\text{Constraints;} \begin{cases} d_i - \langle \omega, x_i \rangle - b \leq \varepsilon + \xi_i \\ \langle \omega, x_i \rangle + b - d_i \leq \varepsilon + \xi_i^* \\ \xi_i, \xi_i^* \geq 0,\ i = 1,2,3, \dots, l \end{cases}$$

$$L = \frac{1}{2} \parallel \omega \parallel^2 + C \sum_{i=1}^{l}(\xi_i + \xi_i^*) - \sum_{i=1}^{l} \alpha_i(\varepsilon + \xi_i - d_i + \langle \omega, x_i \rangle + b) - \sum_{i=1}^{l} \alpha_i^*(\varepsilon + \xi_i^* + d_i - \langle \omega, x_i \rangle - b) - \sum_{i=1}^{l}(\eta_i \xi_i + \eta_i^* \xi_i^*) \tag{9}$$

where α_i, α_i^*, η_i and $\eta_i^* \geq 0$ and these coefficients are called Lagrange multipliers. If ω, b, ξ_i and ξ_i^* are taken as partial derivatives of L, ω and b are obtained (Basak et al., 2007; Smola and Schölkopf, 2004). SVM performs a nonlinear regression operation using a kernel function in the form of a $K(x, x_i) = \varphi(x)\ \varphi(x_i)$ instead of a multiplication of $\langle x_i, x_j \rangle$. The other unknown b (bias) coefficient in the equation is found by the Karush-Kuhn-Tucker (KKT) conditions (Smola and Schölkopf, 2004). Two conclusions are drawn from the KKT conditions. First, the sample data is found in ε tube only when $\alpha_i = C$ and $\alpha_i^* = C$. The second is that $\alpha_i * \alpha_i^* = 0$ and there are no α_i and α_i^* different from zero at the same time.

$$\omega = \sum_{i=1}^{l}(\alpha_i - \alpha_i^*)x_i$$

$$\begin{cases} b = d_i - \langle \omega, x_i \rangle - \varepsilon, & \alpha_i \in (0, C) ise \\ b = d_i - \langle \omega, x_i \rangle + \varepsilon, & \alpha_i^* \in (0, C) ise \end{cases}$$

$$f(x, \alpha_i, \alpha_i^*) = \sum_{i=1}^{l}(\alpha_i - \alpha_i^*)\langle x_i, x \rangle + b \tag{10}$$

Equations of RBF (Radial Basis Function), linear, polynomial, and sigmoid functions from the kernel functions commonly used in SVM are given below.

RBF:	$\exp(-\gamma \lvert x - x_i \rvert^2)$	Polynomial:	$(\gamma \langle x, x_i \rangle + r)^d$
Linear:	$\langle x, x_i \rangle$	Sigmoid:	$\tanh(\gamma \langle x, x_i \rangle + r)$

2.4. Model Evaluation Methods

In order to determine the success of the model and to evaluate the results, statistical indices are used. The MBE (Mean Bias Error), MAE (Mean Absolute Error), MAPE (Mean Absolute Percentage Error), RMSE (Root Mean Square Error), percentage RMSE (RMSE%) and R^2 (Determination of coefficient) are calculated by the equations given by 11, to 16. The If MBE is negative, the estimate is less than the actual value, and if it is positive, the estimate is greater than the actual value. The MAE and RMSE values give the magnitude of the mean error. R^2 expresses the magnitude of the relationship between two quantities.

$$\mathrm{MBE} = \frac{\sum_{i=1}^{n}(E_i - O_i)}{n} \tag{11}$$

$$\mathrm{MAE} = \frac{\sum_{i=1}^{n}|E_i - O_i|}{n} \tag{12}$$

$$\mathrm{MAPE} = \frac{100}{n} * \sum_{i=1}^{n}\left|\frac{E_i - O_i}{O_i}\right| \tag{13}$$

$$\mathrm{RMSE} = \sqrt{\frac{\sum_{i=1}^{n}(E_i - O_i)^2}{n}} \tag{14}$$

$$\mathrm{RMSE}(\%) = \frac{100*n}{\sum_{i=1}^{n}(O_i)} * \sqrt{\frac{\sum_{i=1}^{n}(E_i - O_i)^2}{n}} \tag{15}$$

$$R^2 = \frac{\left[\sum_{i=1}^{n}(E_i - \bar{E})(O_i - \bar{O})\right]^2}{\sum_{i=1}^{n}(E_i - \bar{E})^2 \sum_{i=1}^{n}(O_i - \bar{O})^2} \tag{16}$$

In these formulas, n refers to the total number of samples. And E_i, O_i, $\bar{E}$ and $\bar{O}$ shows the estimated, measured, average of estimated and average of measured values of SD, respectively.

3. Result and Discussion

For the estimation of monthly SD, 10 input parameters were selected from 26 parameters in the data set. The orders of importance of them were given in Table 3. The SEVIRI channel data, which contains daily changing information about land and atmosphere, were contributed to the accuracy of the SD estimation more than the geographic parameters and the VIIRS data. It is concluded that the seventh and ninth channels, providing information about the earth and clouds from the SEVIRI channels, were the two most important inputs for the monthly estimation of SD. The extra-terrestrial solar radiation was determined to be as another important input coming after the SEVIRI channel data. The two, four, five, and seventh channels of VIIRS where they record data in the visible region of electromagnetic spectrum, find applications in the ocean and aerosol areas and the channel eight provides information about cloud particle size. In addition to these inputs, latitude and longitude values were also used because they improved the model's success by reducing the error values. When the inputs of the model are examined, it is seen that the channels, which have larger wavelength than the thermal channel data of the SEVIRI sensor, have high importance for estimating the monthly SD. The solar channel data obtained from the VIIRS sensor, short wavelength channels recording in the visible region and near infrared, are also important. Using the input set, the most suitable values for γ and C parameters were investigated and γ = 0.8 and C = 3.5 were found. For the model, ε = 0.1 was chosen. The model were trained these parameters and b was determined as 6.7830 in the decision function.

Table 3. Input parameters of the model

Order of importance	Inputs	Order of importance	Inputs
1	SEVIRI IR8.7	**6**	VIIRS M04
2	SEVIRI IR10.8	**7**	VIIRS M07
3	extra-terrestrial solar radiation	**8**	VIIRS M08
4	VIIRS M02	**9**	Longitude
5	VIIRS M05	**10**	Latitude

Table 4. Statistical results of the model

	MBE	MAE	RMSE	MAPE	%RMSE	R^2
Train	-0.1267	0.3902	0.9172	8.1601	13.5232	0.9098
Test	-0.1103	0.7746	1.1842	16.3647	17.3482	0.8545

The statistical results of the model were calculated and given in Table 4. The MBE values were found to be negative. MAPE and percentage RMSE were found to be as 8.1601% and 16.3647% for training phase and 13.5232% and 17.3482% for test phase, respectively.

The scattering graphs were constructed and given in Figure 1 (the training results on the left and the test results on the right). The applied fit and its equation to the data and the determination coefficient R^2 were given in the graphs. R^2 = 0.9098 for the training phase and R^2 = 0.8545 for the test phase.

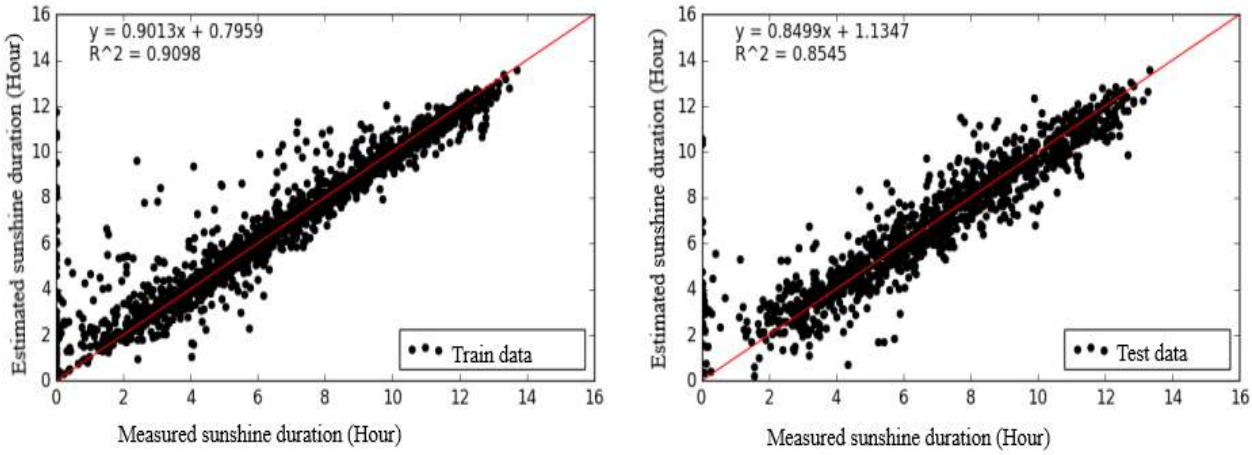

Figure 1. Scattering graphs of the model

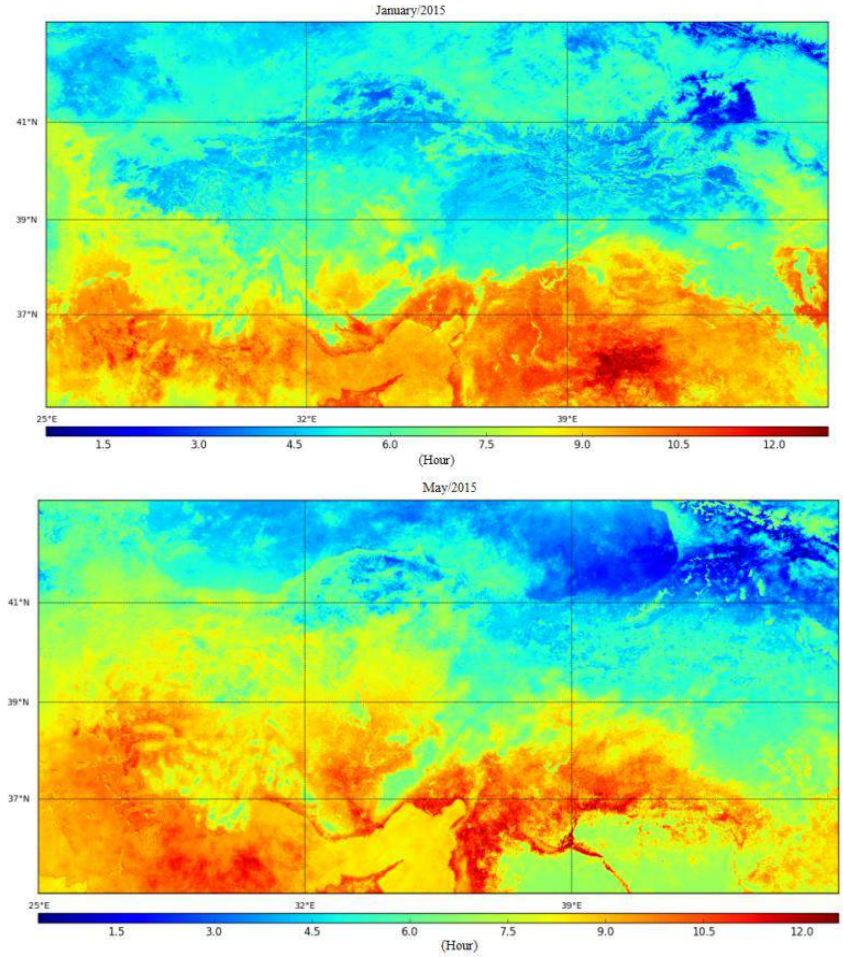

Figure 2. Generated SD maps corresponding to January and May 2015

In Figure 2, GS maps produced by the monthly model are given for January and May of 2015. In January, the minimum value of GS was 0.61, the maximum value was 12.85, the average was 6.91 and the standard deviation was 2.11. In March, the minimum value of GS was 0.46, the maximum value was 13.11, the average was 6.98, and the standard deviation was 2.37. In May, the minimum value of GS was 0.30, the maximum value was 12.57, the average was 6.94, and the standard deviation was 2.17. In July, the minimum value of GS was 0.35, the maximum value was 12.26, the average was 7.2 and the standard deviation was 1.73. In September, the minimum value of GS was 0.50, the maximum value was 12.00, the

average was 6.95 and the standard deviation was 1.54. In November, the minimum value of GS was 0.18, the maximum value was 13.21, the average was 6.92 and the standard deviation was 2.72. The data for the remaining months are the similar as the above values.

4. Conclusions

Monthly dataset of atmospheric and geographical parameters, which were assumed to affect the SD, were constructed. The monthly dataset was composed of 26 different monthly parameters which includes the thermal channels of the geostationary orbiting Meteosat SEVIRI sensor, the solar channels of the polar orbiting Suomi-NPP VIIRS sensor and extra-terrestrial solar radiation, day length, sun hour angle, declination angle, Julien day number, location (latitude, longitude, altitude) and time (year, month). Inputs of model were determined by using recursive feature elimination (RFE) algorithm that selects the most suitable parameters among the monthly dataset. It is seen that, the fifth and sixth channel data of SEVIRI sensor that contain water vapour and high cloud information and the eighth channel, which gives information about the ozone gas in the atmosphere were not used in the model. The Julien day, sun hour angle and day length were also found to be insignificant for the model. The VIIRS sixth channel, which is mainly used for atmospheric correction, the ninth channel, which contains information about the cirrus clouds, the 10th channel, which contains snow information, and the 11th channel that gives information about clouds could not be used as input data in the model. These data were found to have less importance than those of used in the model. It is also concluded that, the SEVIRI thermal channel data is more important than the VIIRS solar channel data for the estimation of monthly SD although it is expected that the solar channel data reflectance values are more important than the thermal channel data. This can be logical because only a single image in a day is obtained from the VIIRS sensor. As we think that the change in the atmosphere is more rapid in the spring months than in the summer and winter, it is not possible to capture a rapid change of weather during the day using only a single image of VIIRS sensor. For this reason, the daily mean SEVIRI data represent the quick changes of weather in a day and became much important input data for the model. Consequently, using the most appropriate function and its parameters of SVM model, SD estimations were performed for the considered pixels. Monthly SD maps of Turkey were created with a 600 meters spatial resolution. Errors were calculated for the training and test phases and results were analysed. Mean bias error (MBE), root mean square error (RMSE) and coefficient of determination (R^2) were found to be as -0.1103h, 1.1842h and 0.8545 respectively for the test stage. This study shows that SVM is efficient tool and can be successfully used for the estimation of SD.

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References

Al-Alawi, S.M., Al-Hinai, H.A., 1998. *An ANN-based approach for predicting global radiation in locations with no direct measurement instrumentation*. Renew Energ 14, 199-204.

Alpaydın, E., 2013. Yapay Öğrenme. İstanbul, Boğaziçi Üniversitesi Yayınevi.

Basak, D., Pal, S., Patranabis, D.C., 2007. *Support vector regression*. Neural Information Processing-Letters and Reviews 11, 203-224.

Bertrand, C., Demain, C., Journee, M., 2013. *Estimating daily sunshine duration over Belgium by combination of station and satellite data*. Remote Sens Lett 4, 735-744.

Ch, S., Sohani, S.K., Kumar, D., Malik, A., Chahar, B.R., Nema, A.K., Panigrahi, B.K., Dhiman, R.C., 2014. *A Support Vector Machine-Firefly Algorithm based forecasting model to determine malaria transmission*. Neurocomputing 129, 279-288.

Chapelle, O., Haffner, P., Vapnik, V.N., 1999. *Support vector machines for histogram-based image classification*. Ieee T Neural Networ 10, 1055-1064.

Chen, J.-L., Liu, H.-B., Wu, W., Xie, D.-T., 2011. *Estimation of monthly solar radiation from measured temperatures using support vector machines–a case study*. Renew Energ 36, 413-420.

Cortes, C., Vapnik, V., 1995. *Support-Vector Networks*. Mach Learn 20, 273-297.

Devanathan, M., 1975. *Weather and the yield of a crop*. Exp Agr 11, 183-186.

Ding, F.L., Sun, L.M., 2015. *Prediction of Tobacco Sales Based on Support Vector Machine*. Liss 2014, 891-896.

Eissa, Y., Marpu, P.R., Gherboudj, I., Ghedira, H., Ouarda, T.B.M.J., Chiesa, M., 2013. *Artificial neural network based model for retrieval of the direct normal, diffuse horizontal and global horizontal irradiances using SEVIRI images*. Sol Energy 89, 1-16.

El-Metwally, M., 2005. *Sunshine and global solar radiation estimation at different sites in Egypt*. J Atmos Sol-Terr Phy 67, 1331-1342.

Erdi, E., 2015. *Güneşlenme Süresinin NWCSAF Bulut Tipi Ürünü Kullanılarak Yapay Sinir Ağları İle Tahmin Edilmesi*, Adana, p. 74.

Essa, K.S., Etman, S.M., 2004. *On the relation between cloud cover amount and sunshine duration*. Meteorol Atmos Phys 87, 235-240.

Good, E., 2010. *Estimating daily sunshine duration over the UK from geostationary satellite data*. Weather 65, 324-328.

Guyon, I., Weston, J., Barnhill, S., Vapnik, V., 2002. *Gene selection for cancer classification using support vector machines*. Mach Learn 46, 389-422.

Jain, A., Mehta, R., Mittal, S.K., 2011. *Modeling impact of solar radiation on site selection for solar PV power plants in India*. Int J Green Energy 8, 486-498.

Javadi, F., Ahmadi, M.M., Qaderi, K., 2015. *Estimation of River Bedform Dimension Using Artificial Neural Network (ANN) and Support Vector Machine (SVM)*. J Agr Sci Tech-Iran 17, 859-868.

Kaba, K., Kandirmaz, H., Avci, M., 2016. *Estimation of Daily Sunshine Duration Using Support Vector Machines*. Int J Green Energy.

Kandirmaz, H.M., 2006. *A model for the estimation of the daily global sunshine duration from meteorological geostationary satellite data*. Int J Remote Sens 27, 5061-5071.

Kandirmaz, H.M., Kaba, K., 2014. *Estimation of Daily Sunshine Duration from Terra and Aqua MODIS Data*. Adv Meteorol.

Kandirmaz, H.M., Kaba, K., Avci, M., 2014. *Estimation of Monthly Sunshine Duration in Turkey Using Artificial Neural Networks*. Int J Photoenergy.

Kaytez, F., Taplamacioglu, M.C., Cam, E., Hardalac, F., 2015. *Forecasting electricity consumption: A comparison of regression analysis, neural networks and least squares support vector machines*. Int J Elec Power 67, 431-438.

Kim, S., Shiri, J., Kisi, O., 2012. *Pan evaporation modeling using neural computing approach for different climatic zones*. Water Resour Manag 26, 3231-3249.

Mohandes, M.A., Rehman, S., 2013. *Estimation of sunshine duration in Saudi Arabia*. J Renew Sustain Ener 5.

Rahimikhoob, A., 2014. *Estimating sunshine duration from other climatic data by artificial neural network for ET0 estimation in an arid environment*. Theor Appl Climatol 118, 1-8.

Sanchez-Lorenzo, A., Calbo, J., Brunetti, M., Deser, C., 2009. *Dimming/brightening over the Iberian Peninsula: Trends in sunshine duration and cloud cover and their relations with atmospheric circulation*. J Geophys Res-Atmos 114.

Sen, Z., 1998. *Fuzzy algorithm for estimation of solar irradiation from sunshine duration*. Sol Energy 63, 39-49.

Smola, A.J., Schölkopf, B., 2004. *A tutorial on support vector regression*. Statistics and computing 14, 199-222.

Suehrcke, H., Bowden, R.S., Hollands, K.G.T., 2013. *Relationship between sunshine duration and solar radiation*. Sol Energy 92, 160-171.

Tehrany, M.S., Pradhan, B., Jebur, M.N., 2014. *Flood susceptibility mapping using a novel ensemble weights-of-evidence and support vector machine models in GIS*. J Hydrol 512, 332-343.

Trnka, M., Zalud, Z., Eitzinger, J., Dubrovsky, M., 2005. *Global solar radiation in Central European lowlands estimated by various empirical formulae*. Agr Forest Meteorol 131, 54-76.

Unal, Y., Kindap, T., Karaca, M., 2003. *Redefining the climate zones of Turkey using cluster analysis*. Int J Climatol 23, 1045-1055.

Vapnik, V., Golowich, S.E., Smola, A., 1997. *Support vector method for function approximation, regression estimation, and signal processing*. Advances in Neural Information Processing Systems 9 9, 281-287.

Vapnik, V.N., Mukherjee, S., 2000. *Support vector method for multivariate density estimation*. Adv Neur In 12, 659-665.

Wild, M., Gilgen, H., Roesch, A., Ohmura, A., Long, C.N., Dutton, E.G., Forgan, B., Kallis, A., Russak, V., Tsvetkov, A., 2005. *From dimming to brightening: Decadal changes in solar radiation at Earth's surface*. Science 308, 847-850.

Yadav, A.K., Chandel, S.S., 2014. *Solar radiation prediction using Artificial Neural Network techniques: A review*. Renew Sust Energ Rev 33, 772-781.

Zheng, B.J., Myint, S.W., Thenkabail, P.S., Aggarwal, R.M., 2015. *A support vector machine to identify irrigated crop types using time-series Landsat NDVI data*. Int J Appl Earth Obs 34, 103-112.

Appraising Generalized Additive Models (GAMs) in GIS Framework

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Abstract

Analysing the data and producing some reliable spatial and non-spatial models in GIS are the critical steps for making a comprehensive assessment. Linear models (LMs) are relatively preferable due to simplicity. These are also prevalent to describe and implement data with regards to inference and interpretation. On the other hand, conventional LMs can have important limitations from the point of predictive power and flexibility. Generalized Additive Models (GAMs) are semi-parametric algorithms for predicting non-linear responses to a suite of indicator variables. GAMs obtain a general framework for extending a standard linear model by allowing non-linear functions of each of the variables, while maintaining additivity. In a GAM-based analysis, each term in the linear sum of predictors require not be the indicator variable itself, but can be an empirical smooth function of it. In this study, the usability of GAMs in GIS framework is presented by two different type real studies. In the first application, the conventional regression model structure has been used and a qualitative variable encountered in GIS problems has been added in the predictor variable sets. The modelling has been performed using the splines functions. In the second application, based on a geostatistical setting, the coordinates have been chosen as the indicators (as in a trend surface). The case studies showed that GAMs can be used for GIS-based problems as the effective modelling tools for moving beyond linearity.

Keywords
GAMs, GIS, Spline, Forest Fire, Cement.

1. Introduction

Geographic Information Systems (GIS) cover some computer-based tools that analyse, store, manipulate and visualize geographic information. Furthermore, a project-based GIS analysis comprises of some fundamental steps such as collecting data, entering and analysing data, and producing informative maps (de By and Georgiadou). By using GIS, various types of information can be compared and contrasted. The system can include data about people, such as population, traffic, or education level. It can include information about the landscape, such as the location of streams, different kinds of forest, and different kinds of rocks. It also has the ability to demonstrate multiple types of information on multiple geographical locations in a single map, enabling to appraise patterns and relationships between different information points (Huang 2017).

To make a comprehensive appraisal, analysing data and producing reliable spatial and non-spatial models in GIS are the critical steps. The Linear models (LMs) are prevalent tools to identify and implement data with regards to inference and interpretation. These methods are also relatively preferable due to simplicity. Conventional linear regression can be exemplified for the LMs. On the other hand, conventional LMs can have important limitations from the point of predictive power, poor approximation and flexibility. Recently, new spatial models and Geographically Weighted Regression analysis have suggested for eliminating the drawbacks of conventional regression analysis (Fotheringham and Wegener 2001; Lloyd 2010).

Generalized Additive Models (GAMs) are semi-parametric algorithms for predicting non-linear responses to a suite of indicator variables. GAMs obtain a general framework for extending a standard linear model by allowing non-linear functions of each of the variables, while maintaining additivity. Similar to LMs, GAMs can be applied with both quantitative and qualitative responses. In a GAM-based analysis, each term in the linear sum of predictors require not be the indicator variable itself, but can be an empirical smooth function of it. Use of GAMs in the GIS problems is a relatively new topic in literature (Li et al. 2012; Feng and Tong 2017).

In this work, the usability of GAMs in GIS framework is discussed by two different real studies. In the first case study, instead of linear components, non-linear relationships and classification structure has been used and a qualitative variable encountered in GIS problems added in the predictor variable sets. The modelling has been performed using the splines functions. In the second case study, based on a geostatistical setting, the coordinates have been chosen as the indicators (as in a trend surface). The applications demonstrated that GAMs can be used for GIS-based problems as the effective modelling tools for moving beyond linearity.

2. Methodology

As a supervised learning method, linear regression is a useful tool for predicting a quantitative response. The multiple linear regression structure can be expressed as follows:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_1 x_{i2} + \cdots + \beta_p x_{ip} + \varepsilon_i. \quad (1)$$

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Generalized Additive Model replaces each linear component $\beta_j x_{ij}$ with a (smooth) non-linear function $f_j(x_{ij})$. By this way, the new structure allows for non-linear relationships between each feature and the target variable. From a non-linear modelling perspective, we can write the model as (Hastie et al. 2009):

$$y_i = \beta_0 + \sum_{j=1}^{p} f_j\left(x_{ij}\right) + \varepsilon_i$$
$$= \beta_0 + f_1(x_{i1}) + f_2(x_{i2}) + \cdots + f_p(x_{ip}) + \varepsilon_i. \quad (2)$$

The structure addresses an additive model since a separate $f_j$for each X_j is calculated. After that all of the contributions are added together. Fitting a GAM with a smoothing spline is the one of the reliable modelling approach. This technique fits a model involving multiple predictors by repeatedly updating the fit for each predictor in turn, holding the others fit (James et al. 2013).

GAMs can also be employed in situations where *y* is qualitative. Assuming that *Y* takes on zero or one, and let *p(X) = Pr(Y=1\X)* be the conditional probability that the response equals one. In linear structure, the logit is the log of the odds of P(Y=1\X) versus P(Y=0\X) and this denotes as a linear function of the predictors. To provide a non-linear relationship with qualitative variables, the following expression can be expressed (Wood 2017):

$$log\left(\frac{p(X)}{1-p(X)}\right) = \beta_0 + f_1(X_1) + f_2(X_2) + \cdots + f_p(X_p). \quad (3)$$

It should also be noted that in addition to splines, both local and polynomial regression can be used to construct a building block for GAMs.

3. Results and Discussion

3.1. Case Study 1

To implement the GAMs-based GIS analysis, in the first case study, the forest fires data set recorded in Antalya has been taken into consideration (Boran and Yorulmaz 2014). Antalya region covers 2.110.997 hectare area; forests are placed in 55%, the rest of the region contains open fields.

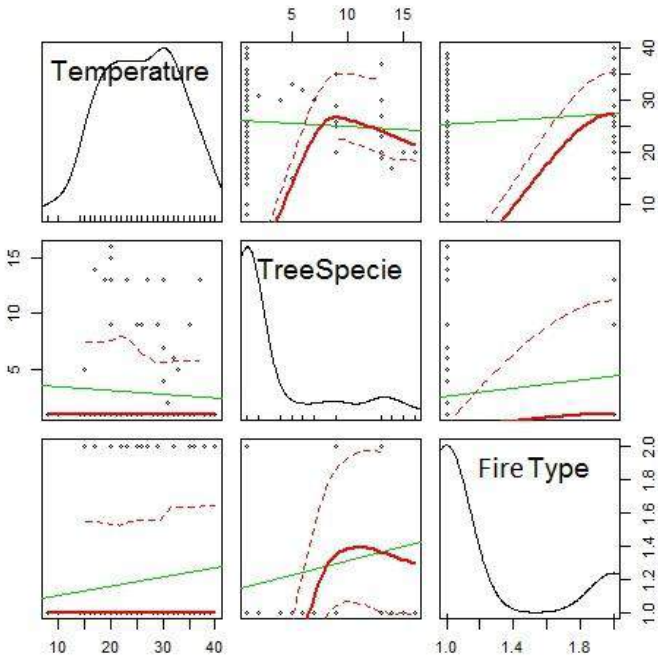

Figure 1: Scatter plot matrix of indicator variables.

Three main parameters such as tree species, maximum temperature and type of fire have been considered as the independent variables, while amount of area has been the dependent variable. Based on a limit (≥ 5 decare burned

areas), 94 observations were used. Figure 1 obtains scatter plots of the input variables with each other in the off-diagonals and smoothed and linear fit lines on the plots. The principal diagonal contains densities and also addressed some skewed distributions both for tree species and fire type.

To provide the best model structures with suitable functions, a series of experiments and ANOVA tests have been performed. By this way, use of linear and non-linear functions is examined. The *p*-values showed that the model including spline-based nonlinear smoothed functions for Temperature and Tree Specie as well as qualitative variable for Type of Fire (dummy) component has been recorded as the best option. Figure 2 illustrates the final functions. Each plot exhibits the fitted function and point-wise standard errors. The first two functions are the regression splines and the third function is a step function, fit to the qualitative variable Type of Fire.

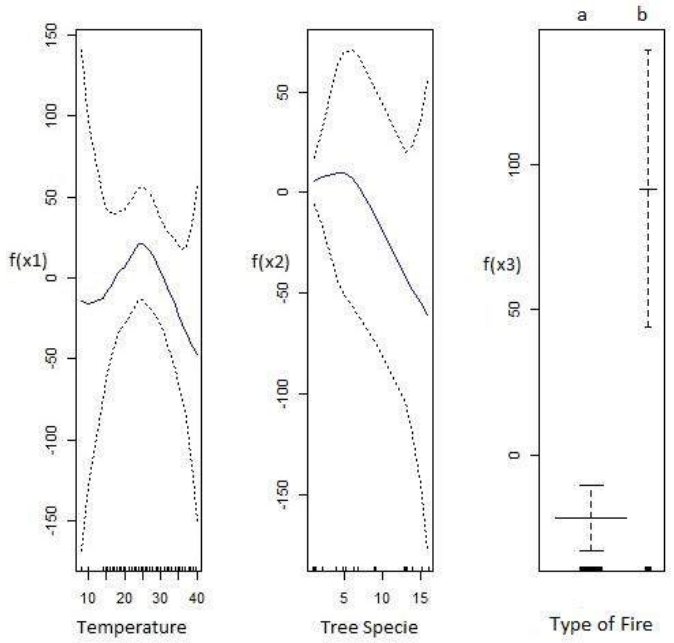

Figure 2: Plots of relationship between each feature and response.

To fit a logistic regression-based fitting (classification approach), binary response variable has been focused. Figure 3 shows the similar results obtained by that of the regression-based GAMs model.

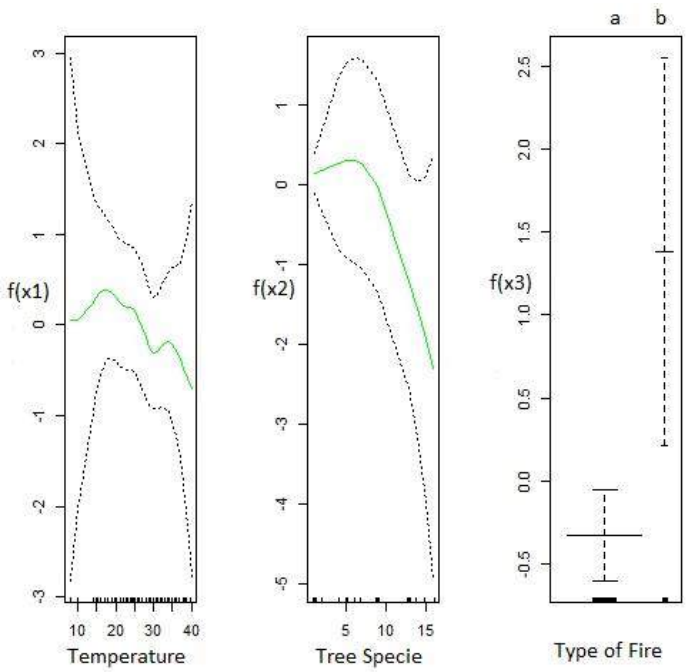

Figure 3: A logistic regression GAM fitting.

3.2. Case Study 2

In the second application, a cement raw material quarry has been examined and based on the coordinates a series of experiments have been conducted. The quarry occurred with marl, marly-limestone and limestones. The data set employed in this study belongs to marl units and comprising of 67 measurements (Dag et al. 2011). In addition to the coordinates and the thickness, CaO concentration which is the one of the most important production parameter in cement science has been considered. In the first step, the relationships between the CaO concentrations and coordinate values have been illustrated (Figure 4). The plots showed that there is randomness but no trend in the spatial system.

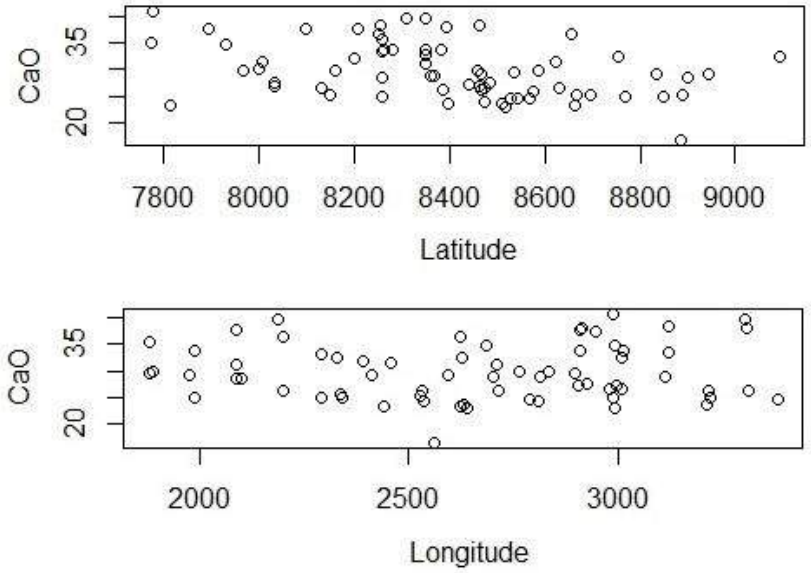

Figure 4: Relationships between coordinates and target variable.

Because all the model parameters are quantitative, three spline functions have been fitted. Based on the experiments and the final ANOVA tests, the best model functions have been obtained. Figure 5 shows the functions.

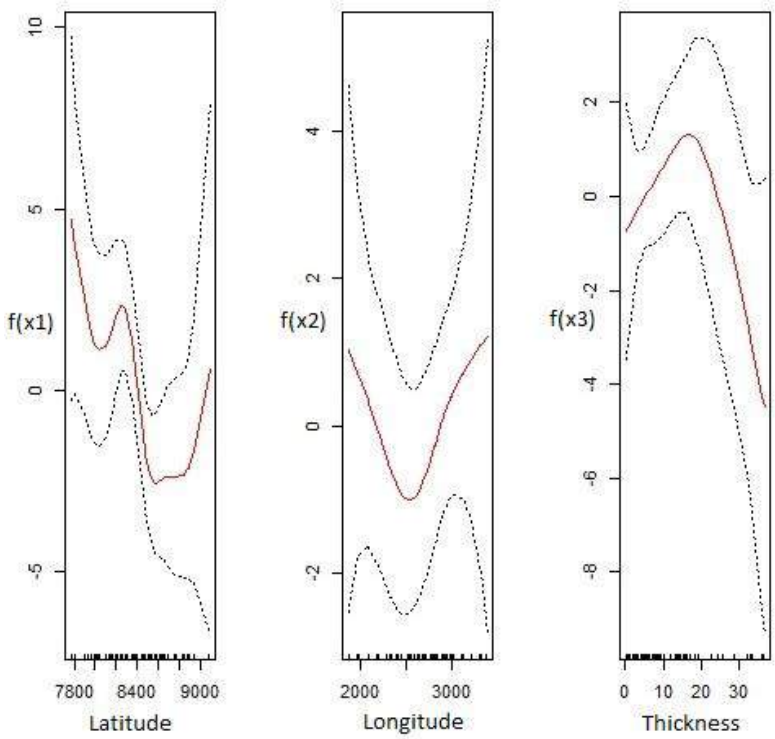

Figure 5: Plots of relationship between each feature and response.

3.3. Discussion

The applications showed that just like the linear models, the GAMs can be implemented with both quantitative and qualitative responses. By the GAMS, we can model non-linear relationships that standard linear regression would miss. One of the most important advantages for the GIS-based problems is that GAMs can be examined the effect of each X_j on Y individually due to additively conducted modelling. This also yields a flexibility to select the suitable function structures in accordance with the shape and degrees of freedom.

Although the GAMS provide many advantages, some critical interactions among the geological and topographical parameters can be missed when we use many variables. In this situation, interaction terms should be added manually.

4. Conclusions

Since a project-based GIS approach encompasses some necessary steps such as collecting and analysing data, some reliable data modelling techniques are required for mapping the systems. GAMs can provide a general framework for extending a standard linear model by allowing non-linear functions of each of the variables, while maintaining additivity. By this way, the non-linear relationships in the GIS parameters can be identified.

The real studies showed that GAM can be used in GIS-based problems as the effective solution tool for moving beyond linearity. The results also indicated that the representation of the smoothness of the function and its flexibility can be provided by this non-linear modelling approach.

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References

Boran A, Yorulmaz T., (2014), *Calculating emissions and economic losses arising from forest fires, a sample district: Antalya*, Bachelor Thesis, Akdeniz University, Antalya (in Turkish with English abstract).

Dag A., Alkan, B., Cira, S.C., (2011), *Investigation of applicability of fuzzy modelling approach in thickness estimation of cement raw material*, PNWSA Engineering Science, 6(1), 88-97.

de By R.A., Georgiadou P.Y., (2014), *Digital earth applications in the twenty - first century*, In: International Journal of Digital Earth, 7, 511-515.

Feng Y.J., Tong, X.H., (2017), Calibrating nonparametric cellular automata with a generalized additive model to simulate dynamic urban growth, Environmental Earth Sciences, 76(14), 496.

Fotheringham S., Wegener M., (2001), *Spatial models in GIS*, Taylor & Francis, Boca Raton.

Hastie T., Tibshirani R., Friedman J., (2017), The elemnts of statistical learning, Springer, New York.

James G., Witten D., Hastie T., Tibshirani R., (2013), *An introduction to statistical learning*, Springer, New York.

Huang B., (2017), *Comprehensive Geographic Information Systems*, Elsevier, Oxford.

Li L., Wu J., Wilhelm M., Ritz B., (2012), *Use of generalized additive models and cokriging of spatial residuals to improve land-use regression estimates of nitrogen oxides in Southern California*, Atmos Environ., 55, 220-228.

Lloyd C.D., (2010), *Spatial data analysis - an introduction for GIS users*, Oxford University Press, Oxford.

Wood S.N., (2017), Generalized additive models: an introduction with R, 2nd. Edition, CRC Press, Boca Raton.

Hierarchical Blockchain Architecture for a Relaxed Hegemony on Cadastre Data Management and Update: A Case Study for Turkey

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Abstract

In Today's globalized and highly democratized and decentralized geospatial data, there are multiple data owners and multiple parties claim different levels of authority on the data. In such an environment, a complete, correct and consistent data could only be created and maintained by collaborative management and mutually reconciled workflows where a new data sharing, de-centralized data approving, quality assurance and data delivery model and mechanism needed. Eventually, geospatial data owned by multiple institutes and even individuals force the conventional ownership and definitions of property rights to be adapted according to new environment. In this study, a problem of inconsistent boundary determination in between succeeding cadastre surveys is introduced and a methodology based on hierarchical blockchain architecture is proposed which may prevent such cases. In the proposed methodology, a transaction of boundary change is not booked in the land registry, unless common and joint approval of all stakeholders. After presenting a case study of two separate physical boundaries which are represented as a unique edge in the cadastre data, in Kırşehir/Turkey, a CAD/GIS enabled methodology based on blockchain technology is proposed to prevent such occasions. In the proposed approach, the landowners are participating as an equal partner in the cadastre survey and decision making process. The 'GIS Engine for Cadastre Data Management' part of the 'Spatio-temporal GIS/CAD Engine' component of Land Registry & Cadastre (LR&C) Blockchain (BC) Node is designed and implemented by using C# and ESRI ArcObjects SDK for .NET and libraries of ArcObjects COM components and an open library of NewtonSoft.JSON.

Keywords

Cadastre, Land registry, Surveying, Boundary, Blockchain, GIS, CAD, Database

1. Introduction

The physical representation of the defined rights in the registry has been maintained in peace by the stakeholders namely owners of the properties and the state authority -usually- namely an organization of land registry and cadastre, unless any of the participants agree on written formal documents and physical reality.

Despite, new technology provides sub-centimeter accuracy to determine the boundary and extent of properties and land, usually a discrepancy between layout of documented coordinates, edges, areas with the physical reality. Many of the countries, handle and manage land registry and cadastre data separately to prevent an occurrence of conflict between legislation and modern cadastre surveys.

In this study, a geospatial data enabled blockchain model comprising three components, namely 'blockchain database', 'middleware' and 'GIS/CAD'. These tree components are loosely coupled. the 'blockchain database' component handles the communication and trace of transactions, 'the middleware' component handles the relationship and communication between 'blockchain database' and 'the GIS/CAD' in a lossless geo and non-geo data transaction and 'the GIS/CAD' component handles the geometrical part. In the 'blockchain database' component which is the hierarchical blockchain architecture, there are three levels in a hierarchy to control and mutually decide on any transaction by approval of relevant participants in accordance with the land registry and cadastre organization as a trusted node watching the procedures.

1.1. Related Work

Vos (2016) and Dijkstra et.al (2015) reported examples of blockchain research and application on land registry from Sweden, Georgia, Honduras and Ghana. Honduras. Meanwhile, Vos (2016), gives a structural approach for land registry transaction processes and how blockchain fits with them. Dijkstra et.al (2015) states that, blockchain technology is suitable for land registry and cadastre. Chachkhunashvili (2016) states that National Agency of Public Registry NAPR of Georgia has started the use of blockchain approach for land property transaction. Bal (2016) reports the international efforts on blockchain studies as well as a view of Indian Registry from the perspective of potential benefits. The Lantmateriet-Sweden (2016) reports, a conducted project which covers Today's land registry and real estate transactions and a pilot project to create an application that would use blockchain technology to facilitate transactions which is mutually executed by several stakeholders such as real estate agent, bank, buyer, seller, and the Lantmateriet.

In our study, despite the available studies are all concentrated on land registry, is on surveying the technology, projects and applications. This study aims at using blockchain technology to minimize the boundary surveying problems caused by incautious considerations in order to minimize the mistakes that cause unsolvable problems at cadastre surveying phase and has to be handled at cadastre courts.

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1.2. Scope of the Work

Within the scope of this study, a three component and hierarchical -three levels- blockchain architecture is presented, as well as a database model, data structures, algorithms that runs as a parallel process along land registry transaction database which runs on blockchain technology. In this study we only handle one component namely 'Temporal GIS/CAD Engine for Land Registry and Cadastre of Blockchain'. Although the functionalities and participation in the proposed architecture are given in the paper for completeness, the other two components -Blockchain Transaction Engine and Middleware- will be handled and implemented separately.

2. The Cadastre System of Turkey and Cadastral Survey Campaigns

Countries survey and maintain the physical view of their territories and cadastre for use of large communities in addition to public works and private sector needs in the form of maps or digital data. The governmental institutions, private sector, academia, real estate sector largely use cadastral data for multiple purposes such as planning, land management, utility, risk assessment.

2.1. Turkish Cadastre System and the Legislation

The history of cadastral legislation in Turkey started in 1847 by establishing the first Land Registration Organization'; in 1924 'General Directorate of Title Deed' (Law # 658) was founded; in 1934 modern cadaster works started in urban areas with 'the law of Registry and Cadastre' (Law # 2613) followed by another 'Cadastre Law' for cadaster of rural areas in 1950 (Law # 5602); the law in 1987 (Law # 3402) described a unique cadaster for urban and rural, a type of public announcement replaced the announcement relevant bodies to save cadastre expenses, as well as a very detailed definition of how cadaster would be conducted in practice, in addition to new technical concepts such as 'spatial databases'.

With some ratifications on Law # 3402 in recent years, 'General Directorate of Land Registry and Cadastre-GDLRC' is conducting both 'land registry' and 'cadastre' works and keeping 'land registry books' regularly under the same organizational frame despite the similar cadastre systems such as German and Dutch. Turkish Cadaster System, being based on 'legal system' also aims at taxation, maintaining the cadastral maps and data updated for governmental, private and individual users (Gruber et.al., 2014; Jones, 2012; Cete, 2014; Demir et.al, 2008; GIM, 2007; TKGM, 2008; Yaşayan et.al., 2011; TKGM, 1987).

In Turkish Cadastral System, title for each parcel is registered in the 'registration book' with the information of landowner, legal position of person/parsons regarding the parcel, legal rights of person/persons to use the property and a link to parcel geometry described in the cadaster data which has a unique ID number that binds cadaster and land registry.

2.2. Establishing the Base Cadastre of Turkey

With attempts of her own capabilities in the first years, after the National Assembly made the law number 3402 in 1987, the GDLRC started a campaign to establish up-to-date, digital, modern, survey based cadastre with modern techniques with outsourcing the cadaster survey to newly growing private surveying sector. Starting from 2005, great efforts made by GDLRC and private sector as contractor resulted completion of 'Base Cadaster Surveys' by the end of 2012. In the 'Cadastre Campaign' of ten years of effort, 14.5 Million cadastre parcels out of the total number of 57.5 Million has been surveyed, registered and put in digital databases with a total contracting cost of USD 427 Million excluding the costs of GDLRC in house and with an approximate cost of USD 34.01 per parcel (TKGM, 2017_1; TKGM, 2017_2).

The lack of large scale cadastre data in urban, near urban and along the corridors of infrastructure routes, forced other governmental institutes such as Directorates of 'Water Works', 'Roads', 'Rail Roads', 'Urban Development' to produce their own large scale 'as-is maps' –with an almost equal content of large scale cadastre data- multiple times at the same locations. Compliance, edge matching, integration, finding the most current, maintenance and management of cadastre data created by GDLRC and other governmental institutions is a hot problem to be resolved to meet the needs of developing Turkish Economy with limited resources, preparing the country for 3D/4D Cadastre as well as compliance with INSPIRE and national SDI initiatives and goals stated in FIG Cadastre 2014 (FIG, 2017; ISO 19152, 2012).

2.3. The Updating Needs for Cadastre Data

Due to the increasing cultural developments through whole country and results of some investigations on technical and legal aspects of the 'Cadastre Campaign' emerged the need for update for cadastre with problems which has been approved in very limited case of the Law # 3402. Since then, there has been a campaign of so called 'Updating due to 22-a' which has been partly financed by a USD 203 Million of long term credit under contract with World Bank. The experienced cadastral update which exceeds far beyond the 'parcels with technical surveying problems' creates a new cadastre data set which only could be a very relaxed legal interpretation of Civil Code (Law # 4721) and Cadastre Law (Law # 3402) (TKGM, 2016; Sarı, 2017; Toker, 2016; Kaya, 2003).

2.4. Analysis of Court Cases on Cadastre

The mistakes, observation errors, evaluation errors made by field team cause further disputes as the registration done. In many cases, these mistakes are recognized when a property is to be sold third person whom wants the property to be shown and measured in the field. Dissolving the disputes are quite difficult by the courts after several years where limited data is stored.

As the base cadastre works populated the geospatial attributes in land registry, the landowners whom are aware of the change raised their claim during the announcement time or applied the court to resolve the dispute case. During and after the extensive cadastre survey campaign, the increasing tendency of the number of cases stated in the cadastre courts, is declining in the last 5 years. These statistical data are concerning the cadastre courts whereas the cases about claims on land registry are evaluated. On the other hand, the statistics about the claims concerning the objection for cadastral surveys just after the announcement of cadastre survey that are handled by other courts - not called cadastre courts- are not depicted in the graphic, because of lack of information. Starting from 2005, about 370000 cases has been conducted in Cadastre Courts with a decreasing trend until 2015.

3. The Blockchain Technology and Its Applications on Land Registry and Cadastre

The aim of using blockchain in cadastre is introducing the landowner participation into the boundary determination process which causes conflicts. Despite the centralized systems controlled by a single authority for land registry, blockchain technology provides a revolutionary system and solution having the characteristics such as decentralization, openness, transparent for booking land registry with assured legal guarantee for transactions of property rights.

3.1. Blockchain Technology

The specifications of blockchain technology makes it useable for registering such as land registry for land parcels and properties (Vos, 2016; Dijkstra et.al., 2015; Chachkhunashvili, 2016; Lantmateriet-Sweden, 2016). The blockchain architecture is a network of nodes. Each node has same or defined rights for corresponding transactions to be executed as approval of all relevant nodes. All the information about accomplished or non-ended transactions are maintained in all relevant nodes in chains of blocks. Any manipulation such as creation of updating of a transaction needs to be approved by relevant nodes/participants with their cryptography (ID and KEY). In this way, the transaction is executed and the registry (ledger) is updated in a safe way without a central authority. Even if a node disappears or quits from the system, the registry and track of transaction is safely maintained in the blockchain.

Blockchain Database (BCDB) have the characteristics such as decentralization, immutability and management of any object as a registered asset. A blockchain transaction is not completed, unless all relevant nodes approve it. The blockchain technology comes with a trade-off between redundancy and safety of transactions. Decentralization is employed such that a node only stores the KEYs of other nodes which allows, thus every node keeps a registry of KEYs but not all.

3.2. Blockchain and Its Use for Boundary Surveys in Cadastre

Almost all, -but limited number- of previous studies and applications are using blockchain for transactions of land registry. Although, the aim of various efforts is different than each other, the common goal is digitization of multistep and long procedures without losing any information in the time-trace of land registry transactions. The secondary goal is executing the property transactions under eye-watch of certified authorities as well as all participants whereas the government applications are not so trustable.

Cadastre observations are providing the base geospatial information and information and location about the general boundary. Both the surveying and stake out surveying are data source of land registry. The registrar makes the decision based on the information collected by the certified surveyor in the field about area, general boundary, physical and usage features about the property.

Along with the technical and scientific problems and considerations in cadastre survey such as datum transformations, conversion between coordinate systems, considering consequences of plate tectonics, QC/QA of surveying, the quality control and quality assurance regarding the exact compliance with the regulations is

These kinds of problems could be prevented by using blockchain DB. Since the number of participants and data content changes, the DB has to be scalable, and supporting real-time transactions and pushing relevant data to the interested parties on the web which are not common specifications of the traditional database architectures where the architecture is built on user access, efficiency, consistency and analytical capability.

As BCDB can store, manage and manipulate any kind of data, it is particularly useful for asset transaction under authority of multiple parties within a common decision base. The following are some of the specifications of BCDB relevant with cadastre data surveying and recording.

- Transactions for an asset are created by none/one or many participants in the BCDB.
- The types of transactions are ‘create’ and ‘transfer’.

- ‘Deletion’ is generally not applicable in BCDB transactions.
- The assets are attributed and defined as non-dissolved, non-divisible as well as divisible.
- Transactions of an asset could be performed by mutual policy defined by the owners.
- The authorization could consist cryptographically sign due to asset definition.
- The transaction is verified as the conditions are satisfied due to definition of the asset.
- Any double-transaction is prevented.
- All the information related with an asset in a timeline and time trace are all preserved in the registry.

3.3. The Data and Methods

3.3.1. Introducing the Data and Problem: Boundary Dispute, Two Physical Boundaries

The ‘Base Cadastre’ due to Law#3402, had been conducted in 2004, after first cadastral surveys in 1982. The surveys in 2004 updating process comprises digitization of old cadastre maps, datum transformation and re-measuring the physical boundaries as well as staking the existing boundary out the field, if the boundary has no physical reference. Starting from 2016, cadastral surveys so called ‘Updating Cadastre due to Law #3402 Item 22-A’ planned for execution.

The parcels xxxx/4 (The parcel numbers are not given by intention) and xxxx/5 have a common physical boundary – a stone wall- and a shared graphic representation in the cadastre data during base cadastre campaign conducted in 1982, (Figure 1.a and Figure 1.b). This boundary has been approved by the landowners at both sides of the bounding edge, namely xxxx/4 and xxxx/5. When the landowner of xxxx/5 passed away, the property sold to third party whom asked a certified surveyor to stake-out his land’s boundary. The concrete-metal fence has been built after the newly field measurement. The distance between two boundaries is 60 cm’s.

The change in boundary with 60 cm, cause a difference of 21 m2 for the parcel for a total area of 525 m2, where the error limit (clearance) is 9.6 m2 (= 0.00042 x scale x SQRT (area)), due to error threshold in cadastre applications.

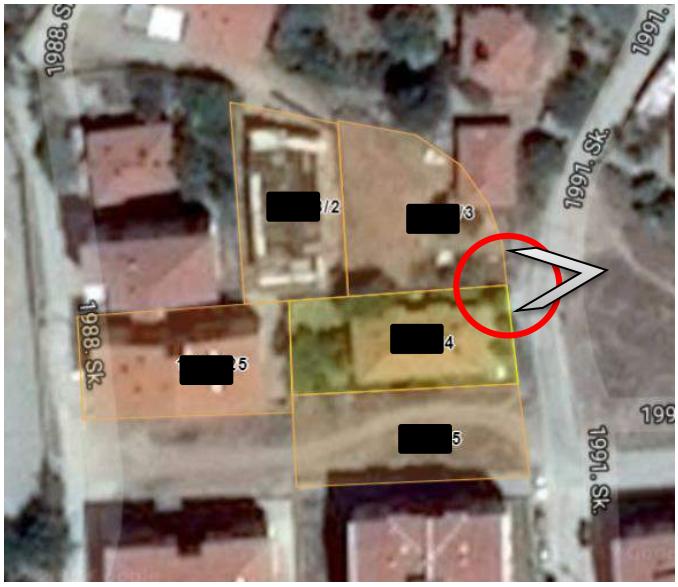

Figure 1.a: Parcel Boundary (General Boundary)

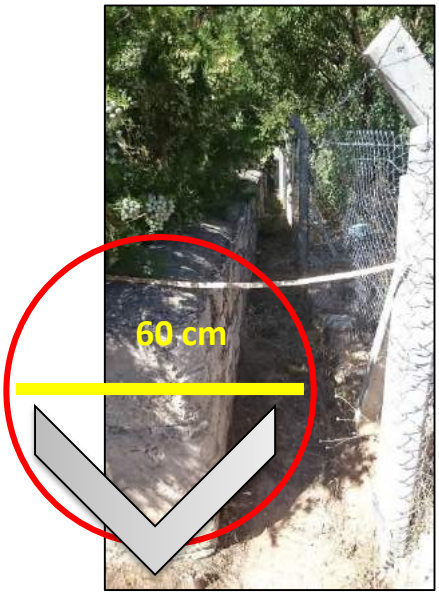

Figure 1.b: Gap Between Two Parcel Boundaries

3.3.2. A Use Case: Cadastral Survey for a Boundary

In order to prevent dispute cases regarding multiple physical boundaries, the cadastre surveys need to be handled by approval of the participants. To handle such a problem, the rights and approval authorization for data registration and updating are made possible by means of a CAD/GIS data structures which keeps a registry (ledger) of transactions that are shared among multiple partners in a distributed network of computers. This model is called ‘Blockchain’. In the Blockchain framework, the partners can manipulate (add, update, delete) the registry and data in a secure way without the need for a central authority by using authorization right and using cryptography. In Blockchain model, the individuals could be enabled to access and manipulated the data whereas they are authorized along with public institutions (Bal, 2017; Dinh et.al., 2017; English et.al., 2016; Bartosh, 2012).

A use case of cadastral survey for a boundary is given in Figure 2, whereas there are four stakeholders on the property. The land registry and cadastre are authoritative and trusted nodes in the use case. The landowners having shared boundaries have approval rights for the transaction. The certified surveyor is not presented here because it has been

assumed in cadastre. In the use case, one of the owners start the transaction, as cadastral survey is approved by both owners, the outcome is registered in the land registry book. In case of a dispute, the transaction could not be ended. In case of non-finalized transactions, the data is stored however nothing changes in the state.

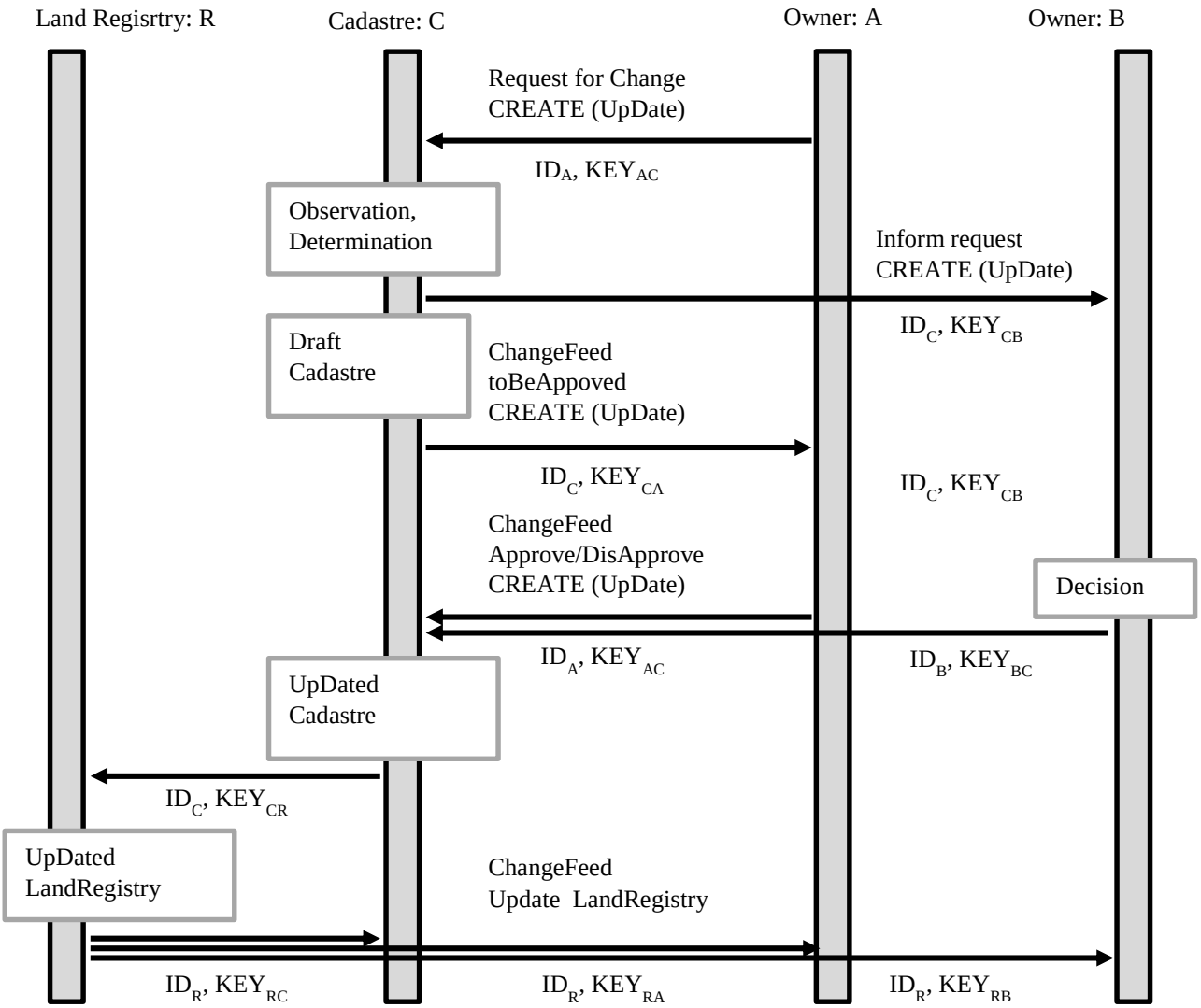

Figure 2: A Use case for LR and Cadastre data transaction

3.3.3. Methodology: Architecture of Blockchain Cadastre Database and Data Processing

There are three components which are loosely coupled, namely 'blockchain database', 'middleware' and 'GIS/CAD', in the proposed geodata enabled blockchain model.

In the proposed architecture, there are three main components in a Land Registry and Cadastre (LR&C) Blockchain (BC) Node, given below. Brief explanation about the functionality of the components described below.

Land Registry and Cadastre (LR&C) Blockchain Database (LR&C BC Database): This component handles the communication and trace of transactions.

The LR&C BC DB is designed in three layers. These layers are

- The LR&C BC Application: The application provides an interface for all the users such that the transactions are performed at three levels, namely 'institutional', 'landowner' and 'geometry'.
- The LR&C BC Transaction Engine Model comprises three sub models namely 'LR&C BC Engine', 'LR&C Data Model', 'Community Consensus'
- Blockchain Infrastructure: The computational infrastructure of the BC model is based on three levels and communication protocols between the levels, namely Ubuntu as operating system, RethinkDB as DBMS and BigchainDB as BC database instance.

LR&C Transactions Middleware (Python) : This component Synchronizes the 'LR&C BC DB' and 'Temporal GIS/CAD Engine for LR&C Transactions' and Maintains Common Registry (Ledger) and handles a lossless geo and non-geo data transaction.

Spatio-temporal GIS/CAD Engine for Land Registry and Cadastre Blockchain Transactions (GIS/CAD Engine for LR&C BC Transactions): This component handles the geometrical part of cadastre survey with two sub components; GIS for management and decision support and CAD for storing and managing high accuracy geo-data.

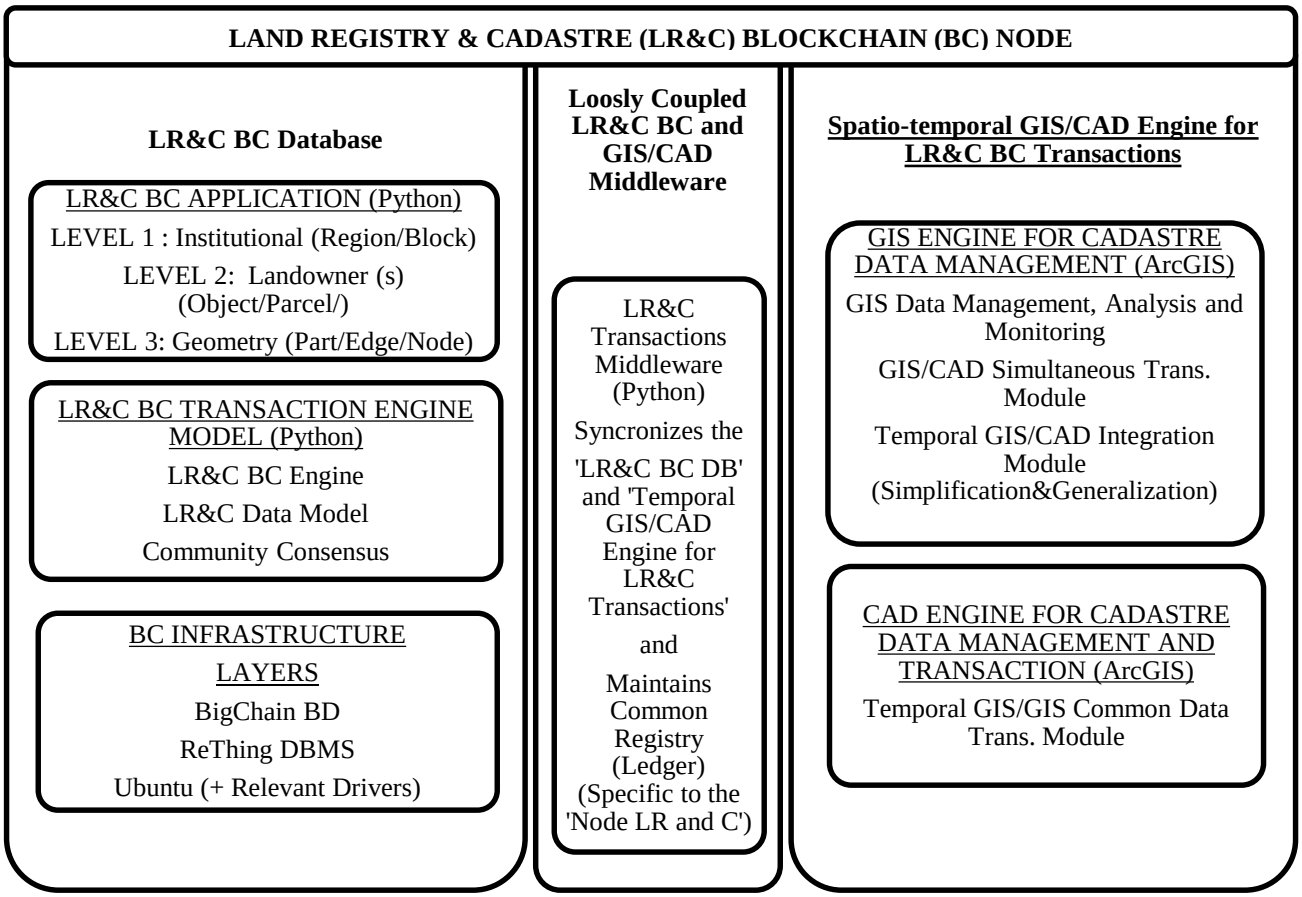

Figure 3: Architecture for Land Registry and Cadastre (LR&C) Blockchain (BC) Node

In the LR&C BC Database component of blockchain architecture, there are three levels in a hierarchy to control and mutually decide on any transaction by approval of relevant participants in accordance with the land registry and cadastre organization as a trusted node watching the procedures. Each node has to have all components unless the community members decide in another way. For instance, the individual land owners need not to have the GIS/CAD component as a whole, despite other institutions which produce cadastre data such as ‘As is Map/Plan’.

4. Designing and Implementing GIS/CAD Component of Blockchain Architecture for Cadastre

The ‘Spatio-temporal GIS/CAD Engine’ has the functionality of ‘GIS Engine for Cadastre Data Management’ and ‘CAD Engine for Cadastre Data Management and Transaction’. The GIS module handles all data management such as approving a cadastre transaction, managing the changes in temporal geospatial databases with linked CAD data, booking and watching time traces of assets among others. The CAD module is responsible for performing the geometric part of the transaction unless the GIS module approves.

Implementation of the cadastre transaction in a geo-data structure and a geodatabase in blockchain environment are presented in Figure 4. The realization of the physical model is accomplished in ESRI ArcGIS programming environment. The communication between the GIS/CAD module and the other components are handled by using tokens and triggers.

4.1. Designing a Geodata Transaction in Spatio-Temporal GIS/CAD Engine: Geodata Transaction at Data Set (Database) Level in Blockchain

The blockchain database transaction at data class (a data class consists of same kind of data (features)) level in a geo-database is handled as depicted in Figure 4. The geo-transaction is handled as follows;

- At epoch ti , the geometries of two parcels are at stable state.
- As, the landowner 'A' of parcel 'N1' at node 'Nm' require an update, the draft geometries of the parcels are stored in a temporal data class where relevant data is prepared to update the parcels in case of approval by all parties. The parcel 'N1' is extended and kept in a separate data class so as the shrinking parcel 'N2', whereas these parcels are labeled as '#N1' and '#N2' respectively.
- As all the relevant parties approves the transaction, the new state of the parcels are replaced with the old one in the current data class. In parallel process, the parcels at previous stage and the data created at update level are all stored in the 'Data Class (Historical Trace)'.

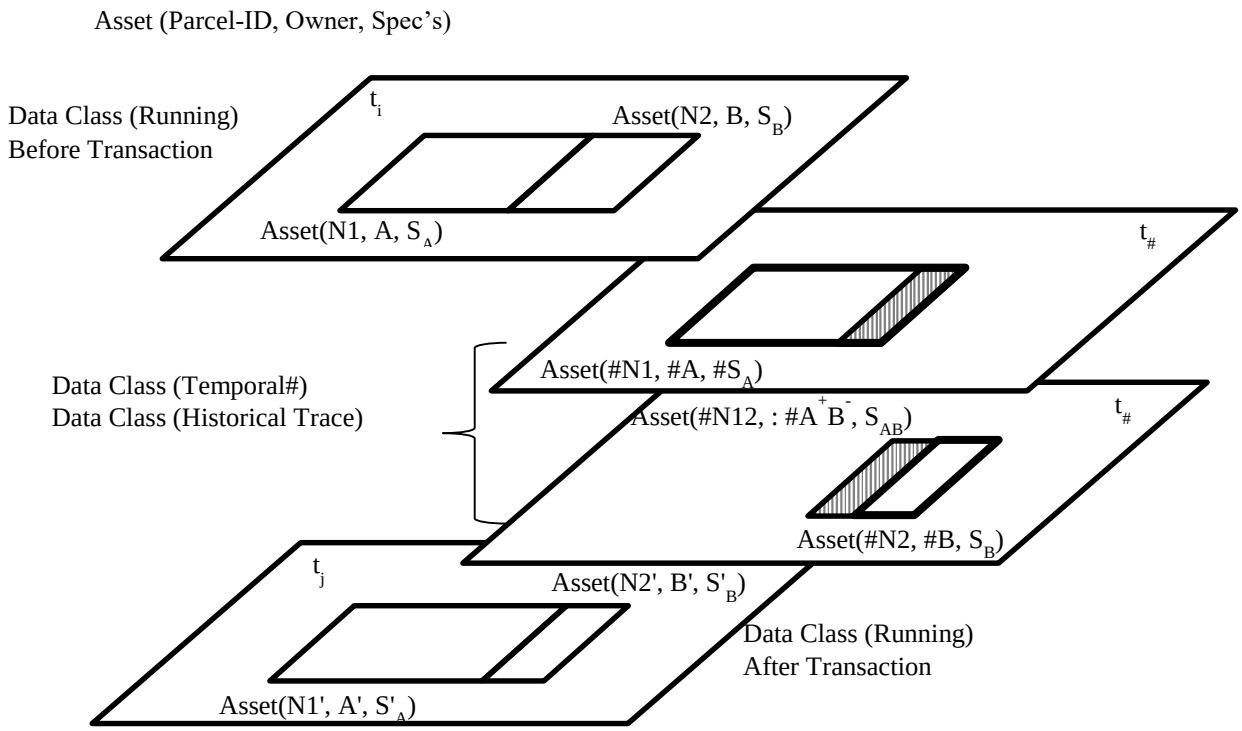

Figure 4. GIS/CAD Data Classes in BC Geo-Database to support geometric data transaction

4.2. Process-Flow of Blockchain Cadastre (Editing)Transaction System – BCCTS

Figure 5 depicts the process flow and data flow in the implemented BC Cadastre (Editing) Transaction System. Any user interacts with the BC Cadastre Transaction System (BCCTS) via the same interface by means of 'KEY' and 'ID'. The users are only allowed to start/request a transaction, access the data or any other given privileges through the 'Current Data'. Started transactions are maintained in 'Temporal Data' until all relevant parties perform their role and approve the transaction within a given time period or given conditions. Another transaction cannot be started for the same entity, unless the current one is finalized or the transaction is dropped due to a rule of 'BC Community'. In any case; either successfully finalized or dropped, all data is transferred into the 'Archive Data' to be stored. In the prototype, the temporal and archive data are stored in the same physical repository. Eventually, all data in archive is linked to the property that is currently in use. Any data in the 'Archive Data' is bound to a transaction by means of transaction ID which uniquely identifies participants, time track as well as all the previous and next state of the entity. Besides, the BC GeoDatabase maintains all text and geodata during the process of interaction. The geometries are stored as in GeoJSON format with a link to the database. As any user requests a previous geometry, the GeoJSON data is converted into a feature that ArcGIS can process by using the library of NewtonSoft.JSON.

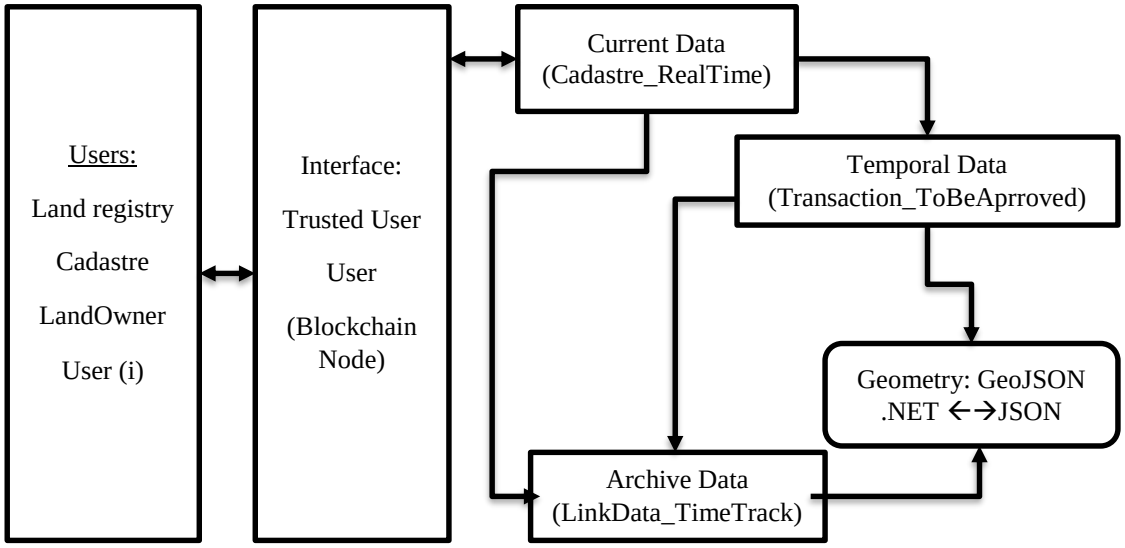

Figure 5: Blockchain Cadastre (Editing)Transaction System – BCCTS

4.3. Implementing Geodata Transaction in BC Spatio-Temporal GIS Engine

In Figure 6, the request for geometry change (boundary change) by a user and the proposed new geometry along with the previous old geometries are accessible by relevant users for approval. As all the parties approve the transaction, the approved geometry is transferred into the current data. In Figure 6, the red boundary represents the neighboring parcel, whereas the black boundary is the initial state of the parcel subject to transaction. The green (selected) polygon is one of the proposed change where the hatched green polygon with vertices is the second proposal for change. Both proposals are maintained in the dataset. As the trusted authority approves one of the proposals, the transaction is set and the new state of the parcel replaces the current state (black boundary). The current state, the proposals and any other geometry changes are all moved to the 'archive dataset'.

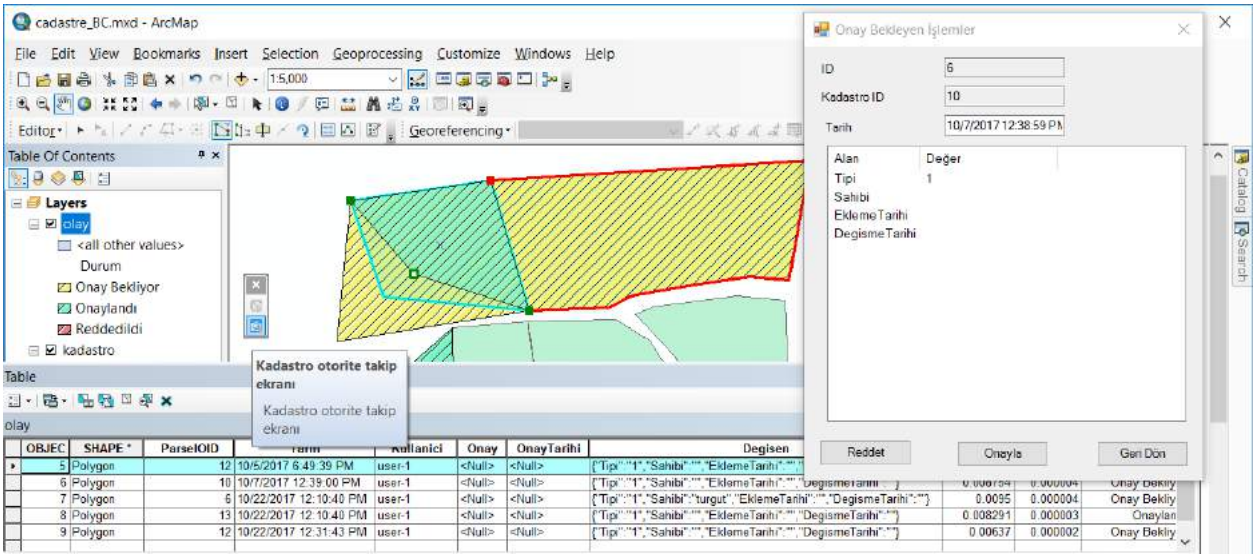

Figure 6: The Transaction Process for Approval

4.4. The Technology Used for Implementation

The prototype BC geo database has been developed on ESRI ArcGIS by using C# and libraries of ArcObjects COM components. The ESRI ArcObjects SDK for .NET has been used to code this application. ArcGIS GeoDatabase is designed to support the integrity conditions defined in the use case. As the scope of this paper is, developing a prototype to perform geodata transaction to prevent boundary errors, the non-relevant cadastre information is not modeled in the geodatabase. The interface is realized as an ArcGIS toolbox. The state of an entity, information about transactions are

stored in JSON, the temporal and archived geometries are stored in GeoJSON and current state of the geometries are stored in physical data set. Although this model seems a bit complex, this approach enables the system to maintain non-atomic, multi-level, multi-characteristics data as a manageable package. The conversion of attribute values in the ArcGIS geodatabase into JSON, the open source DLL, NewtonSoft.JSON is used. The NewtonSoft.JSON serializer converts types of .NET and types of JSON, in between.

5. Evaluation and Conclusions

5.1. Evaluation

Evaluation from Economical and Legislative Point of View

The cost of at base cadastre campaign and cadastre updating survey are USD 34.0 and USD 12.0. Cost of a stake-out survey by certified surveyor is about USD 200-250 USD and cost of a court case which takes about three years is about 3000 USD, if the court is not busy and stocked with court cases. These costs have been given, how the cost of determining boundary of a parcel, unless the cadastre surveys are conducted with qualified teams, with all relevant partners among others. Nevertheless, technical personnel of the local cadastre organizations are very much engaged in the requirements of expertise from the cadastre courts to conduct field work or submit technical report.

Although the initial costs are very low, the succeeding costs for re-measurement by a certified surveyor is about 8 times more, eventually the cost of a court case is about 100 times costly in case there exist a kind of dispute caused by low quality cadastral survey.

Based on the legislation in the Turkish Civil Code which reads as ‘booking and maintaining register is under guarantee of the State’, the courts including the Constitutional Court, consider the land registry and cadastre as separate tasks and any mistakes in cadastre survey is not under responsibility of the State. The courts assume the land owners to have to know the area and boundary during transactions. In this respect, courts and Constitutional Court evaluated and made decisions about the cases that argue the responsibility of the State for cadastre surveys.

Evaluation from the Point of Cadastre Survey and Cadastre System

There are two physical boundaries in the field although there is unique in cadastre data, in the given case study. The physical boundary demarked with the stone wall is due to the cadastre works in 1982, on the other hand, the boundary demarked with metal fence is result of a stake out survey based on 2004 cadastre survey. This situation, indeed, can be extended through all parcels in the neighborhood and most probably in the whole town.

Besides the technical, legal problems of Turkish Cadastre including the initialization started by unnecessarily detailed Law # 3402 and over-integration of Cadastre and Land registry under the same roof despite other examples of cadastre organizations from German tradition.

There are several reasons of the case studied in this paper. Main causes of this occasion are; these are The efficiency considerations in the ‘base cadastre survey campaign’, the quality of cadastre processes, the over tightly integrated structure of the cadastre organization, the unnecessarily detailed and over-intervening characteristic into cadastre survey and implementations of the Law # 3402.

Evaluation from the Point of Modern User Requirements

There is increasing demand for precise cadastre data for many purposes including smart cities, digitalization of urban management, autonomous car navigation among others. The data created in first ‘Base Cadastre Data’ for planning, land development, urbanization, farming among others as well the ‘New Base Cadastre Data’ have already been used by many institutions, individuals Thus there is a dual, triple existence of data such that; ‘the base cadastre data’, ‘the update’ and ‘the date created by other institutions for a particular project’.

In the ‘digitalization’ era, the user of cadastral data are machines but not human; such as ‘navigation engine in a car’. In this environment of the ‘to-be-digitalized World’, the owners of data are no more centralized, data from multiple sources has to be reconciled for accurate decision making where a new data sharing, de-centralized data approving, quality assurance and data delivery model and mechanism needed. Besides, democratization and decentralization of spatial data among multiple institutes and even individuals compel the Global Cadastre Community to search, find and realize new approaches where ‘data owner is the king’.

5.2. Conclusions

In this paper, we have introduced a case study of two physical boundaries belonging to an identical cadastre boundary data. This particular dispute case could only be resolved in a cadastre court after one of the landowners claim for unification of the physical boundary. Meantime, we have given the cost of a parcel survey at base cadastre survey campaign, in the updating process, a survey service provided by a certified surveyor and an average cost of a court case, to give the reader how the cost exponentially increases, unless a careful cadastre process implemented. Finally, we have

proposed a system designed on blockchain technology to prevent mistakes in cadastre survey and booking pahases where the landowners are participating as an equal partner in the cadastre survey and decision making process.

The 'GIS Engine for Cadastre Data Management' part of the 'Spatio-temporal GIS/CAD Engine' component of Land Registry & Cadastre (LR&C) Blockchain (BC) Node is designed and implemented. The GIS module handles all aspects of geometry of cadastral parcel and survey and data management such as approving a cadastre transaction, managing the changes in temporal geospatial databases with linked CAD data, booking and watching time traces of assets among others.

This study gives design and the implementation of 'the GIS part' of the component based on a given use-case which manages the geometry part of the BC transaction in the systems. In this respect the following has been designed and implemented;

- Architecture of the Node of Blockchain Cadastre Database (BCCD) and Data Processing having three components namely 'blockchain database', 'middleware' and 'GIS/CAD', is designed and the 'GIS/CAD' component is realized.
- The design and implementation of process flow and data flow are accomplished of the BC Cadastre (Editing) Transaction System.
- The realization of the physical model of BC geo database is accomplished by using C# and ESRI ArcObjects SDK for .NET and libraries of ArcObjects COM components.
- An open library of NewtonSoft.JSON is used for converting non-atomic attributes of text and geodata between .NET and JSON) GeoJSON.

This study is pioneering to use blockchain technology to minimize the surveying problems caused by incautious considerations and application of cadastral regulations at surveying and data manipulation phases where the landowners are regarded as equity partners in mutual decision making. In the proposed framework, the current authority and hegemony of the organization for cadastre and land registry is considerably limited for the sake of landowners. In this respect, although the time/money efficiency of cadastral survey may decline considerably, the quality of the cadastre data and appreciation of landowners be increased by avoiding costs of court cases.

The international surveying society-FIG, UN-GGIM, World Bank and international branches of national cadastre and land registry organizations have been helping developing and low-developed countries of which land administration is non existing at a rate of 70% for decades. The aid from the developed countries, societies and international organizations have been appreciation, though they might not goal the real problems due to lack of knowledge on cultural, traditional, historical, legislative, socio-economic issues. Despite great efforts from the international societies towards the developing countries, the goals are not easily accomplished.

The case study in this paper is a clear example of problem characteristics in a developing country, Turkey where huge investments has been oriented for better cadastre and better land management in the era of digitalization and smart countries. Eventually, a 'Hierarchical Blockchain Architecture for a Relaxed Hegemony on Cadastre Data Management' is presented that aims at both solving a particular problem of multiple physical boundaries for an identical cadastral boundary data and for providing an approach to introduce the land owners into the core of cadastral decision making in the environment of open-data-policy, decentralization and democratization of geospatial data

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References

Bal, M. (2017), *Securing Property Rights in India through Distributed Ledger Technology,* ORF Occasional Paper # 105 January 2017

Bartosh, C.D. (2012), *Integrating Land Survey Data into Measurement-Based GIS: An Assessment of Challenges and Practical Solutions for Surveyors in Texas*, MSc. Thesis, Faculty of The USC Graduate School University of Southern California

Cete, M. (2014), *An Analysis of the Turkish Cadastre in View of the Cadastre 2014 Vision*, FIG Working Week 2015, Sofia, Bulgaria, 17-21 May 2015

Chachkhunashvili, S. (2016), *Using Blockchain Technology for Land Registration - National Agency of Public Registry NAPR*, Georgia, Report of Joint Conference EuroGeographics-CLRKEN, PCC, EULIS, Bratislava, 2016

Demir,O., B. Uzun and M. Çete (2008), *Turkish Cadastral System,* Survey Review, 40, 307 pp.54-66 (January 2008)

Dijkstra, P., C Lemmen, A De-Boer, E M Unger (2015), *Surveying the Future: Mapping the Bitcoins*, FIG Working Week, Young Surveyors Session. file:///C:/Users/Administrator/Downloads/FIGWW2015_ys_dijkstra_lemmen_deboer_unger_bitcoins.pdf

Dinh, T.T.A. , R. Liu, M. Zhang, G. Chen, B.C.Ooi, J. Wang (2017), *Untangling Blockchain: A Data Processing View of Blockchain Systems*, arXiv:1708.05665 [cs.DB]

English, M.S. Auer, J. Domingue (2016), *Block Chain Technologies & The Semantic Web: A Framework for Symbiotic Development*, http://cscubs.cs.uni-bonn.de/2016/proceedings/paper-10.pdf, Accessed Sept_09 2017

Fetai, B. (2015), *Analysing the Effects of Merging Land registration and Cadastre,* MSc Thesis, the Faculty of Geo-Information and Earth Observation of the University of Twente, March 2015, Enschede, the Netherlands,

FIG (2017), *CADASTRE 2014 and Beyond*, FIG Publication No:61, http://www.fig.net/resources/publications/figpub/pub61/Figpub61.pdf, Accessed Sept_09 2017, Accessed Sept_09 2017

GIM (2007), *Registry and Cadastre Under One Roof, Turkish Cadastral Organisation*, GIM International, https://www.gim-international.com/content/article/turkish-cadastral-organisation, Accessed Sept_09 2017

Gundelsweileri, G., T. Bartoschek, L.A.C. Marques de Sá (2007), *Development in The German Cadastre*, Bol. Ciênc. Geod., sec. Comunicações, Curitiba, v. 13, no 2, p.423-432, jul-dez, 2007.

Gruber, U., J. Riecken, M. Seifert (2014), *Germany on the Way to 3D-Cadastre*, 139. Jg. 4/2014 zfv, DOI 10.12902/zfv-0028-2014, Fachbeitrag

ISO 19152 (2012), *Geographic information — Land Administration Domain Model (LADM),* International Standard, First Edition, 2012-12-01

Jones, B., N. Land (2012), *Cadastre 2.0 – A technology vision for the cadastre of the future,* FIG Working Week 2012, Rome, Italy, 6-10 May 2012

Kaya, S. (2003), *Dünya Bankası ve Dünya Bankası Kredilerinin Denetimi,* Sayıştay Başkanlığı, Araştırma Raporu

Lantmateriet-Sweden (2016), *The Land Registry in the blockchain: A development project with Lantmäteriet (The Swedish Mapping, cadastre and land registration authority),* Telia Company, ChromaWay and Kairos Future, July 2016,

Louwman, W. (2017), *Advantages and Disadvantages of a Merger Organization: The Case of the Kadaster-Netherlands*, 2017 World Bank Conference on Land and Poverty", The World Bank - Washington DC, March 20-24, 2017

Sarı, N.İ (2017), *22/a Uygulamasi Nedir? Ne Değildir? Sorunlar Ve Çözüm Önerileri*, İzmir Kadastro Md.lüğü, http://www.izmirkadastro.gov.tr/User_Files/dokumanlar/22a_uygulamasi_sorunlari.pdf

TKGM (1987), *3402 Sayılı Kadastro Kanunu*

TKGM (2008), *Turkey Land Registration and Cadastre Modernization Project (P106284)*, The World Bank

TKGM (2016), *Additional Financing for Land Registry and Cadastre Modernization Project, World Bank Loan Agreement No 8541-TR,* http://documents.worldbank.org/curated/en/990601500026396525/pdf/TU-85410-AF-Land-Registry-and-Cadastre-2016-Audit-report.pdf, Accessed Sept_09 2017

TKGM (2017_1), *Tesis Kadastrosunun Bitirilmesi Projesi,* https://www.tkgm.gov.tr/tr/icerik/tesis-kadastrosunun-bitirilmesi-projesi , Accessed Sept_09 2017

TKGM (2017_2), *MEGSIS Performans Çizelgesi,* https://cbs.tkgm.gov.tr/istatistik.aspx, Accessed Sept_09 2017

Toker, N.K (2016), *Kadastro Mevzuatı, 2016*, Tapu ve Kadastro Genel Müdürlüğü, Kadastro Dairesi Başkanlığı

Reference: UNDESA (2017), *World Population Prospects,The 2017 Revision, Key Findings and Advance Tables*, Department of Economic and Social Affairs Population Division, Report ESA/P/WP/248, Newyork 2017

Yaşayan A., H. Erkan, S. G Seylam (2011), *Kadastro Kavramı ve Türkiye Kadastrosu*, TMMOB HKMO 13. Türkiye Harita Bilimsel ve Teknik Kurultayı, Nisan 2011, Ankara

Vos, J. (2016), *Blockchain-Based Land Registry: Panacea, Illusion or Something in Between? Legal interference of Registrars in the e -conveyancing process,* 7th Publication, European Land Registry Association (ELRA)

Management of Estate with "Business Process Management" and Geographic Information Systems Integration

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Abstract

According to the regulation about recording of Public Institutions' estates, the Institutions have to record and report their estates [1]. Estates are constantly changing in terms of geometry, feature and ownership. Therefore, Public Institutions need to record and manage their current estates. They need estate management software that enables them to manage their data with different access levels for different departments. By using the software, not only the record but also the rental, selling, allocation and conveyancing businesses can be managed.

Keywords
Estate Information System, Business Process Management, Geographic Information System

1. Introduction

Kocaeli Metropolitan Municipality, one of the Public Institutions that needs to manage their estate records, have been using a web based Geographic Information System(GIS) and Business Process Management (BPM) software which has been developed by Netcad Software Co. to satisfy the management issues. Department of Estate and Expropriate have been following their own workflow while they are operating about estates. Renting, selling, allocation and conveyancing are some of the operations that needs to be managed by workflows. Estates and also the operations need to be managed and to show in thematic maps. Estate Information System developed as BPM integrated GIS software to manage all operations with the department's specific workflows. The software also enables the users to get thematic maps, warnings of some events and let them know what will be the next step of the work process. Users can access the data according to the authorization levels defined for them. Therefore, different departments can manage their process on database and the reports can be generated using all data. Users either get reports which related with regulation and also the other reports to how their manager.

2. Estate Information System

Location information is one of the most important part of Estate Information System (EIS). Therefore, while the software has been developing, a relational spatial database model is designed. Users can manage the database by using web based software. The software has interfaces to generate queries, show query result, look and update data. Different access levels must be specified for different persons. Therefore, while some persons can only show the data some others can also update the data.

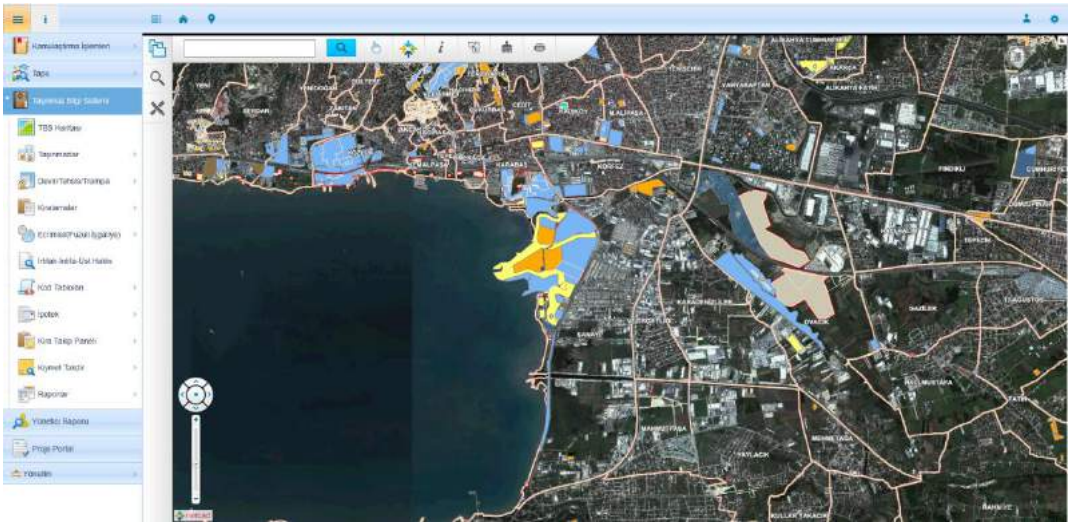

Figure 1: EIS Software Interface

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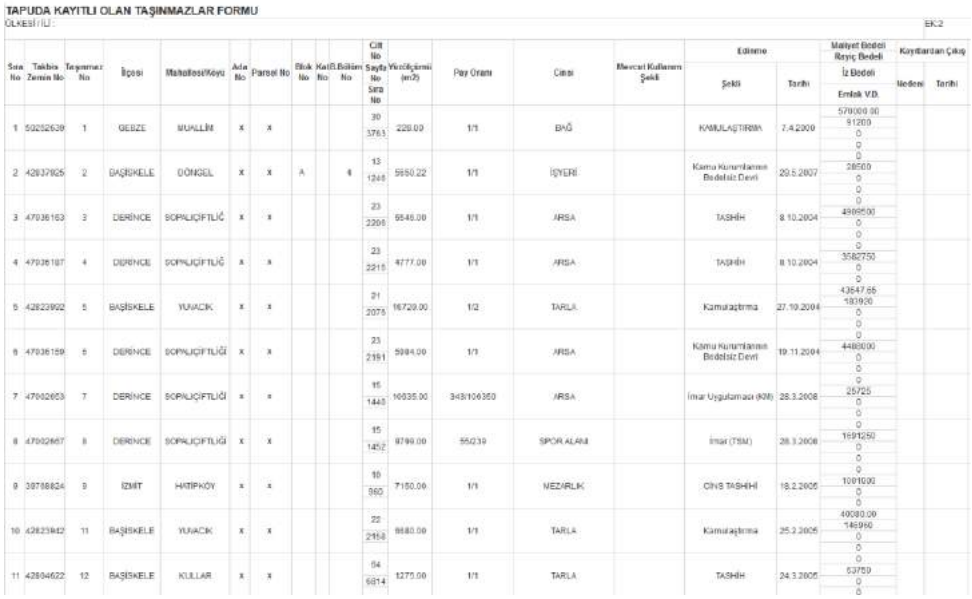
According to the regulation about recording of Public Institutions’ estates, the Institutions have to record and report their estates. Estate and Expropriate Department of Kocaeli Metropolitan Municipality can automatically report their estates according to regulation by using the software.



TAPUDA KAYITLI OLAN TAŞINMAZLAR FORMU

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2	42837925	2	BAŞİSKELE	DÜNGEL	x	x	A	4	13 1248	5550.22	1/1	İŞYERİ		Kamu Kurumlarının Bedelsiz Devri	29.5.2007	28500 0 0 0		
3	47036163	3	DERİNCE	SOPALIÇİFTLİĞİ	x	x			23 2208	9546.00	1/1	ARSA		TASHİH	8.10.2004	4909500 0 0 0		
4	47036187	4	DERİNCE	SOPALIÇİFTLİĞİ	x	x			23 2216	4777.00	1/1	ARSA		TASHİH	8.10.2004	3582750 0 0 0		
5	42823902	5	BAŞİSKELE	YUVACIK	x	x			21 2075	16729.00	1/2	TARLA		Kamulaştırma	27.10.2004	43647.66 130930 0 0 0		
6	47036159	6	DERİNCE	SOPALIÇİFTLİĞİ	x	x			23 2191	5984.00	1/1	ARSA		Kamu Kurumlarının Bedelsiz Devri	19.11.2004	4488000 0 0 0		
7	47002653	7	DERİNCE	SOPALIÇİFTLİĞİ	x	x			15 1443	10035.00	343/10035	ARSA		İmar Uygulaması (KM)	28.3.2008	25725 0 0 0		
8	47002667	8	DERİNCE	SOPALIÇİFTLİĞİ	x	x			15 1452	9799.00	55/239	SPOR ALANI		İmar (TSM)	28.3.2008	1691250 0 0 0		
9	39788824	9	İZMİT	HATIPKÖY	x	x			10 960	7150.00	1/1	NEZARLIK		CİNS TASHİHİ	18.2.2005	1001000 0 0 0		
10	42823942	11	BAŞİSKELE	YUVACIK	x	x			22 2158	9880.00	1/1	TARLA		Kamulaştırma	25.2.2005	40080.00 146960 0 0 0		
11	42804622	12	BAŞİSKELE	KULLAR	x	x			04 6814	1275.00	1/1	TARLA		TASHİH	24.3.2005	53759 0 0		

Figure 2: EK-2 Standard Regulation Report

Department of Estate and Expropriate has own workflows for operating about estates. The operations that related with estates are:

- Rental
- Selling
- Allocation
- Conveyancing
- Adequate Pay
- Occupancy
- Barter

Workflows of the department integrated on the software for each operation type. Therefore, all software users can know which step will be come for which record. Also users can generate state based query results and export them in excel or html formats.

Figure 3: Occupancy-Adequate Pay Workflow Design of Department of Estate and Expropriate

Software enables users to get warnings on map screen or query results about some criterieas that they specified before. For example, in rental operations, users can see the estates with expired contracts and less than two months to last day of contract. If the operation is rental by tender, users can see which applicant can join the tender and which one is banned for tender. Users can also use map screen to search for estates and operations directly. Map screen can show the result as geometry, thematic class and basic information of the record.

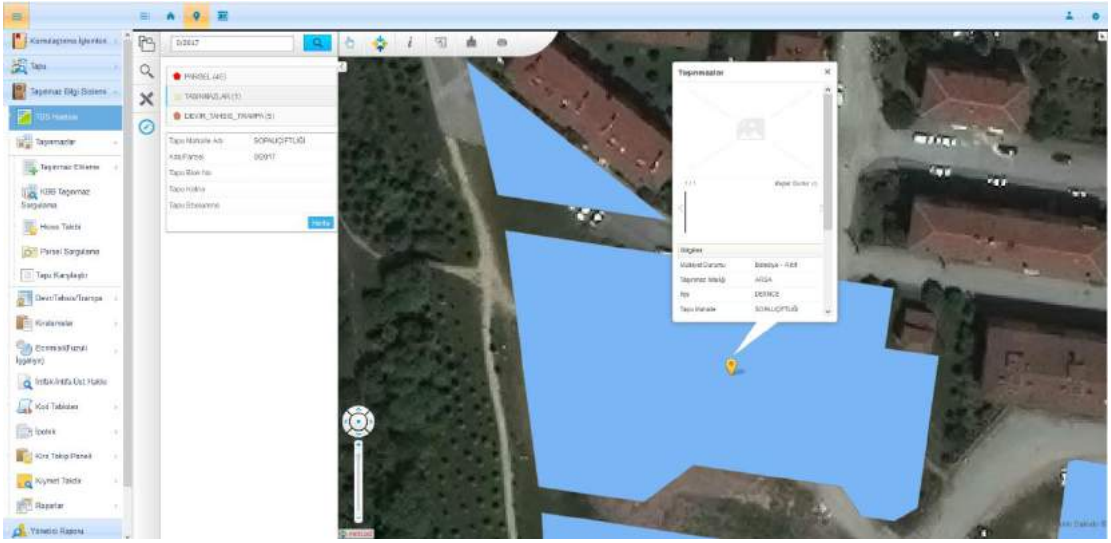

Figure 4: Map Query Screen

3. Acquirements

As a result of using of EIS software, records of the estates can be kept in database according to regulation rules. Therefore, users can get reports automatically in the format that specified by regulation. Estate and operation data is constantly being updated by responsible staffs. Thanks to the relational spatial database and current data, instant verbal or spatial queries can be made by the software. Thematic maps and reports, the outputs of the software, provide a decision support mechanism for managers.

References

[1] Kamu İdarelerine Ait Taşınmazların Kaydına İlişkin Yönetmelik, T.C. Resmi Gazete, 26307, 2/10/2006

Map-assisted elevator inspection monitoring project

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Abstract

Umraniye Municipality, which is the first municipality to achieve Class A elevator inspection certificate from Turkish Accreditation Agency and they have been launched a campaign across the district with the slogan "İn çık, in çık asansör bile yorulur". Within this scope, the elevators in the buildings located in Umraniye district are inspected and certified as compliance with standards. Umraniye Municipality has been carrying out a project that integrates with Netcad to monitor elevator inspection activities. The purpose of the project is to Show the elevators in different status thematically on the map and to reach some basic meta data via this map. Elevator compliance status associated with building door numbers using third party software and recorded in the system consist of 4 categories: Red, Yellow, Blue, Green. The unique UAVT building codes for each door number and elevator control status are stored in the database of the third-party software. Elevator data prepared with third party software can be viewed on Netcad Netgis Map Client using Netcad Netgis services.

Keywords

Netcad, Netgis, Municipality, Thematic, UAVT

1. Introduction

Map-assisted elevator inspection monitoring project is basically four-step process:

- Creating tables and views
- Creating base maps
- Loading config file of module
- Determination of user permissions

2. Creating tables and views

Tables and views were created to associate the verbal data of the third-party software company with the Netcad spatial data and display them on the map (Table 1).

Table 1: Creating tables and views

Table Name	Column Name	View Name	Column Name
Elevator	Objectid	Keos Elevator	Objectid
Elevator	Uavt code	Keos Elevator	Number of elevators
Elevator	Uavt building code	Keos Elevator	Control status
Elevator	Elevator no	Keos Elevator	Neighborhood name
Elevator	Control status	Keos Elevator	Geometry
Elevator	Validity date	Keos Elevator Building Door Number	Objectid
Elevator	Active/Passive	Keos Elevator Building Door Number	Control status
Elevator	Recording date	Keos Elevator Building Door Number	Geometry
Elevator	User name	Keos Elevator Building Door Number	Neighborhood name
Elevator	Recording status	Keos Elevator Building Door Number	Street name
Elevator	Geometry	Keos Elevator Building Door Number	Building door number

3. Creating base maps

Netcad Netgis Server Map Client was used to create and publish thematic maps according to elevator control status (Figure 1).

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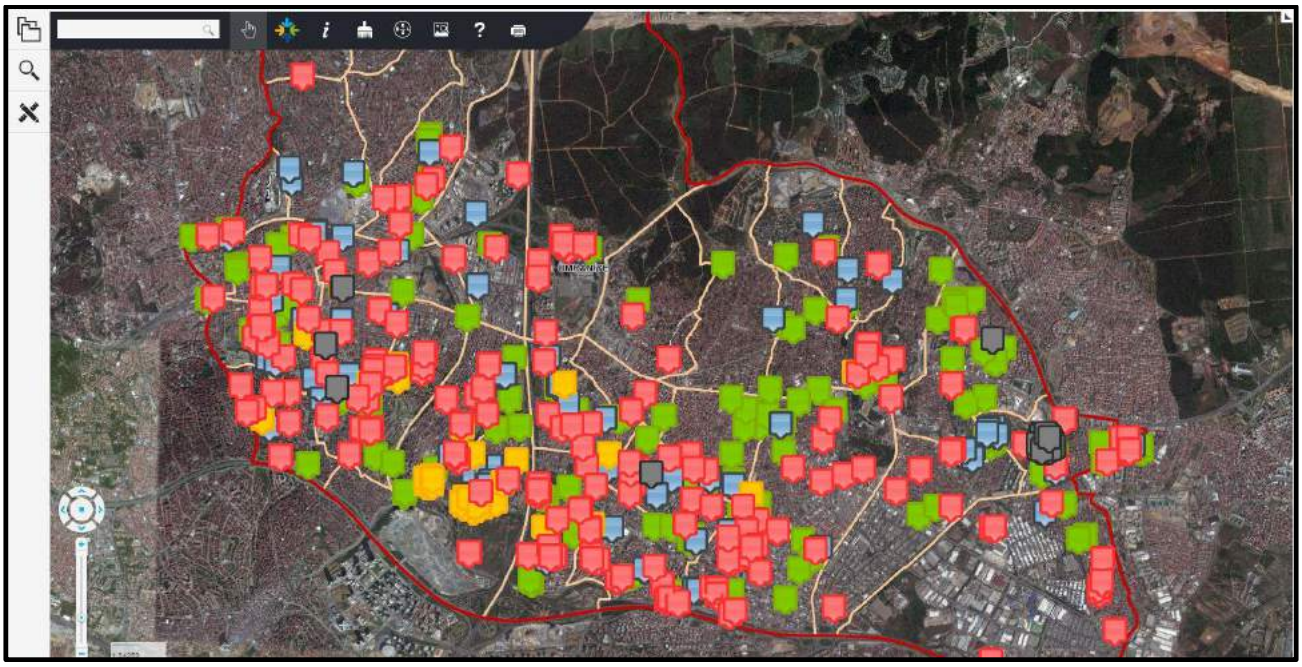
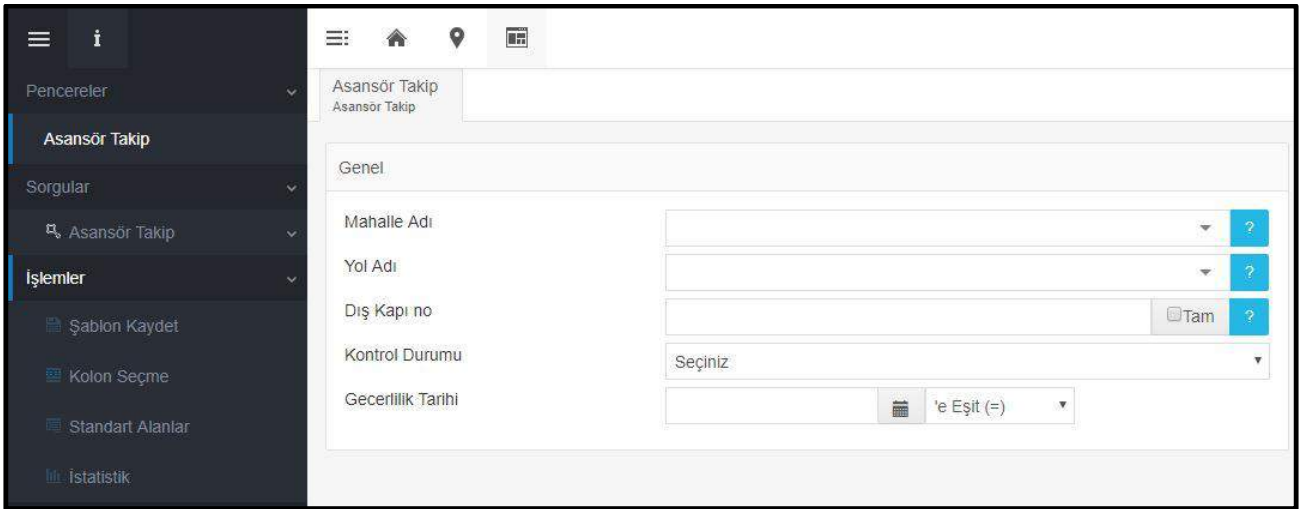


Figure 1: Thematic map by elevator control status

4. Loading config file of the module

Netcad Netigma Framework was used to create queries and thematic maps based on elevator control status, address information and control validity date (Figure 2).



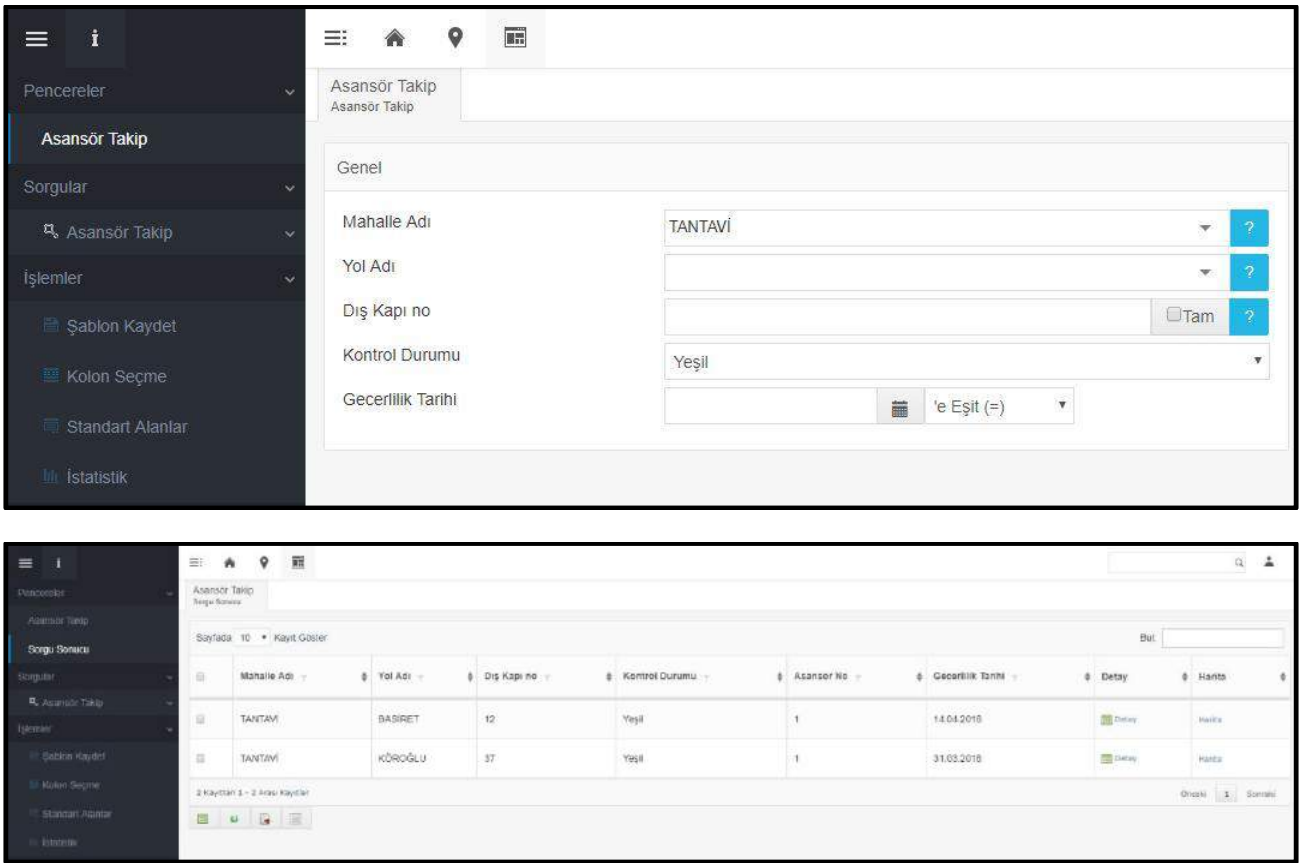


Figure 2: Address based Netigma queries

5. Conclusions

As a result of the project, according to matching door numbers, elevator control status is shown in red, yellow, blue and green colors on the map. The buildings belonging to these doors are also colored by transparent hatching according to the control status colors. Address based elevator control status can be queried with the menu created with Netcad Netigma Framework.

Acknowledgements

This project has been done with Umraniye Municipality, Netcad Software Company and Zeytun Software Company.

References

http://portal.netcad.com.tr/display/NCDN/NCDD.PUTINFOEX
http://portal.netcad.com.tr/display/NCDN/CONMAN.GETINFOEX
http://portal.netcad.com.tr/display/NCDN/NETIGMA+Ana+Sayfa

WebGIS for Archaeological Sites with Use of QGIS

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Abstract

Turkey is a large country to do historic research for archaeologists, historians, and anthropologists; our country is also a very important region for tourism. Access to information about these areas via internet based technologies and detailed inquiries will surely increase the level of knowledge and consciousness about archaeological sites. For this purpose, archaeological sites in the Lycian region, including Antalya and Muğla districts, and a system of historic places were gathered to provide quick and practical information about these areas. QGIS was used as open source software in the study. First, the selected site Patara was classified with supervised classification, and the result has been used as an additional layer. Sentinel-2 multispectral images have been used for this purpose. Several available tools for WebGIS development have been used and some examples are given. These plugins are QGIS Cloud, Qgis2Web, Web App Builder and also Apache Server (Tomcat), Geoserver, PostGIS, QGIS, Leaflet and JavaScript, Web Application Builder tool in ArcGIS Desktop and ArcGIS Online. So not only plugins for QGIS were investigated, also some for ArcGIS were also examined with the system, it is possible to search for places on the online map and to make inquiries according to certain criteria.

Keywords

WebGIS, Archaeology, Antalya, Remote Sensing, Open Source Software, Lycia

1. Introduction

Ancient places are important for understanding the history, tourism and discovering our Planet. There are a lot of historical places in Turkey which shows how our history is rich. Beside of having a rich history, the ancient sites need to be protected and transferred to the next generations. In 21. Century, the usage of internet is beneficial both for storing a big amount of data and also having any knowledge (Keeler 1995). In this work, ancient sites were identified and shared their information on the internet based system. The need of an online database is a need to explore the sites according to their location before visiting them. The researchers who work for ancient sites would also have benefit to using such system to share their knowledge with the public. In this study, we first aim to classify ancient sites for identification of the land-use around, secondly developing web-based GIS with use of several tools to show the several options for creating such system to the readers. The selected region is from Antalya and Muğla where there are a lot of ancient sites.

2. WebGIS

Geographical Information Systems based on the internet (Web GIS), is a system to publishing spatial data on internet and analyze it (Yigitcanlar 2010). WebGIS is a system which has a connection between the client and server PCs. The clients are the public, get the information easier, quicker, so it needs less labor force than traditional offline information systems.

In this work, we focus on development a WebGIS system based on several available tools to share the information about the archaeological sites, museums etc around Antalya and Muğla where the region is called as 'Lycia'.

Usually, Web GIS is a structure of Client-Server using HTTP (Hypertext Transfer Protocol) to communicate based on TCP/IP (Transmission Control Protocol/Internet Protocol). GIS uses Web Browser to send a command to the server. The server sends the results via URL (Uniform Resource Locator). A client usually uses a web browser (Aydinoglu 2002). Structure of Client-Server is shown in Figure 1.

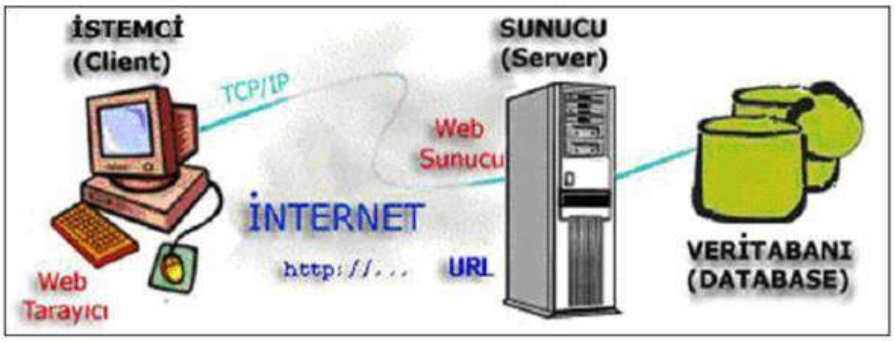

Figure 1: Structure Client-Server (Aydinoglu 2002).

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3. Study Area

The cities of Antalya and Muğla have a rich history, have hundreds of ancient sites, the hometown of many ancient Lycian cities, and also they natural beautiness. This makes the region very important for the tourism and understanding the history. The selected sites and number of visitors are listed in Table 1.

Table 1: General statistics of Museums and Ruins, the number of visits for the month of May 2015 taken from Antalya Provincial Directorate of cultural and tourism is shown (URL 1).

MUSEUM / RUINS NAME		PAID VISITORS	FREE VISITOR	TOTAL VISIT (Other Records are also Included)
MUSEUMS	ANTALYA MUSEUM	4.845	7.421	16.895
	ALANYA MUSEUM	1.032	2.124	3.372
	SIDE MUSEUM	2.413	2.601	6.196
	ELMALI MUSEUM		2.991	3.113
RUINS	ASPENDOS	8.679	9.445	39.836
	PERGE	3.758	2.319	14.117
	PHASELIS	14.568	3.092	25.028
	CHRİSTMAS FATHER MUSEUM	6.419	4.096	44.827
	ARYKANDA	639	66	852
	ALANYA CASTLE	18.328	11.046	41.357
	SIDE THEATER	9.276	5.559	18.391
	ANTALYA ATATURK HOUSE		7.480	7.840
	ALANYA ATATURK HOUSE		815	815
	MYRA	5.054	3.262	35.017
	XANTHOS	2.564	1.054	4.106
	SIMENA	2.912	64	3.951
	PATARA	6.732	2.097	11.081
	KARAIN CAVE			0
	OLYMPOS	12.642	3.153	21.474
	TERMESSOS	3.229	993	5.004
				TOTAL: 303.272

As shown in Table 1, there is a high interest in museums and ruins. Therefore, the sharing the information about these sites would be beneficial to maintain and increase the interest.

4. Application

The works start with the classification of a selected region which includes an ancient site, to show the possibility to determine the land cover map with use of remote sensing technique. For this, Patara is selected, where located in the Kaş province of Antalya. This place was the capital of Lycia. at the 3rd century BC and became the popular city of “Lycia”. At the beginning of the 2nd century AD, after Seleucid Empire started to control “Lycia”, Patara is known as the capital of “Lycia”. This became formalized in 167/68 BC when Patara won autonomy against Rome and independence against Rhodes, and Patara became the capital of the “Lycia” League. Patara has 3 of 6 vote rights so it shows how important that city is and also city has important structures like a tower, bridge, lighthouse, mausoleum, temple, theater, mayor city

hall, cistern, hamam. Remote sensing can be defined as collection information technology or science about an object, field, or natural phenomenon without direct contact with the field or natural phenomenon (Lillesand and Kiefer 1994). By using remote sensing methods, Patara Ancient City in Antalya was classified by supervised classification method and the result was transferred to the web environment. After processing, studies have reached the distribution of land cover and land use. The historical information of Antalya and Muğla regions, the attribute information used in the database;

- Isim
- Tur
- Bulundugu_Yer
- Koordinatlar
- Resim
- Onemli_Yapilar
- Ilk_Kullanim_Donemi
- Yaygin_Kullanim_Donemi
- Sona_Eris
- Onemli_Olaylar
- Kentin_Onemi
- Genel_Bilgiler

Table 2: A sample attribute table for Patara Ancient city

Isim (Name)	Patara
Tur (Kind)	Antik Kent
Bulundugu_Yer (Location)	Kas/Antalya
Koordinatlar (Coordinates)	36.261427, 29.315474
Resim (Picture)	https://drive.google.com/file/d/0B6B_a7H1J_qAdTdTVzZjUEpFNnM/view
Onemli_Yapilar (Important Structures)	Kule, Köprü, Fener, Kilise, Tiyatro, Büyük Meclis Binası, Sarnic, Hamam
Ilk_Kullanim_Donemi (First Use Period)	Helenistik Dönem
Yaygin_Kullanim_Donemi (Widespread Use Period)	Roma Dönemi
Sona_Eris	N/A
Onemli_Olaylar (Important Events)	Patara Antik Kenti İ.Ö. 3.y.y.'da Ptolemaios egemenliğine girmiştir ve bu sayede Likya'nın önder kenti olmuştur. İ.Ö. 2.y.y.'ın başlarında Likya'nın Seleukos Krallığı tarafından kontrol altına alınır ve Patara Antik Kenti Likya'nın başkenti gibi kabul görmektedir. İ.Ö.167/68 yıllarında Patara Roma'ya karşı özerkliğini ve Rhodos'a karşı ise bağımsızlığını ilan eder. Bu bağımsızlık ve özerklik ilanından sonra Patara Likya Birliğinin başkenti olmuştur (URL 2).
Kentin_Onemi (Importance an City)	Likya birliğinde üç oy hakkı olan altı kent bulunmaktadır. Patara Antik Kenti bunlardan birisi olması nedeniyle kentin önemini göstermektedir.
Genel_Bilgiler (General Information)	http://www.antalyamuzesi.gov.tr/tr/patara-orenyeri

Sentinel-2 satellite image (which include NDVI, PCA, RGB TO HIS bands on the date of 22.10.2016) used for classification of Patara Ancient City and also night light data (DMSP-OLS-2014) and digital elevation model (DEM) used as additional data. Accuracy assessment was applied on the results to calculate the quality of results. Classification and analysis process made on ERDAS Imagine software package.

The work focuses on the variants of usage several WebGIS plug-ins for QGIS and also ArcGIS. These plugins are QGIS Cloud, Qgis2Web, Web App Builder and also Apache Server (Tomcat), Geoserver, PostGIS, QGIS, Leaflet and JavaScript, Web Application Builder tool in ArcGIS Desktop and ArcGIS Online.

Apache Tomcat is used to show a web page with basic html codes without any program. Tomcat is a Java Server, that uses javascripts which needs to be configured for Tomcat's server options (URL 3). The application can be published on the internet with use of host name and domain.

4.1. Qgis2web

QGIS is as an open source software package. One of QGIS plugins is Qgis2Web which is used to create a Web Based Application. The advantage of this plugin is making a query for specific criteria from the database. Publishing of application on the internet is done by free domain and hosting services. Classification results of Patara Ancient City were added as a layer on the application. Figure 2 and Figure 3 are images from the application.

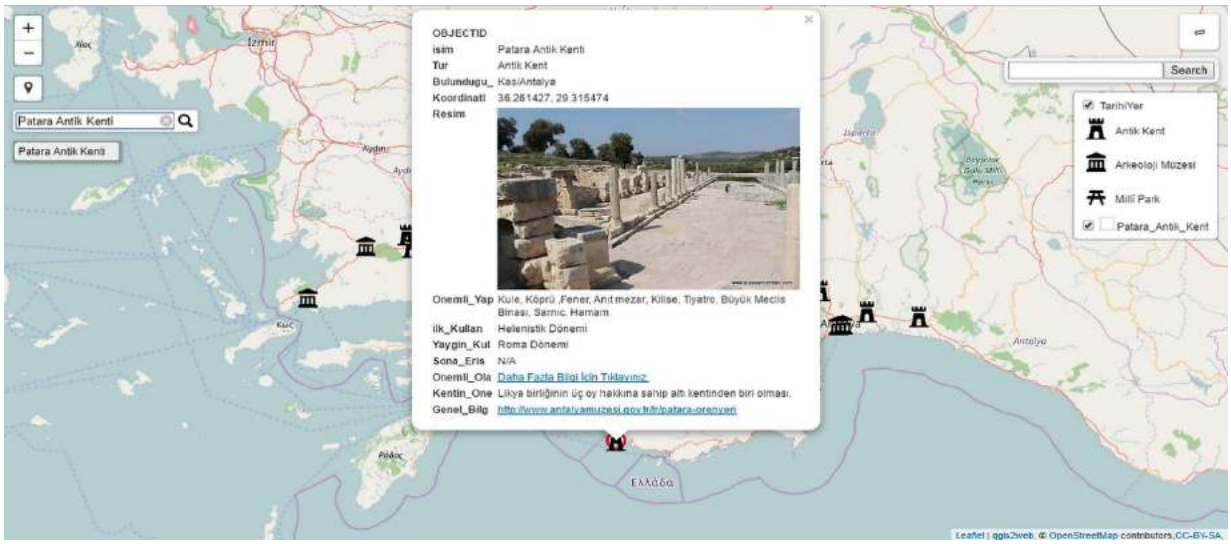

Figure 2: Image of the application made with Qgis2Web

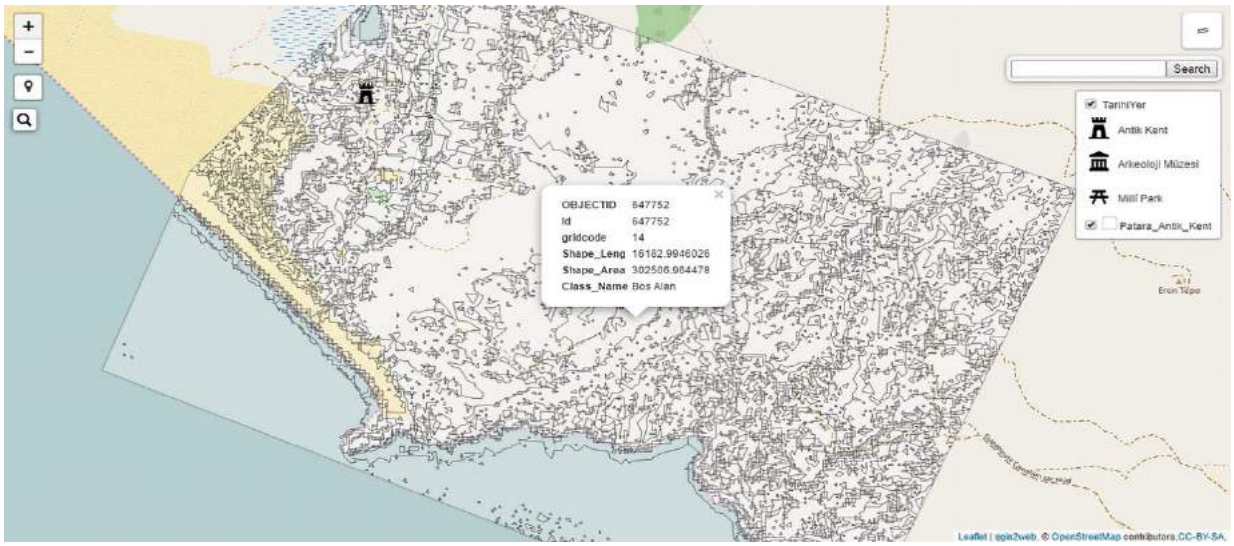

Figure 3: Image of the application made with Qgis2Web (Classification Layer)

4.2. Qgis Cloud

The second plugin used is QGUS Cloud. This application could make a query to names of historical sites but couldn't make a query from the database because it is a free plugin which doesn't contain that (In some query results there is no avaible information because that query only includes a place where application applied). In commercial version there is a query from the database, interface options, making places name which client wants. There is a limitation of usage of characters on attribute tables because of its information about historical places added as Google Drive links. Figure 4 and Figure 5 shows some sample images from the application.

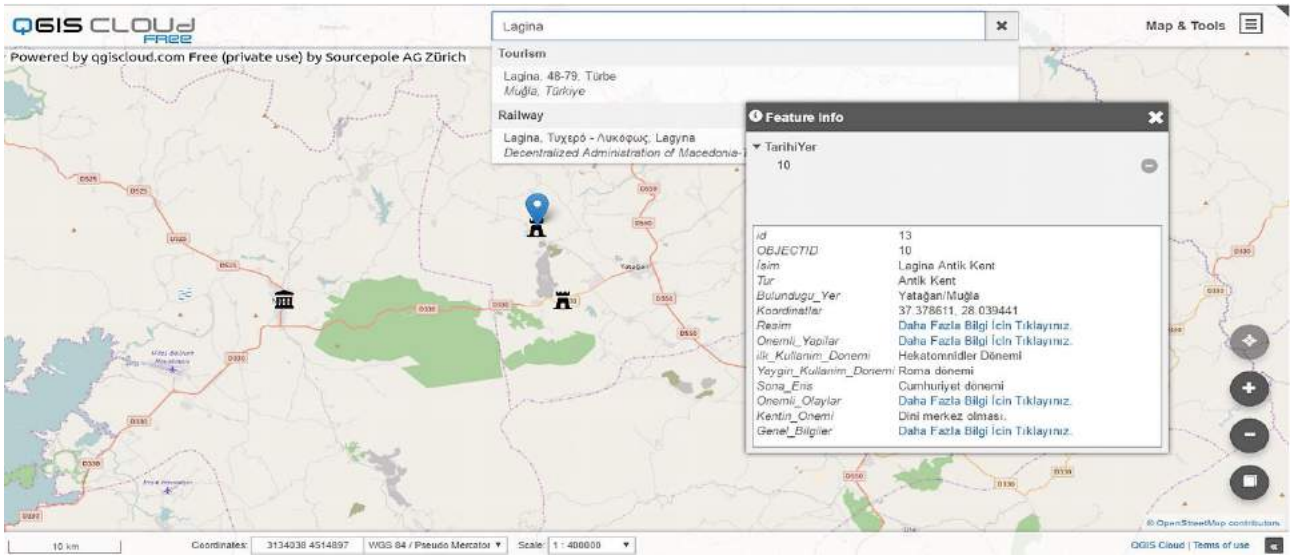

Figure 4: Image of the application made with QgisCloud

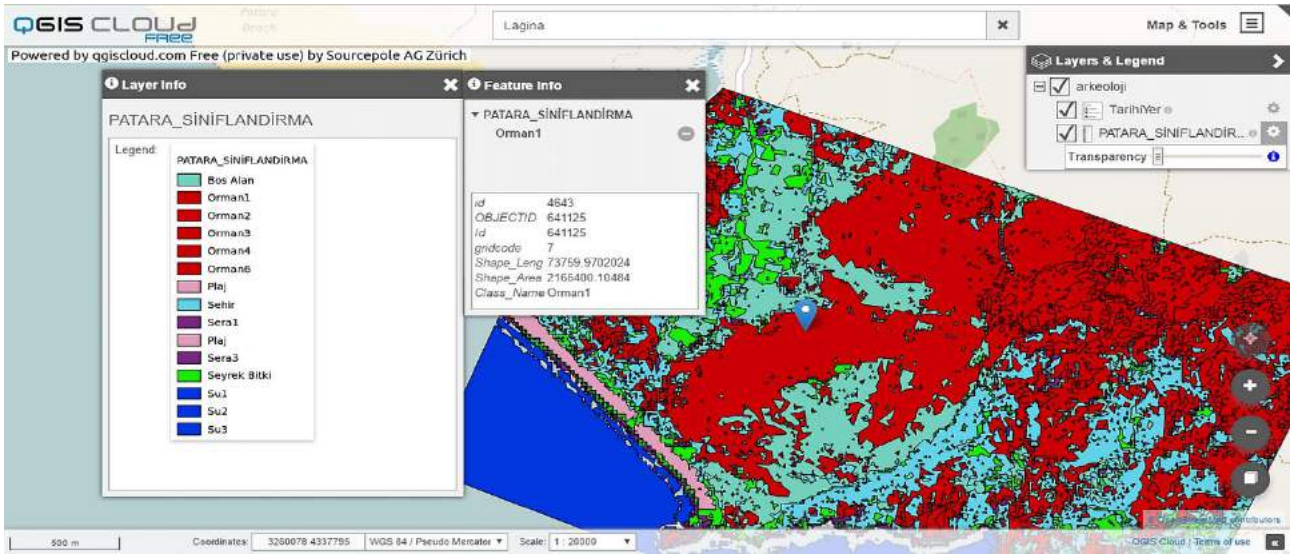

Figure 5: Query Result and Classification Layer

4.3. Web App Builder (BoundlessGeo)

Web App Builder is a plugin for QGIS and developed by BoundlessGeo company. This plugin used in this application. Historical place. That plugin provides to search historical places by names or any specific attribute from the database. BoundlessGeo doesn't allow SVG format so in the application there are only icons. There are area calculations, taking screen shots and location information as also other applications. Classification results of Patara Ancient City is also added as a layer on the application. Figure 6 and Figure 7 are some sample images from the application.

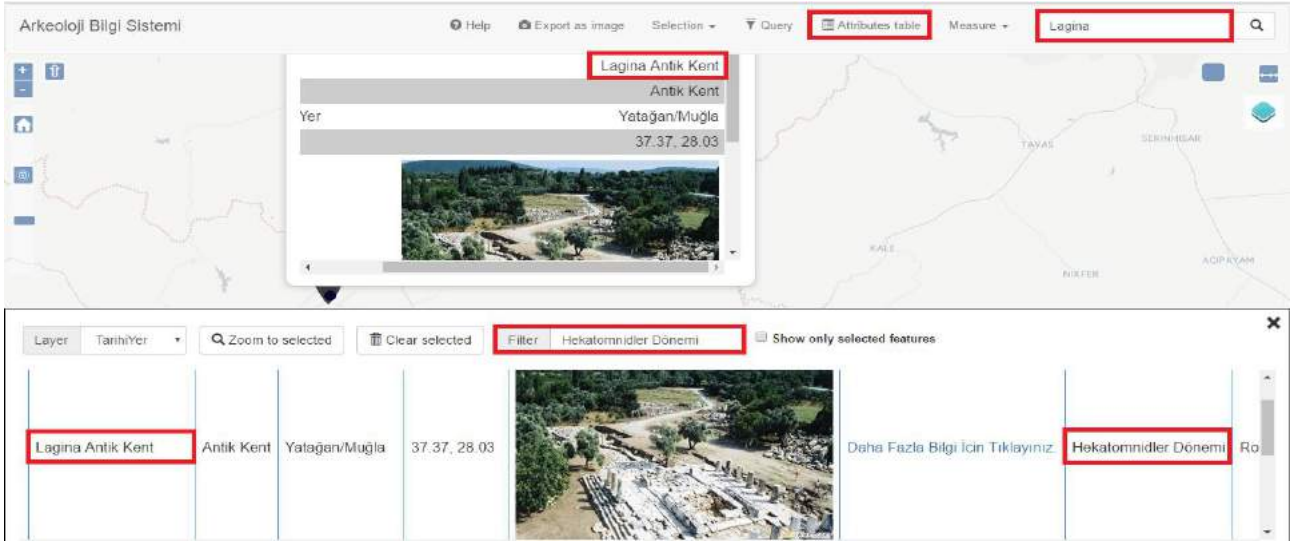

Figure 6: Image of the application made with Web App Builder (BoundlessGeo)

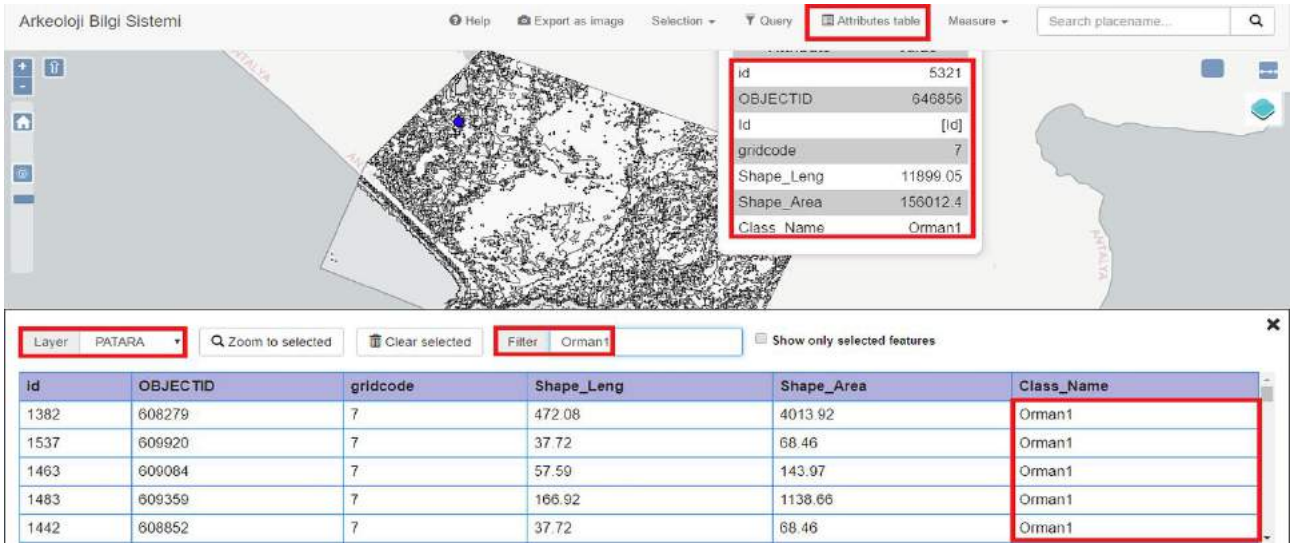

Figure 7: *Query Result* and Classification Layer

4.4. Web Application Builder

This application is created by Web Application Builder in ArcGIS and ArcGIS online which commercial program. When the query made by a historical place in the attribute table, results coming from the database. Landsat 8 satellite images used as a background map. This application used commercial program ArcGIS as a 21 days trial version. Figure 8 and Figure 9 has images from the application.

Figure 8: Image of the application made with ArcGIS Online

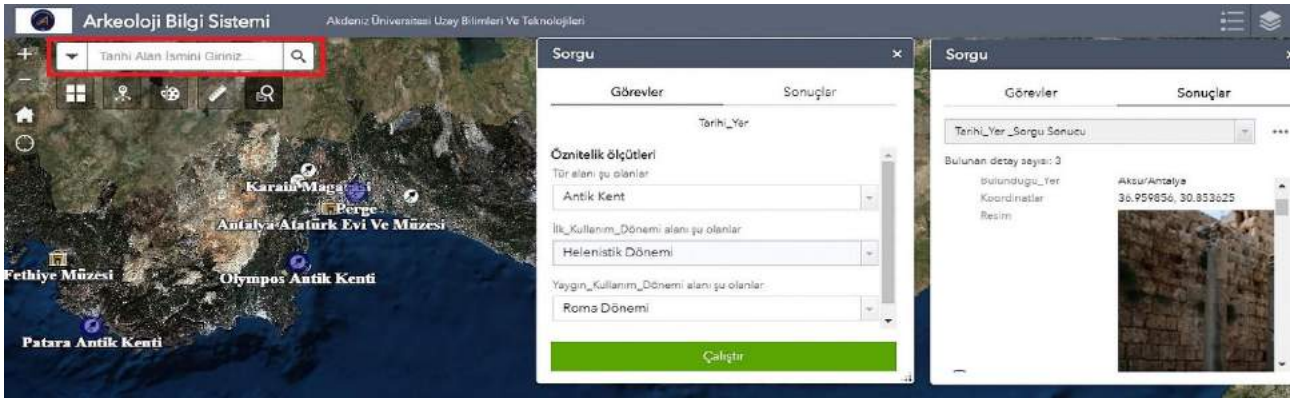

Figure 9: Query Result and Classification Layer

4.5. Localhost

This application is created by Apache Server, Geoserver, PostGIS, QGIS, Leaflet, and JavaScript. Applic drawing, distance calculation, and field calculation on the map. Figure 10 and Figure 11 are sample images from the application.

Figure 10: Image of the application

Figure 11: Attribute İnformation

5. Conclusions

In this work, we focused on the generation of WebGIS which allow querying regarding the information about Lykian ancient sites. Several tools were investigated with examples both for commercial and open-source plugins. The open source plug-ins were mainly for QGIS platform and commercial tool for ArcGIS. The work also includes showing the possibility to include any classification result as a layer. With this work, the researchers would benefit to get an introduction regarding available tools for WebGIS development and also the public would have useful information about the test site with the use of the developed systems.

Acknowledgements

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References

Aydinoglu A.Ç., (2002), *İnternet Tabanlı CBS Uygulaması: Trabzon Örneği*, Selçuk Üniversitesi Jeodezi ve Fotogrametri Mühendisliği Öğretiminde 30. Yıl Sempozyumu, Konya.

Keeler, L., (1995), *Cyber Marketing, United States of America* (Akt.: Çakır, M.; Yalçın A.E., "Kültür ve Turizm Tanıtımında Bir Araç Olarak İnternet Kullanımı") Retrieved from http://teftis.kulturturizm.gov.tr/Eklenti/4715,kultur-ve-turizm-bakanliginda-bir-arac-olarak-internet-.pdf?1

Lillesand, T.M. and Kiefer, R.W., (1994), *Remote Sensing and Image Interpretation*, 3rd. Ed., John Wiley and Sons, Inc., Toronto.

Yigitcanlar T., (2010*), Planning Online: A Community-Based Interactive Decision-Making Model*

URL 1, *Antalya İl Kültür ve Turizm Müdürlügü*, http://www.antalyakulturturizm.gov.tr/TR,175878/muze-ve-oren-yerleri-istatistikleri.html

URL 2, *Antalya Müzesi Resmî Web Sitesi Patara Örenyeri*, http://www.antalyamuzesi.gov.tr/tr/patara-orenyeri

URL 3, Akyüz., (2011), *Tomcat Nedir ve Nasıl Kurulur*, http://www.serefakyuz.com/2011/06/tomcat-nedir- nasl-kurulur.html

Availability of Spatial Analysis in Emergency Health Stations Site Selection; Ordu Province Example

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Abstract

Emergency health services; emergency medical care, accident, injury, etc., medical equipment support, all health services provided at the scene, transportation and health institutions by specially trained teams. The Emergency Service (112) health care services, has vital importance without exception, for each unit. Accurate and timely medical care saves lives, and the smallest delay can lead to negative consequences that cannot be compensated. In cases where emergency medical care is required, it is necessary to ensure that the appropriate treatment of the patient can be delivered to the health facility promptly and that the necessary care be carried out on time. The key word here is 'time', which determines the fine line between death and life. According to the World Health Organization of deaths accidents and injuries that occur in approximately 60% is understood to occur in the first 30 minutes. We need to know from the statistics and from each of our personal experiences, if necessary; Time in Emergency Health Services and its time of arrival, which is its measure, has a vital importance. Emergency Health Service Stations (EHS) play a key role in the reduction of the duration of accidents in emergency medical services. In this context, a mobilization has been initiated in order to ensure that emergency health services are carried out on an equal, accessible, high quality, fast and efficient basis in the country and to reduce emergency transportation time to the shortest extent in order to spread Emergency Health Service Stations (EHS) throughout the whole country. As the basic criteria in determining the numbers, capacities and locations of EHSs, which are accelerated in the direction of this mobilization. Considering the criteria carefully, it's seen as a necessity beyond the convenience of using GIS facilities in station selection. Many analyzes, such as Network Analysis, Nearest Road, Service Area, Location-Allocation Analysis, Service Access Analysis, Population / Case Density Analysis, Value Raster Mapping, etc., are performed to determine the suitability of the location of Emergency Health Service Stations in Ordu and the possible new locations findings were presented to Ordu Provincial Health Directorate. This article was received with great interest by the authorities of the Health Directorate, and hoping that the results would be used immediately, and that discussing the work and its results would be useful for all institutions and organizations in similar pursuits. In our article, which is based on the fact that the practical applications that are vital in addition to scientific researchers are extremely important in order to benefit from GIS facilities at the highest level at the country level, Ordu Provincial Health Directorate will start by requesting the district map and will try to transfer the results obtained from the studies that resulted in the determination of the location of 2 stations that are planned to be done with the compliance of the location of 5 emergency health stations located in our city and the results of the spatial analyzes used.

1. Introduction

"The right to life" is sacred. This sacred right; In the 17th article of our Constitution, "everyone has the right to life, protection and development of their material and spiritual existence." This sacred right of protection is given to the state in the expression of "We allow everyone to maintain his / her life in body and soul health" in Article 56 of our Constitution. To ensure that emergency medical services are carried out equally, in an accessible, quality, fast and efficient manner in the country, in order to be able to fulfill this responsibility towards the citizens of the State, Emergency Health Stations. Emergency Health Stations; are the units established with the approval of the proposal and the governor's office of the directorate as a result of the examinations carried out in accordance with the criteria specified in Article 11 of the Emergency Health Services Regulation with the aim of providing urgent health services and medical intervention. However, in case of need, the station can be opened with the proposal of the governorships and with the approval of the Ministry outside the provincial borders. The criteria for the determination of the station locations are given in Article 11 of the related regulation;

a) The targeted population to be served is at most fifty thousand people,
b) Difficulties of transportation possibilities,
c) the frequency of incidents requiring emergency assistance,
d) The number of traffic and work accidents and the frequency of similar incidents.

For many years, it has been seen that only the population density criterion cannot meet the demand, and it is frequently mentioned by the decision makers that traffic density and topographical parameters, especially accessibility in site selection, require scientific models to be added to the account.

The criteria set out in the Regulation are the ones that are prominent in health service delivery, it is understood that it is almost a necessity to use GIS tools in station selection when considering parameters such as transportation lines, accessibility, traffic density, alternative routes, case density, population density. The process starting from Ordu Provincial Health Directorate's municipality GIS Branch Directorate with the city map request has resulted in the determination of alternative locations determined by spatial analysis. In this study, the spatial analyzes used in this process and the results obtained will be tried to be shared.

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1.1. Emergence of Project Idea

It has been stated that the city map is needed for the determination of two planned EHS sites to be established in our province in interviews with Ordu Provincial Health Directorate officials. It is explained with examples that the place they try to make to the authorities can be done easily, quickly and reliably with GIS facilities, alternative scenarios can be created, causality can be understood by everyone.

1.2. Objectives of the project

The aims of working as a result of the negotiations summarized above;

1. Examination of the appropriateness of the selection of the 5 available emergency health stations in Ordu Province,
2. Determination of the most suitable place for the planned 2 stations
   a. The location of existing stations will not change,
   b. According to the assumption that the position of existing stations may change respectively.

1.3. Project Action Steps

- Placing the problem
- Data Analysis and Data Need Determination
- Collection of Data
- Detection of Analysis Methods to be Used
- Preparing the data for analysis
- Performing Analysis
- Obtaining Preliminary Results
- Production of alternative solutions
- Discussions with Authorities of Provincial Health Directorate
- Reporting of Results Obtained

2. Preparing the Data and Analyzes Made

After the problem has been revealed, it has been tried to determine the necessary analysis for the solution. Analyzes planned to be used;

- Network Analysis (Nearest Road, Service Areas)
- Traffic Density
- Location - Allocation
- Density Analyzes (Population Density and Case Density)
- Geographical Statistics and Interpolations (Krigging and IDW)
- Rasterization
- Creating Value Raster
- Raster Calculator

It was researched as to what data could be obtained from the data requirement and the data collection phase was started. Establishment of topology, filling of attribute fields (min, max, average speed etc.), creation of Network Dataset, data collection of satellite images and traffic intensity maps according to working limits are prepared for analysis to be done. Emergency Health Stations (EHS) located in Altınordu District, which is determined as the study area, are processed on the map and all the roads are added to the same map.

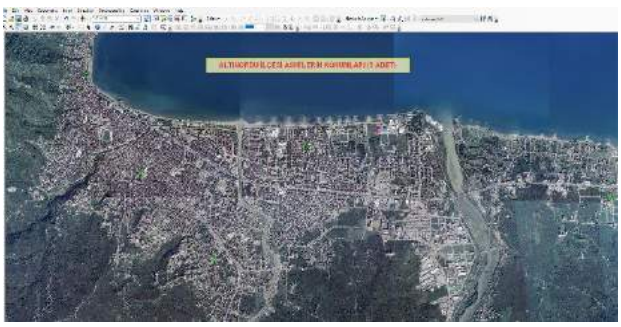

Figure 1: EHS Stations

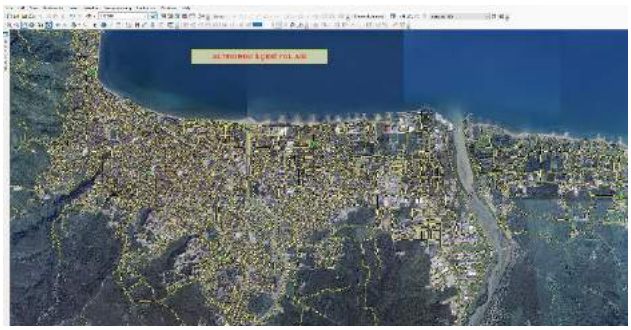

Figure 2. EHS Stations and Road Network

For each road, the minimum, maximum, and average speed values for each road have been determined, taking into consideration parameters such as road coverage, road width and road geometry. Using the path length and average speed values, the transition time value for each path is calculated in seconds.

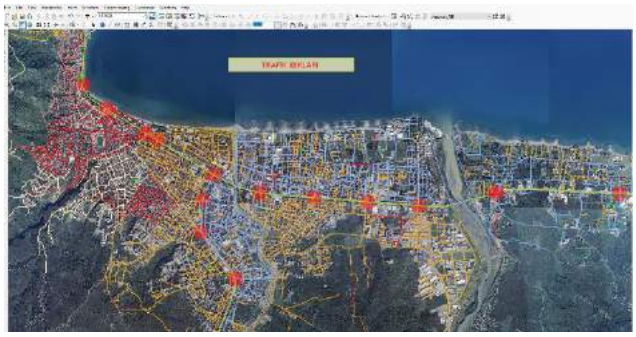

Figure 3: EHS Stations

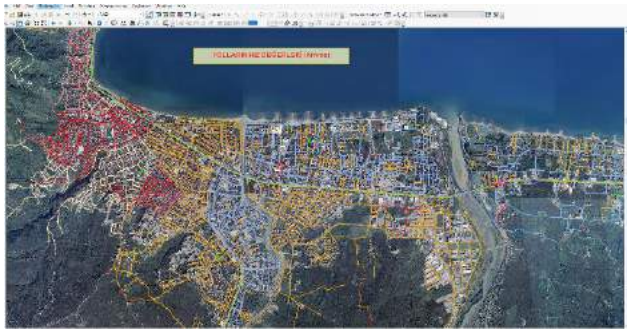

Figure 4: EHS Stations and Road Network

Traffic lights and light-induced delays have been added to the corresponding routes. Each traffic light has a delay time of 15 seconds for each road at 150 meters' distance, and a delay time of 5 seconds for each turn at 30 meters' short distance return. Thus, the transition times for all paths are calculated by summing the delay times due to the average speed, signaling and rotation for each path.

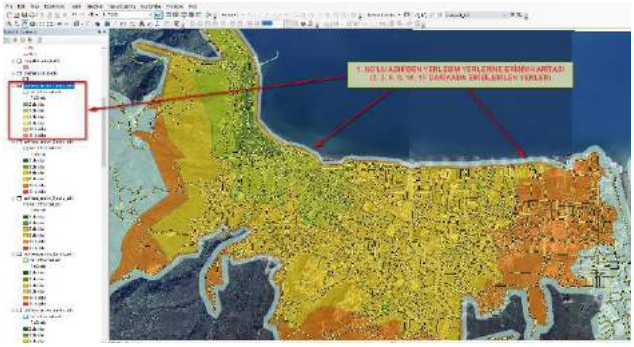

Figure 5: No. 1 EHS Access Map

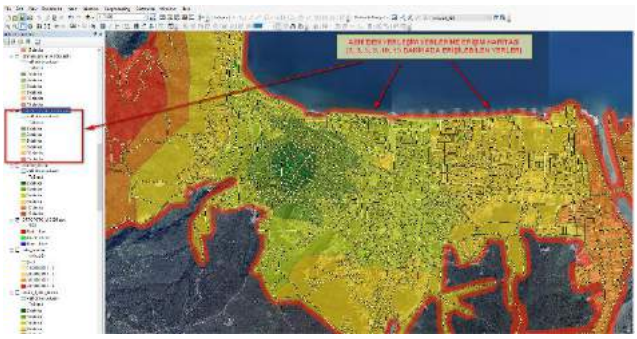

Figure 6: No. 2 Average Access Map

A Spatial Network Database (Network Dataset) has been created in order to perform network analysis which is one of the spatial analysis methods used in Geographic Information Systems applications. Using this data set, access time maps were prepared for each existing EHS using Service Area analysis method which is another spatial analysis method. These access time maps prepared for each of the 5 existing EHSs are converted into "Raster" format; the specific access time values of any point within each access area are calculated.

Due to the fact that all EHSs have an ambulance due to the necessity of EHSs to back up each other, "Case Density" maps were created by adding parameters such as case numbers and population. When the "Case Density" map is examined, it is understood that 30% of the cases are carried out in Yeni, Şahincili and Bucak Districts. It is seen that about half of the cases are realized in these five districts with the inclusion of Akyazı and Karşıyaka neighborhoods in these neighborhoods.

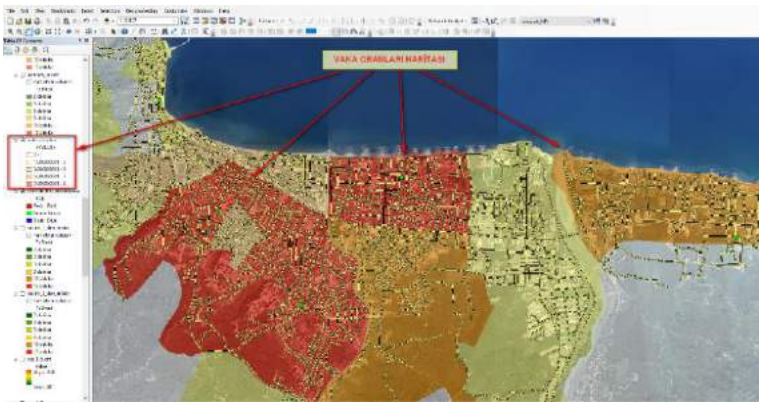

Figure 7: Case Density Map

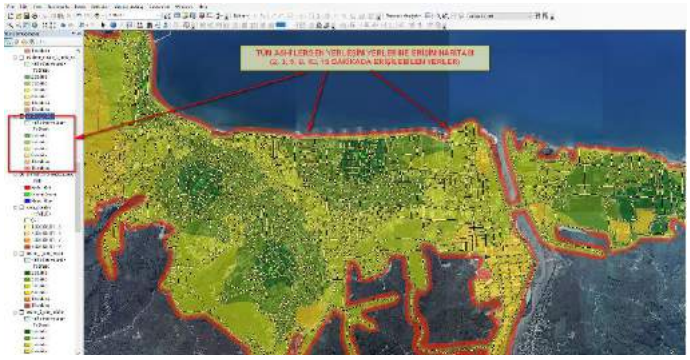

Figure 8: Access Map (All EHSs Separate)

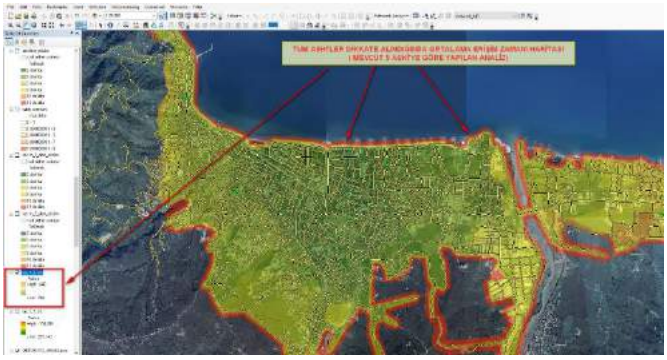

Figure 9: Average Access Map (All EHSs Together)

The five Access Raster maps created for the existing five ASAs are combined into a single "Value Raster" by combining them with the raster calculator method. Thus, an average access time map was created for any point within the county boundaries where all EHSs were considered. As a result of the analyzes made, it was observed that the five existing EHSs were highly suitable and could be intervened in case of normal traffic flow and 15-minute access time under current case distribution conditions.

Further analysis has been carried out for the question of where is the most suitable place for two (2) EHSs planned to be established so that EHSs can back up each other and access times are further reduced.

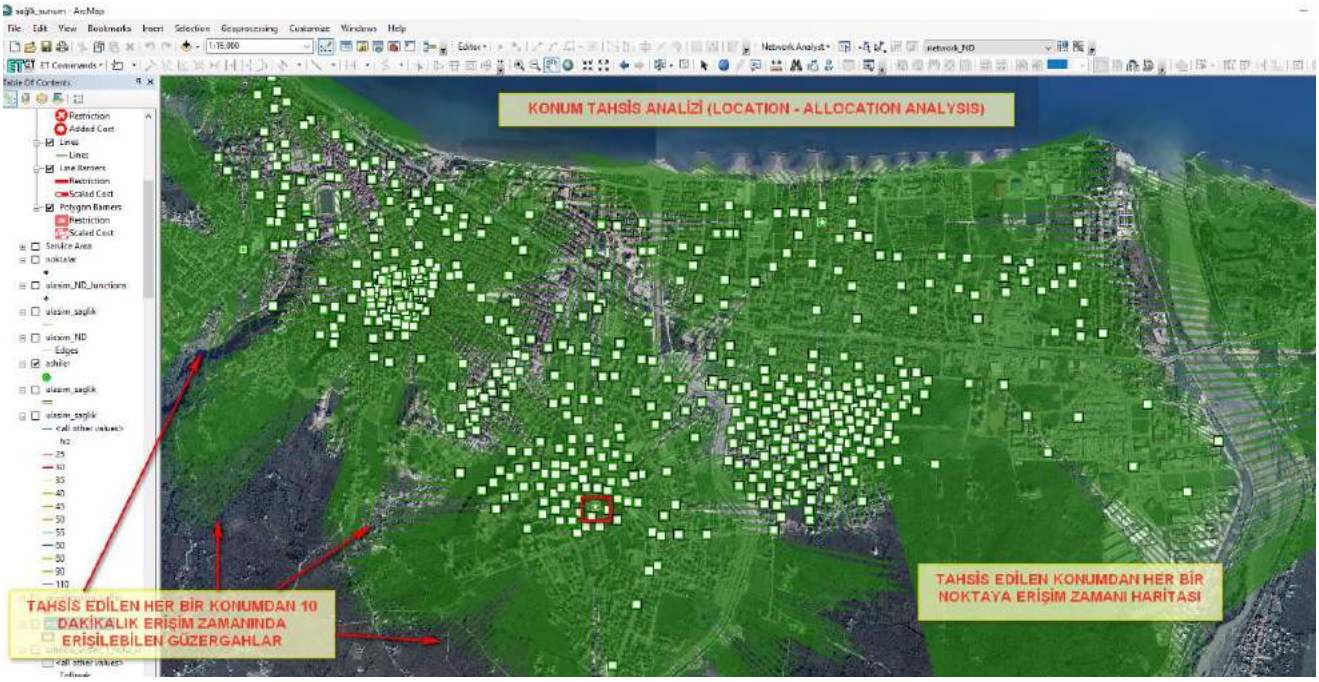

Figure 10: Location - Allocation for Five Compulsory Two Candidate Stations

In addition to the analyzes described above, "Location-Allocation" has been done. In this analysis, 2500 candidate points, 5 of which are "mandatory", were tried to be reduced to 586 by the reduction analyzes and the two most suitable places were determined.

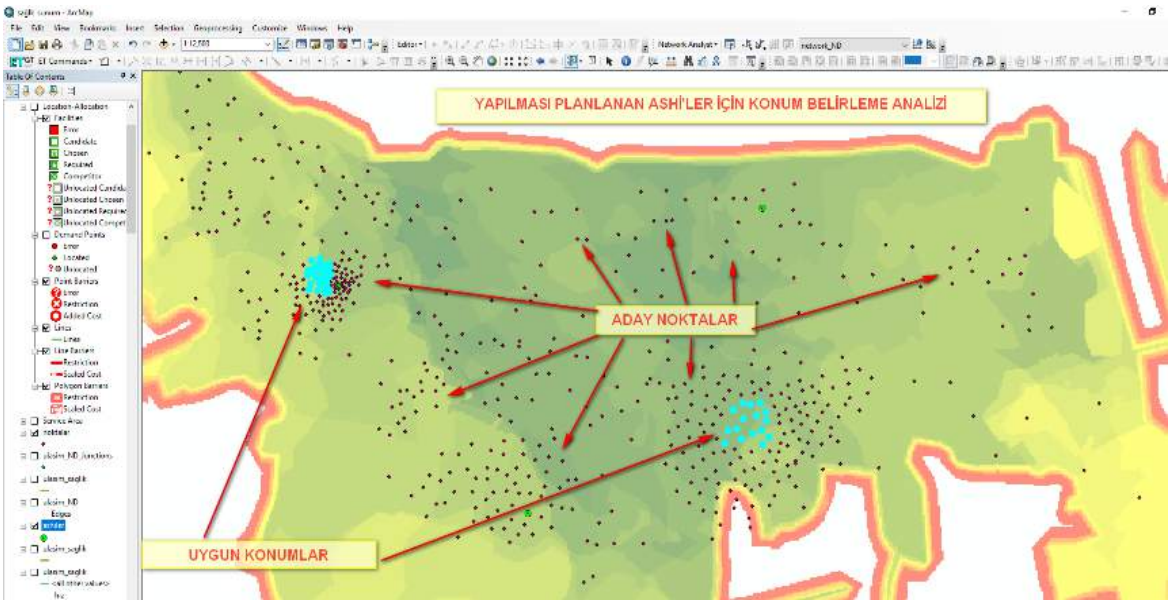

Figure 11: Most likely locations for two candidate stations

During the ten-minute access time, 10,725 routes were created by analyzing a total of 7 EHSs, 5 of which were "compulsory" and 2 of which were "candidates" and the two most favorable destinations were selected as the result of choosing from the fields on the adjacent map.

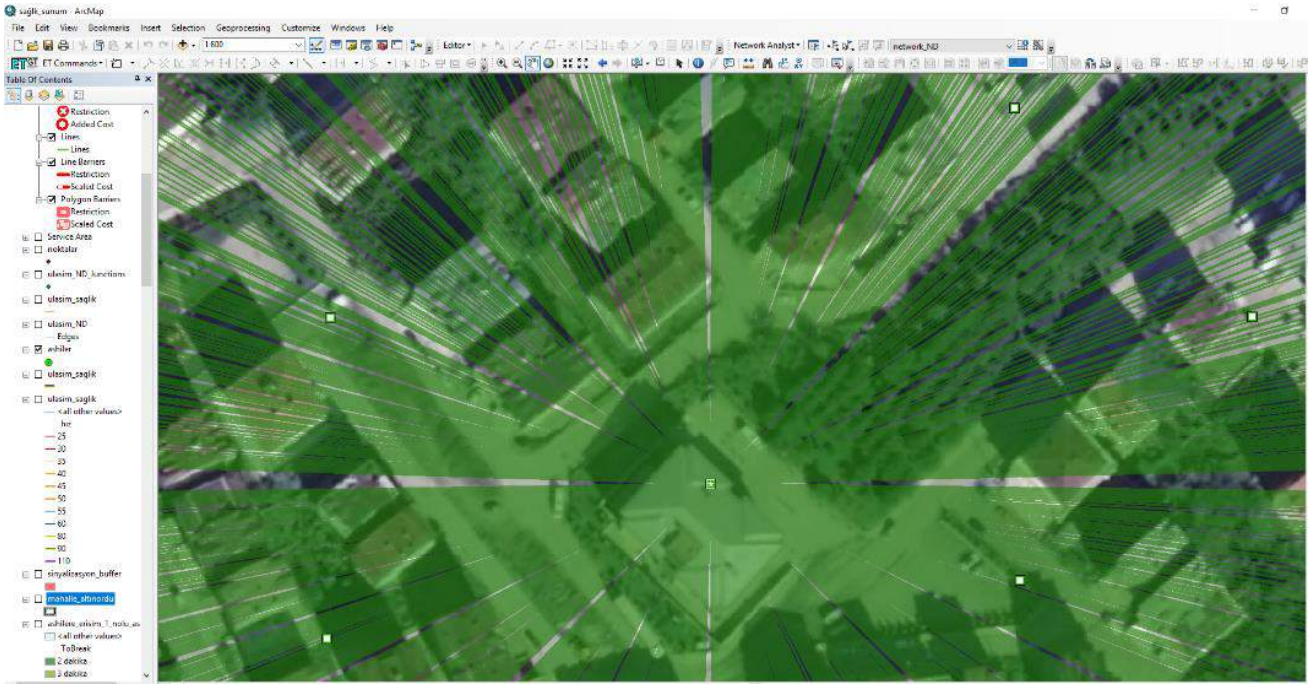

Figure 12: Location - Allocation Analysis for Seven Candidate Stations

For the assumption that the location of the existing Stations may change, the Location-Allocation Analysis is now based on 7 "candidate" EHSs, with the identified candidates near the current stations.

Acknowledgements

According to demand from Ordu Provincial Health Directorate, it has been tried to determine whether the selection of 5 Emergency Health Service Stations (EHS) existing in Ordu Province is appropriate by using GIS facilities. As a result of the analyzes made, it is understood that the 5 existing EHS's locations are positioned to provide the minimum intervention time.

The location of the two EHSs planned to be established in the second phase of the workshop is determined so that existing EHSs can be observed. Findings obtained from the analysis results were discussed with the health professionals, new analysis was repeated in the direction of the new demands and new analyzes and questions were tried to reach the best result.

Repeated Analysis - Additional Demand - Correction - As a result of the analysis cycle; It has been determined that the two most suitable locations for the EHSs to back up each other and to withdraw their access time are the areas shown in the Karsiyaka neighborhood and the Selimiye neighborhood and shown by the point clusters on the map.

By using the powerful and dynamic tools of GIS, it is possible to express EHS's place choice in an objective, fast and accurate manner, as well as in a way that everyone can understand the justifications for the selection made. It is also very important to convince the public about the correctness of the decisions taken, as well as making the right decisions for many institutions that produce services, especially in the public sphere. In this context, GIS provides great ease in making correct decisions with the analysis possibilities it provides, while also making it easy to express the decision made by the generated maps on the other hand.

As a result of the studies made with Ordu Provincial Health Directorate; It is once again understood how important it is to bring together a massive mass of people, such as GIS, with a narrow and enclosed landscape that GIS is trapped in to ensure the necessary benefits at the country level. In addition to scientific research and studies, it is considered necessary to develop practical, solution-oriented and useful applications that are crucial to bringing GIS to more people's lives.

References

1. Bayramoğlu, A., 2009. A Retrospective Analysis on Prehospital Emergency Health Services, M.Sc. Thesis, Department of Emergency Medicine, Atatürk University, Erzurum.
2. Baysal, G., 2006. Usage and examples of GIS in health field, Toxicology Journal, 4, 3-4, 35-41.
3. COŞKUN, N Analytical and Genetic Programming Approaches to Settlement Problem in Emergency Service Systems, Higher Language Thesis, Ç: Ü, 2007
4. Durduran, S. S. et al., 2006. The importance of health centers in terms of detection, monitoring and planning with the help of Geographic Information System, International City and Health Symposium, Uludağ University, Bursa.
5. Lang, L., 2000. Gis for Health Organization, ESRI Press, California, USA.
6. Ong, M. et al., 2009. Geographic-Time Distribution of Ambulance Calls in Singapore: The Utility of Geographic Information System in Ambulance Deployment, Annals Academy of Medicine, 38, 91-94.
7. SB, 2004. Turkey Health Information System Action Plan, TC. Ministry of Health Computer Center Presidency, Ankara.
8. SB, 2008. Progress Report on Health Transformation in Turkey, Ministry of Health, Ankara.
9. http://www.health.gov.on.ca/english/public/program/ehs/land/response time.html>, date of receipt 02.06.2017.
10. SELİM, H., and ÖZKARHAN, İ., 2005. A New Model of Emergency Service Vehicle Placement. MMO Journal of Industrial Engineering1.
11. Terzi Özlem, Samsun Central A1 Type 112 Emergency Stations Service Area Inventory Evaluation with GIS, Expertise Thesis, OMÜ 2010

Three Dimensional, Web Based Geographic Information System Design and Application (YTU Civil Engineering Faculty Building)

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Abstract

Nowadays, technology in every field is developing rapidly. As a result, the applications and field studies in Geomatics Engineering have been also reflecting the impacts of technology. In the past, two-dimensional geographical information systems based on the level of development of technology have begun to transform into three-dimensional GIS depending on the rapid development of computer systems today. In this study, it is aimed to design three dimensional CGA model, web based geographical information system for A, B, C, D, E, F blocks where lecture halls and staff rooms in Civil Engineering Faculty at Yildiz Technical University are available. For this purpose, 3 dimensional models were created by using the Computer Generated Architecture (CGA) Shape infrastructure, which was produced with the help of the CityEngine software that ESRI company started to market in 2008. Three-Dimensional Geographical Information System was established by adding verbal information belonging staff rooms and lecture halls. The created model was then broadcast using ArcGIS Online service. In the running project at present the properties of the faculties can be queried by displaying the Civil Engineering Faculty buildings in 3D, searching for the attributes, and selecting lecture halls or staff rooms in the project.

Keywords:
3D CBS, CGA, CityEngine

1. Introduction

Many public institutions have made significant progress in the widespread use of two-dimensional web-based geographic information systems. In the geomatics engineering departments of the universities, the students have carried out two-dimensional GIS studies in different subjects. Some of them are graduate and undergraduate studies in the Department of Photogrammetry, at Yildiz Technical University. Some of these studies have been published as articles in various journals. It is a GIS study (Bakırman and Gumusay, 2011) that makes it easy for the students who will take their university entrance exams at Yildiz Technical University can easily access the information related to their exam rooms on the university campus. In another two-dimensional study, the systems for the lecture halls and staff rooms of the Faculty of Economics and Administrative Sciences (Ozgun and Gumusay, 2016) and the Faculty of Civil Engineering (Gursoy etc. 2017) were designed in two dimensions and published online web-based ArcGIS. Although two-dimensional GIS meets the needs of many studies, it is possible to model the objects in a realistic way with 3D geographic information systems (Karas et al., 2010). As the internet speed increases and software programs improve, interest in 3D and web-based applications has increased. In this study, the steps of a three-dimensional and web-based study and the results obtained will be explained.

2. 3D Model

In order to create a 3D model, the model must be defined using X, Y, Z coordinates showing. For additional details, 3D model has to be defined using texts and photographs belonging to the facades.

2.1. Computer Generated Architecture (CGA)

Structural modelling is a method used in 3D modelling with the use of CGA, which is a formal grammar. In this method, 3D models are composed of codes representing them instead of drawing (Nielsen 2007). CGA Shape grammar is a programming language used to analyze and construct architectural works (Mathias 2011).

In 1971, George Stiny wrote the idea of the language with a shape-based program in his famous article "Shape Grammars and the Generative Specification of Painting and Sculpture". Structural grammar, similar to the grammar of form, presented to the linguistic committee in 1972. Every n-dimensional figure created on this level is assigned to a letter, and the letters to be assigned are arranged side-by-side in one dimension (Bao 2013).

When we arrived in 2003, the split grammar was introduced in an article entitled "Instant Architecture" which was written by Wonka, Wimmer, Sillion and Ribarsky.

Divided grammar is a special programming language used to describe forms. Significant lines of code to be written in this dile allow automatic modeling of buildings. These ideas and developments can contribute to the creation and production of large-scale urban models of CGA grammar (Stiny 1972).

In 2008, Markus Lipp made a major contribution to structural modeling by working actively on the editing of formal grammar. Explained an interactive method for writing a form programming language with drawing in his paper. With this method, you do not have to write code strings, but create them by drawing.

This method has been used successfully in the construction of architectural models by using the programming language with structural techniques. Due to the written language behind the method, it is necessary to learn some computer knowledge to use this method (Wonka 2003).

In summary, the most effective and efficient language format programming to be used today in the modeling of urban and large areas is becoming a CGA language. The CityEngine, which is a program that successfully uses form grammar with structural modeling, will be used in this project to create the CGA model of the faculty building in the application area.

3. Application

The requirements have been determined for the application first. It is intended to design a response to these requirements. The need for this study is the creation of the 3D model of the building of the Faculty of Civil Engineering, entrance of verbal data, and 3D publication from the Internet. Modeling will be done with Computer Generated Architecture (CGA). Summarize the implementation steps;

- Building architectural projects, collection of verbal information and capture of facade and texture photographs for 3D model and analysis of differently designed places in architectural project
- Editing of CAD files
- Creating wall footprints from edited CAD files and throwing polygons into them
- Performing geographical referencing of the resulting footprints and polygons (moving them to their actual location and correcting the scale) and also entering the attribute information of these polygons
- Determining the facades that will have the same model for the CGA rules that will be used in building 3D models, this step is the most time consuming part of the project. In this step a good analysis should be done to model the entire building with as few rule files as possible.
- Finally, accessing the project via the internet

3.1. Application Area

The lecture halls in the Faculty of Civil Engineering and staff rooms lecturing in that faculty were selected as the application area (Figure 1).

Figure 1: Application area

3.2. System Design

For the system; firstly the hardware and software required were selected. For this purpose, a computer with i5 processors, 8 GB ram, Nvida GTX970 features were used. The publishing process has benefited from a server-capable computer. CityEngine, Microstation, ArcGIS Online and Windows Server 2012 R2 software were used in the system.

3.3. Application Data

- The architectural project of the building to be modeled (Figure 2).

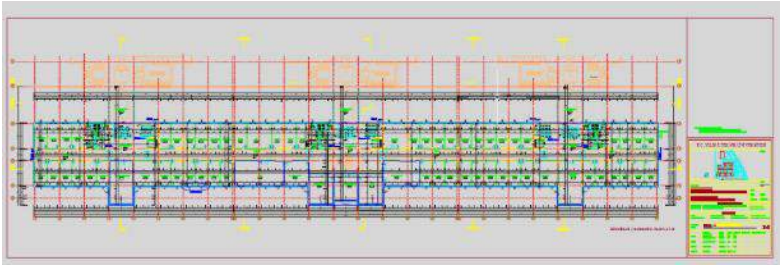

Figure 2: The architectural plan of the Faculty of Civil Engineering on its 2nd floor

- In the application area, a mobile phone was used for taking photos. Taking as many photographs of the building as possible the building enabled us to analyze them during the modeling step. This made the shape and texture of the model close to the original form. In Figure 3, a photograph taken for this purpose and the resulting tissue image of the photographed image are shown.

Figure 3: On the left, the tissue is shown and the tissue created by cropping is shown on the right

Figure 4: An image taken from the building is shown on the left and an image from the model is shown on the right

- The collection of information about the purpose of using the halls and the room owner in the building.

Table 1: The excel form which the information about the rooms was available

Faculty Name	Section	Department	Room Number	Owner	E-Mail	Phone Number
İnşaat Fakültesi	Harita Mühendisliği	Fotogrametri	A Blok-Kat 2-52	Doç.Dr. Ümit GÜMÜŞAY	gumusay@yildiz.edu.tr	+ 90 212 383 53 30
İnşaat Fakültesi	Harita Mühendisliği	Fotogrametri	A Blok-Kat 2-53	Prof.Dr. Bülent BAYRAM	bayram@yildiz.edu.tr	+ 90 212 383 53 29

- *Orthophoto map of the application area*

Figure 5: Image of orthophoto map of the region

3.4. Implementation steps

The plans for the construction faculties' floors in the .dwg format, which are required for the planned 3D web based system, have been obtained from Construction Office at Yildiz Technical University.

Arrangement of the floor plans

Layers that will not be used for the floor plans, but will be used in creating wall footprints have been cleaned using CAD software Microstation (Figure 7).

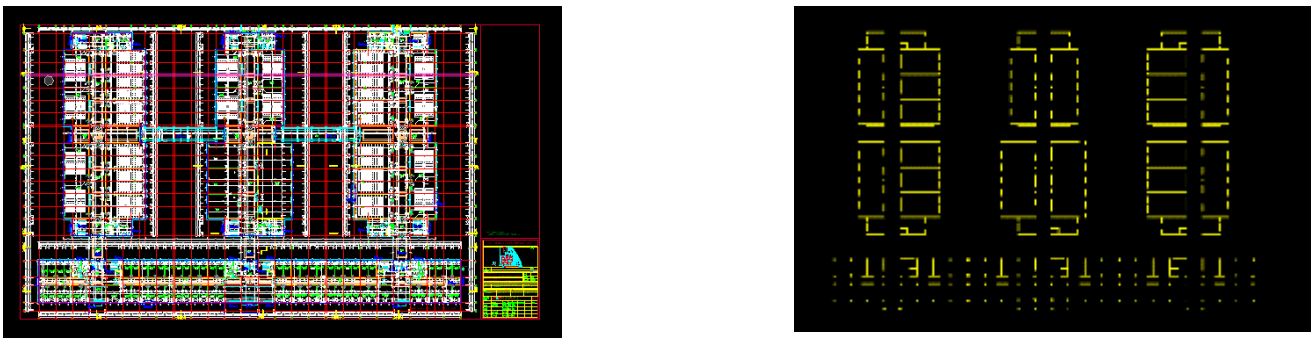

Figure 7: Architectural plan is shown on the left, the view from the cleaned layers is shown on the right side

The lines shown in Figure 7 form the polylines of the building walls and the reason for the cuts is to clean the structures during the cleaning step (window, glass panels, doors etc.).

Creating a Wall Footprint

Cleaned floor plans were transferred to ArcMAP environment to create wall footprints. Polylines were converted into polygons (Figure 8). And the attributes of the rooms were entered into these polygons.

Figure 8: Floor plan in the form of polyline is shown on the left and it has converted into polygon on the right.

At the end of this step, we have designed a 2D GIS system. After this step, the 2D GIS system that is built up will be integrated into the building model of the building and a system will be made to created 3D dimensional analysis.

Solid model

For creating the three dimensional solid model of the building, the rules in CityEngine programmer were written. It was made by writing the rules in the CityEngine program to create the 3 dimensional solid model of the building. The lines on the left below are the part of the rule file, and the part on the right is the solid model.

```
attr Floor_Height = 4.5
attr Exterior_Visibility = 1
Pen_Renk = "#1b8bb4"
SDuvar_Renk = "#e5dfae"
@startrule
Lot -->
 extrude(Floor_Height)
 Floor
Floor-->
comp(f){object.front:FrontFacade | object.back:Back |
 object.left : LeftFacade | object.right : RightFacade |object.top : top }
FrontFacade-->
color(151,255,255)
RightFacade --> // Acık Mavi
   split(x){ 1.5 : A | { ~1.2 :A | 3 : B |~1.2: A }* | 1.5 :A }

B --> // window
  split(y){~1 : C | 2 : D | ~1.6 : F }
D -->  split (y){~0.5: K | 1.7 : H | ~0.5 : K }
A -->split(y){~1 : C | 2 : DX | ~1.6 : F }
DX --> setupProjection(0,scope.xy,0.8,1)    projectUV(0)  texture("metal.png")
 F --> setupProjection(0, scope.xy, 0.8 ,1) projectUV(0)  texture("metal.png")
C -->setupProjection(0, scope.xy, 0.8 ,1) projectUV(0) texture("metal.png")
H -->split (x){~0.5: K | 2.6 : I | ~0.5 : K }
I --> split (y){~0.2: G | 1.6 : J | ~0.2 : G }
J --> split (x){~0.2: G | 2.5 : L | ~0.2 :G }
L --> split (x){0.1:M|0.7:N|0.1:S|0.7:O|0.1:S|0.7:N|0.1:M}
M -->split (y){{0.1:P|~0.6:Q}*| 0.1:P}
N -->  split (y){{0.1:P|~0.6:R}*| 0.1:P}
```

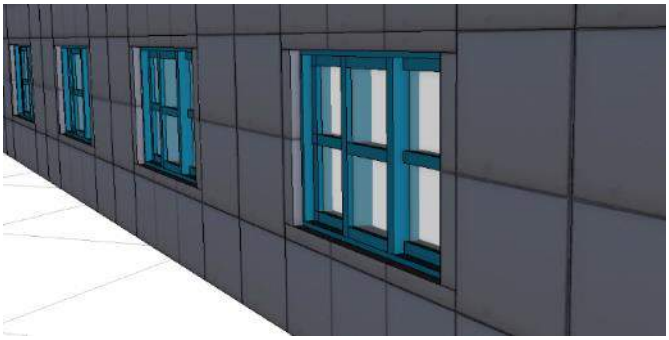

Figure 9: The pattern of the facade.

We created the height values in the CityEngine environment to obtain the image on the left in Fig. 10. The image on the right in Fig. 10 by adding the shp files is obtained from the application of the solid model.

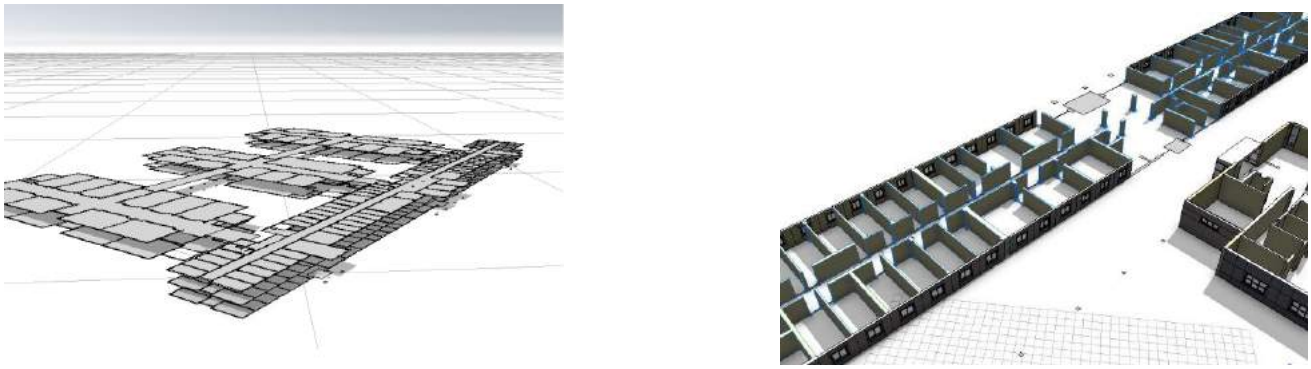

Figure 10: Image of 2D layers is shown on the left and the solid model as shown on right

After applying the rule files created in all 2D layers, the 3D model was created as shown in Fig.

Figure 11: Image from solid model

Publishing the project via the internet

ArcGIS online platform was used to publish the project on the internet. The project can be actively accessed via http://www.gis.yildiz.edu.tr/YTUInsaat3B.html.

Figure 12: The image of the site on the link is shown on the left and the image of the application is shown on the right

Sample Analysis from the application

The application publish on the Internet can be accessed by any internet browser (Figure 13).

Figure 13: View from browser application

By clicking on the eye icon next to the floors that are separated from the layers on the right side of the scanner, the active layers can be closed and the analysis of the required column can be performed (Fig. 14).

Figure 14: View from the closed roof of the application

The information about the rooms lecture halls, laboratories on the model can be obtained by selecting the place with the mouse cursor (Figure 15).

Figure 15: Inquiry of one of the rooms belonging to the staff members

You can query the search bar by writing attributes such as name and room number. The result of the interrogation can be observed on the 3D model or read from the verbal information that comes below the search bar (Figure 16).

Figure 16: View from sample query with search bar

4. Results

This study was selected as one the top 10 projects in ESRI Turkey, young scholars, 2017 competitions and presented in Ankara. In this study, a 3D web based GIS model of the YTU Faculty of Civil Engineering was established. This work contributes to the definition of the Civil Engineering Faculty Building at Yildiz Technical University. It is also aimed to find the rooms and lecture halls more easily and to be able to make inquiries. Creating 3D models of the huge construction projects beforehand is a good way to monitor and control all the processes in the projects. While marketing new construction projects, 3D modelling brings a lot of advantages.

Thanks

I would like to thank my consultant, Assoc.Prof.Dr. M. Umit Gümüşay whose guidance is always appreciated for this project. We would like to thank the Construction Office for the floor plans and Data processing Centre for data supply.

References

Bakırman T., Gümüşay M.Ü., (2011), Yıldız Teknik Üniversitesi (YTÜ) Davutpaşa Kampüsü ÖSYM Salon Bilgi Sistemi, HKMO,Jeodezi Jeoinformasyon Arazi Yönetimi,146-149.

Önal Ö., Gümüşay M.Ü., (2016), Web Tabanlı Coğrafi Bilgi Sistemi Tasarımı ve Uygulaması (YTÜ İktisadi ve İdari Bilimler Fakültesi), UZALCBS 2016, 724-732.

Gürsoy Sürmeneli H., Duman H., Gümüşay M.Ü., (2017), Web Tabanlı Coğrafi Bilgi Sistemi YTÜ İnşaat Fakültesi Uygulaması, TMMOB Harita ve Kadastro Mühendisleri Odası, 16. Türkiye Harita Bilimsel ve Teknik Kurultayı, 3-6 Mayıs 2017, Ankara.

Nielsen A. (2007), A Qualification of 3D Geovisualisation.PhD ,Aalborg University

Mathas M., Martinovic A., Weissenbergy J., Van Gool L., (2011). Procedural 3D Building Reconstruction using Shape Grammars and Detectors. Computer Vision Laboratory. Zürich, Switzerland.

Bao F., Schwarz M., Wonka P., (2013)., Procedural Facade Variations from a Single Layout.

Stiny G., Gips J., (1972), Shape Grammars and the Generative Specification of Painting ans Sculpture, Birkhauser, Basel, Switzerland, 125-135

Automatic Design of Cartographic Projections

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Abstract

The projection of sphere to plane requires a map projection. Because it is impossible to transfer the sphere to plane without deformation, which is a geometric shape that cannot be directly transferred. The deformations vary depending on the shape of the designed projection grid. Depending on the purpose of the map, map projections can be designed by keeping some deformations between acceptable limits. While cartographers fulfill these tasks, they have tried very different methods. They produced very different map projections by changing the perspective properties of the projection geometry, including manual and graphical designs or trial and error methods, or by varying the magnitudes and directions of deformations with mathematical relations. In the light of these centuries-old productions and accumulations, these studies have now been moved to the computer environment, and many cartographic works including map grid designs have begun to be carried out through software. Today, it is possible to come across a series of software on the academic platform to recognize, produce and study map projections. Bernhard Jenny's Flex Projector software is one of them. In this study, three different projections defined by table values of Russian cartographer G.A.Ginzburg, which is not included in Flex Projector program software library, have been implemented. It is intended to introduce the software and provide hints for effective use and also tried to encourage our colleagues to develop different projection processes to achieve alternative results, which are trying to develop appropriate projection parameters for their own use.

Keywords

Map Projections, Flex Projector, Ginzburg

1. Introduction

Map projection is the transfer of the entire or some part of the physical earth to the plane by establishing mathematical relationships and/or geometric relationships with the help of intermediary surfaces such as cone, cylinder and plane. The deformations that occur in this process vary according to the surface of the projection, the shape and the location of the center. Angle, area or length elements can be protected in the projection. When these elements are not protected, certain amounts of deformations occur in each case. These deformations are shaped in the direction of use of the projection. All features must be taken into account when designing the projection.

World map projections with table values can be designed in Flex Projector program and the obtained projections can be evaluated. Ginzburg IV, V and VI projections were introduced and their applications were made on the program. Distortion values of Ginzburg IV, V and VI projections; deformation aberrations, distortion curves and acceptance indices were visualized.

2. Flex Projector

Flex Projector is a free and open-source program that allows you to create world map projections and work on many operating systems. Developed by Bernhard Jenny at the ETH Zurich Cartography Institute with the help of Tom Patterson from the US National Park Service. The interface of the program allows users to easily change many world map projections; It also allows you to make totally new projections with little adjustments. It specializes in cylindrical (real) and pseudocylindrical (unreal) projections as well as conical projections. User interface is created based on Robinson projection design. It is designed as a tool for students, academicians and scientist who are interested in cartography.

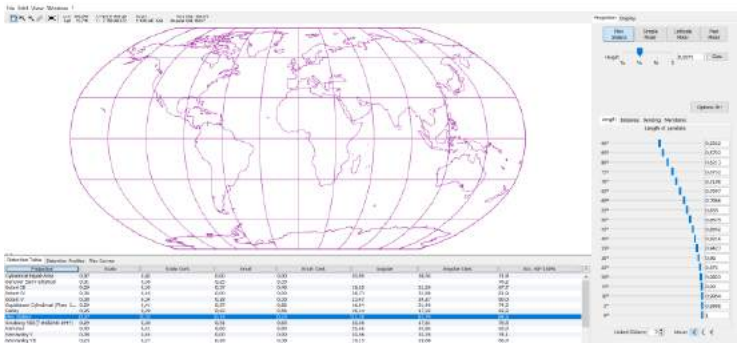

Figure 1: Flex Projector interface

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3. Ginzburg Projections

G.A. Ginzburg, Russian Cartographer, he worked as a cartographer at Russia Research Institute of Geodesy, Aerial Survey, and Cartography (CNIIGAiK). Ginzburg produced six projections which are Ginzburg IV, V, VI, VII (polyconic projections), Ginzburg VIII (pseudocylindrical projection) and Ginzburg III (pseudoazimuthal projection). (Ginzburg & Salmanova, 1957).

3.1. Properties of Projections

Map projection designs often carry symmetry features. Central meridian and equator are the axes of this symmetry. Intervals of meridians and define of using these values the definition of the border meridian is equivalent to the description of the map projection. This definition is sufficient for only a quarter sphere. Designers who produce map projections with table values used these features. Projections of Ginzburg IV, V and VI carry similar features. Table values and deformations are different from each other. All of them are lenticular, modified polyconic projection. Their central meridian is 0° Greenwich Meridian and there are no mathematical equations that define projections. There are table of plane coordinates with 10° intermittent geographic latitude and longitude values. They have not angle, area and length protection. Figure 2, 3 and 4 shows Ginzburg IV, V and VI projections.

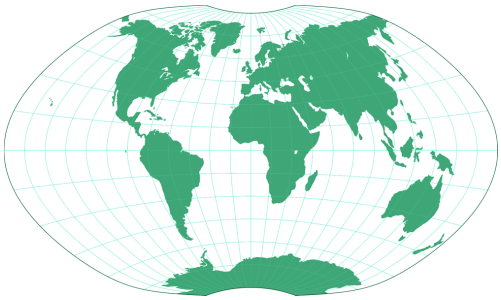


Figure 2: Ginzburg IV (CNIIGAiK 1939-1949)

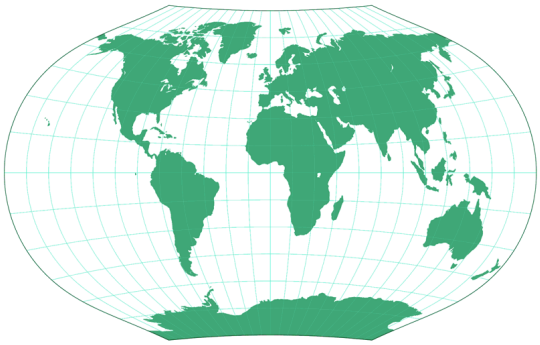


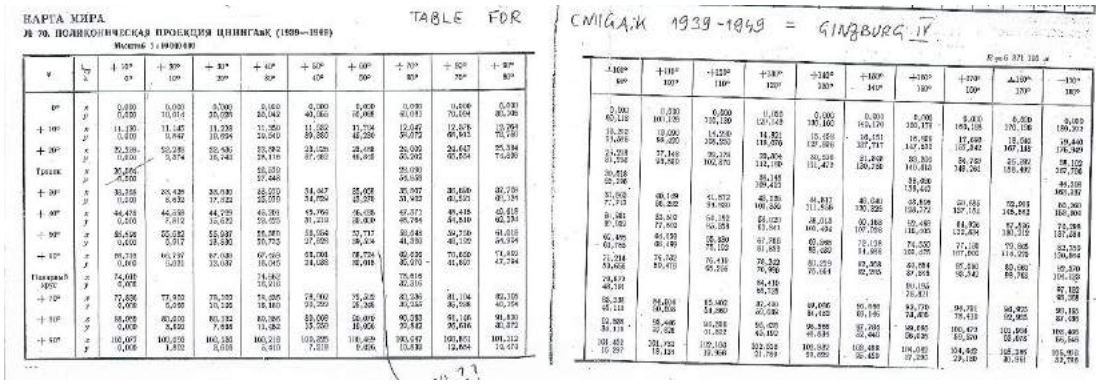
Figure 3: Ginzburg V (CNIIGAiK1950)

Figure 4: Ginzburg VI (CNIIGAiK BSE)

3.2. Table Values of Ginzburg Projections

According to Russian sources, the table values of the Ginzburg Projections are in the form of x, y coordinates corresponding to latitude and longitude values of 10º intervals.

Table 1: Table values of Ginzburg V projection



In the Flex Projector program, the corresponding x and y coordinates of 0º and 180º longitude points and the intersection points of latitude values between 0º-90º are used. These coordinates are the plane coordinates. For the equatorial distances of the parallels, the values of 180º longitude are used instead of the values of x in the central meridian. This is because the equatorial distance of the parallels is shortened along the other longitudes while the end points of the parallels remain constant for 180º after the bend parameters are set. 180º longitude for the lengths of the parallels and y values corresponding to the intersection points of the latitudes are used. The ratio of the values of the middle meridian to the values of x in the 180º longitude are used for the bends of the parallels.

Table 2: Used table values of Ginzburg IV projection

φ	x (cm), y (cm)	λ=0º	λ=180º
0º	x	0,000	0,000
	y	0,000	180,202
10º	x	11,120	19,440
	y	0,000	176,949
20º	x	22,239	38,102
	y	0,000	167,706
30º	x	33,358	55,260
	y	0,000	153,904
40º	x	44,478	70,298
	y	0,000	137,534
50º	x	55,598	82,750
	y	0,000	120,564
60º	x	66,716	92,270
	y	0,000	104,123
70º	x	77,836	99,165
	y	0,000	87,436
80º	x	88,955	103,468
	y	0,000	66,546
90º	x	100,077	105,976
	y	0,000	32,786

R= 6371116 m

Flex Projector program requires 5º table values. Interpolation was performed for this reason and intermediate values were found. In Newton Interpolation tables created in Excel, 5º interval values were calculated by using 10º interval table values of Ginzburg projections. The y values corresponding to the intersections of the latitudes between 5º and 85º with the longitudes of 0º and 180º with the x values corresponding to the intersections with the longitude of 180º were found as the interpolation result.

Table 3: The last values of Ginzburg IV used in the program

φ	$x_{1\,(cm)}$ (λ=0°)	$x_{2\,(cm)}$ (λ=180°)	$y_{(cm)}$ (λ=180°)	x_1/x_2
0°	0	0	180.202	0
5°	5.561612	9.761862	179.3783	0.569729
10°	11.12	19.44	176.949	0.572016
15°	16.67928	28.91731	173.0057	0.576792
20°	22.239	38.102	167.706	0.58367
25°	27.79853	46.90979	161.2577	0.592596
30°	33.358	55.26	153.904	0.603655
35°	38.91779	63.07779	145.9082	0.616981
40°	44.478	70.298	137.534	0.632706
45°	50.03824	76.86816	129.0224	0.650962
50°	55.598	82.75	120.564	0.671879
55°	61.1571	87.92002	112.2672	0.695599
60°	66.716	92.37	104.123	0.722269
65°	72.27551	96.10871	95.96659	0.752018
70°	77.836	99.165	87.436	0.784914
75°	83.39654	101.5917	77.9274	0.820899
80°	88.955	103.468	66.546	0.859734
85°	94.51134	104.8947	52.05025	0.901012
90°	100.077	105.976	32.786	0.944336

3.2.1. Newton Interpolation Method

When table values are given as:

x_i	x_1	x_2	x_3	x_4	x_5
$g(x_i)$	$g(x_1)$	$g(x_2)$	$g(x_3)$	$g(x_4)$	$g(x_5)$

When the differences Δx = xi-xi-1 are constant, the consecutive differences are calculated as follows;

x	f[x]	f[,]	f[,,]	f[,,,]	f[,,,,]
x_1	$g(x_1)$				
		$g(x_{1,2})$			
x_2	$g(x_2)$		$g(x_{1,2,3})$		
		$g(x_{2,3})$		$g(x_{1,2,3,4})$	
x_3	$g(x_3)$		$g(x_{2,3,4})$		$g(x_{1,2,3,4,5})$
		$g(x_{3,4})$		$g(x_{2,3,4,5})$	
x_4	$g(x_4)$		$g(x_{3,4,5})$		
		$g(x_{4,5})$			
x_5	$g(x_5)$				

Along with;

$g(x_{1,2})=[g(x_2)-g(x_1)]/x_2$		
	$g(x_{1,2,3})=[\ g(x_{2,3})-g(x_{1,2})]/x_3$	
$g(x_{2,3})=[g(x_3)-g(x_2)]/x_2$		$g(x_{1,2,3,4})=[\ g(x_{2,3,4})-g(x_{1,2,3})]/x_4$
	$g(x_{2,3,4})=[\ g(x_{3,4})-g(x_{2,3})]/x_3$	$g(x_{1,2,3,4,5})=[\ g(x_{2,3,4,5})-g(x_{1,2,3,4})]/x_5$
$g(x_{3,4})=[g(x_4)-g(x_3)]/x_2$		$g(x_{2,3,4,5})=[\ g(x_{3,4,5})-g(x_{2,3,4})]/x_4$
	$g(x_{3,4,5})=[\ g(x_{4,5})-g(x_{3,4})]/x_3$	
$g(x_{4,5})=[g(x_5)-g(x_4)]/x_2$		

As a result, newton interpolation polynomial for a given x value is obtained as;

$$g(x)= g(x_1)+ g(x_{1,2})*(x-x_1)+ g(x_{1,2,3})*(x-x_1)*(x-x_2)+ g(x_{1,2,3,4})*(x-x_1)*(x-x_2)*(x-x_3)+ g(x_{1,2,3,4,5})*(x-x_1)*(x-x_2)*(x-x_3)*(x-x_4)$$

(Press, Flannery, Teukolsky & Vetterling, 1989).

3.3. Parameters of Ginzburg Projections

In the Flex Projector program, the lengths of the parallels and the equatorial distances must be between 0, 1. For this reason, for the equatorial distances of the parallels, before entering the parameters, the x value corresponding to the intersection of 90º latitude and 180º longitude is considered 1 and the other x values are calculated according to this value. For the lengths of the parallels, the y value 1 corresponding to the intersection of 0º latitude and 180º longitude is accepted and the other y values are calculated according to this value. When the twist of parallels is calculated, the x values corresponding to the intersections of 0º and 180º longitudes of all latitudes are grouped as x1 and x2, and the ratio x1/x2 is calculated. Since Ginzburg Projections have parallel convex curvature, this ratio is subtracted from 1 to find bending values.

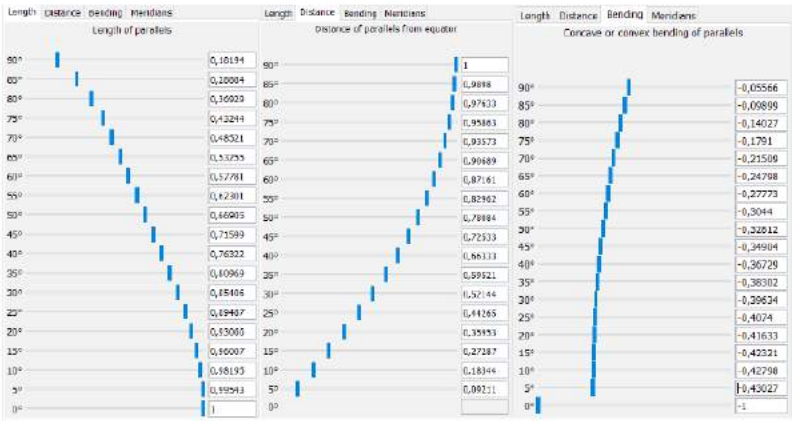


Figure 5: Ginzburg IV Parameters in Flex Projector interface

In addition, the height-to-width ratio is calculated by the ratio of the length of the middle meridian to the length of the equator in order to produce projections correctly.

Once the parameters are entered, the projections shown in the interface are exported as a map in PNG format. The projections were drawn with 10º latitude and longitude intervals. The projections were drawn with 10º latitude and longitude intervals. All operations were done for Ginzburg V and VI projections.

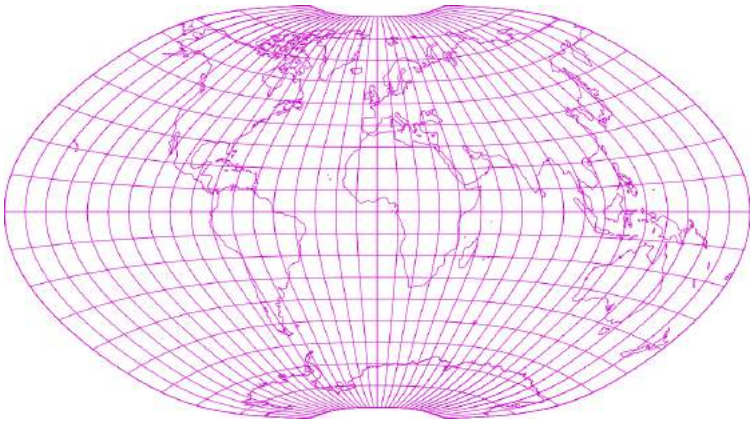


Figure 6: Ginzburg IV (Flex Projector)

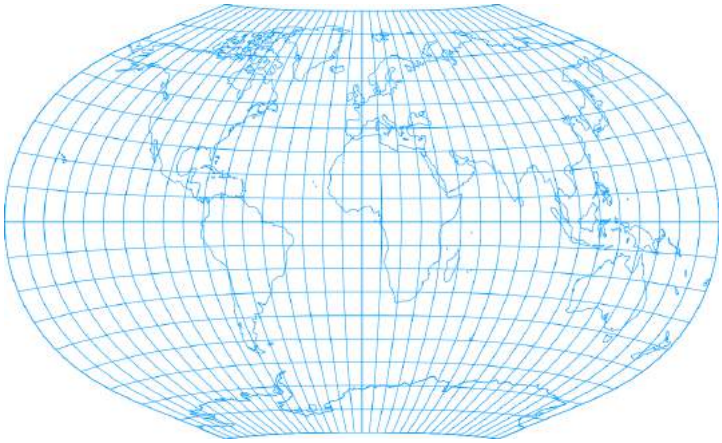


Figure 7: Ginzburg V (Flex Projector)

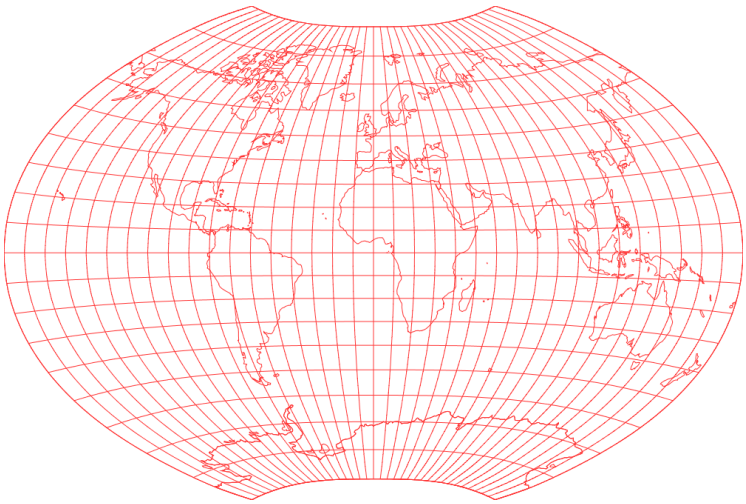


Figure 8: Ginzburg VI (Flex Projector)

4. Distortion (Deformation)

After the parameters are entered in the Flex Projector program, the deformations in the project are visible in the distortion table. The weighted average error for scale, area and angle distortion is calculated in two ways: all fields and only the continental areas. In addition, there are a customizable acceptance index that integrates areal and angular distortion, visualization of the acceptance index, interactive sections to generate distortion profiles, and diagrams with derivatives of flex curves. These four tools allow visualization and evaluation of the distortion model of the projection (Jenny and others, 2010). Richard Capek sums up these projections by creating a distortion table Q for about 100 projections used to produce world maps. This table created the parameters of the projections, the distortion formulas, the distortion values tables for the limited amount of points and the distortion lines drawn on the square networks. The distortion characterization Q is the acceptance Q index in the Flex Projector program.

Table 4: Ginzburg IV Distortion Table

Distortion Table | Distortion Profiles | Flex Curves

Projection	Scale	Scale Cont.	Areal	Areal Cont.	Angular	Angular Cont.	Acc. 49° 150%
Eckert III	0,29	0,35	0,37	0,45	18,25	21,20	87,7
Natural Earth	0,25	0,31	0,19	0,25	20,54	22,98	87,5
Winkel II	0,27	0,31	0,17	0,23	24,20	25,65	87,4
Natural Earth II	0,25	0,30	0,18	0,21	21,43	24,64	86,5
Kavrayskiy VII	0,23	0,27	0,28	0,38	19,15	20,88	86,5
Winkel Tripel	0,28	0,26	0,18	0,26	23,28	22,77	85,0
Robinson	0,27	0,32	0,19	0,23	21,27	23,75	84,3
Fahey	0,25	0,29	0,42	0,56	16,14	17,12	83,2
Eckert IV	0,26	0,45	0,00	0,00	28,73	31,88	81,9
Wagner VI	0,26	0,32	0,34	0,48	20,41	22,52	80,4
Eckert V	0,30	0,34	0,29	0,35	23,47	24,27	80,0
Winkel I	0,29	0,30	0,23	0,28	25,80	25,75	78,1
Denoyer Semi-elliptical	0,31	0,36	0,25	0,35	-	-	76,3
Flex Sliders	0,33	0,33	0,58	0,31	37,84	26,48	75,8
Equidistant Cylindrical (Plate C...	0,29	0,41	0,57	0,82	16,84	21,48	74,3
Kavrayskiy V	0,38	0,44	0,00	0,00	30,36	33,28	74,1
Wagner VII	0,37	0,40	0,00	0,00	30,71	31,07	74,0
Cylindrical Equal-Area	0,57	0,82	0,00	0,00	30,90	38,53	71,9
Mollweide	0,29	0,43	0,00	0,00	32,28	32,96	70,6
Ginzburg VIII (TsNIIGAiK 1944)	0,29	0,30	0,51	0,63	20,36	17,61	70,5
Nell-Hammer	0,43	0,53	0,00	0,00	30,90	34,14	70,2
Putnins P1	0,39	0,40	0,10	0,12	38,79	31,66	69,1
Miller Cylindrical I	0,39	0,55	1,38	1,94	7,63	10,15	62,9
Pattberson	0,55	0,48	0,76	1,07	16,44	14,50	62,9
Hammer	0,43	0,42	0,00	0,00	35,66	33,86	63,0
Larrivée	0,35	0,45	1,05	1,45	10,06	10,29	61,7
von der Grinten (I)	0,41	0,52	1,46	2,06	7,75	7,38	57,4
Mercator	-	-	-	-	0,89	1,18	57,4
Sinusoidal	0,51	0,49	0,00	0,00	39,01	36,24	57,1

In the order of the Richard Capek's Q-index (characterization) table, the Ginzburg V projection is ranked 1 st among the 100 projections and the Ginzburg IV projection is ranked 49 th (Capek, 2001). While this table is being generated, the Q index is calculated in some projections by cartometric and in some by computer. There are projections calculated by both methods. The best projections according to the Q index are those with over 80% value. In Capek's table, the values of the Ginzburg Projections were calculated using only cartometric processing. Ginzburg's Q-indexes are also found in Flex Projector and are written on the table so that they can be compared with cartometric values.(Table 5).

Table 5: List of projections according to Q index (with percentage values)

place	projection	*Q* set by	
		computer	cartometry
1	CNIIGAiK (or TsNIIGAiK) 1950 (= Ginzburg V)	85.7	84.7
4	Robinson		82.6
12	Winkel III $\varphi_0 = \pm 50.46°$	80.7	80.6
17	Wagner VIII		80
18	Eckert III	79.9	79.8
19	Hufnagel 7		79
27	CNIIGAiK 1954 (= Ginzburg VII)		77
28	Eckert V	76.7	76.1
45	CNIIGAiK BSE (= Ginzburg VI)	71.8	73.2
47	Putnins P4'	72.4	73.6
49	CNIIGAiK 1939-1949 (= Ginzburg IV)	75.9	72.3
50	Kavrajskij VI = Wagner I	71.2	70.6
55	Eckert VI	68.9	68.7
67	CNIIGAiK 1944 (= Ginzburg VIII)		63.4
69	Putnins P3	62.9	61.5
75	CNIIGAiK with oval distortion lines (= Ginzburg III)		60.5
76	Craster = Putnins P4	60.3	61.5
88	Fournier I	50.1	
89	CNIIGAiK 1944 (formulae by Canters - Decleir)	49.5	
99	Lagrange		27
100	August		20.7

4.1. Tissot Indicatrix (Deformation Ellipses)

The classic way of showing a deformation of projection naturally is to use tissot indicatrix. Deformation ellipses are shown with 30º intervals. Moving away from equator, the ellipses grow, indicating that the deformation increases in high latitude regions.

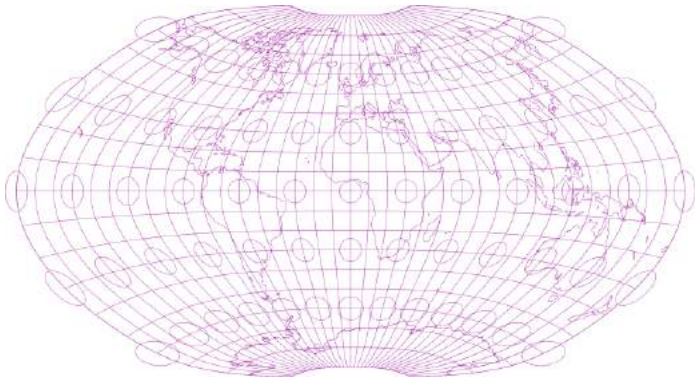


Figure 9: Deformation Ellipses of Ginzburg IV

4.2. Area and Angle Distortions

Distortion states lengths, fields, and angles, and the value changes constantly from point to point (Capek, 2001). The equidistance value between curves is chosen as 5º for angular distortion curves. Distortion curve maps show where maximum angular distortions occur (Figure 10).

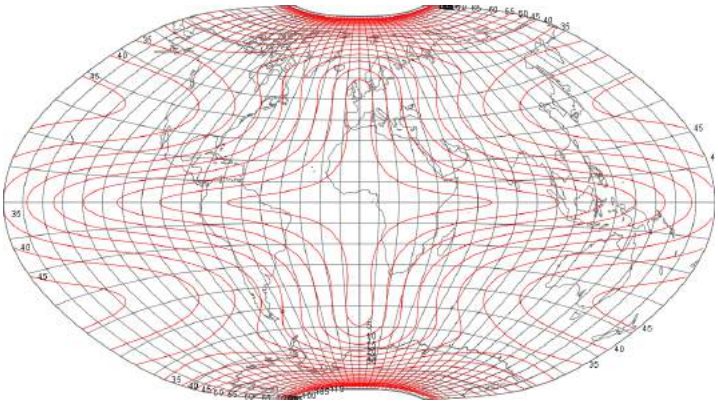


Figure 10: Maximum angular distortion curves of Ginzburg IV

Moreover, for showing the areal distortion the equidistance value between curves was chosen as 0.5 (Figure 11).

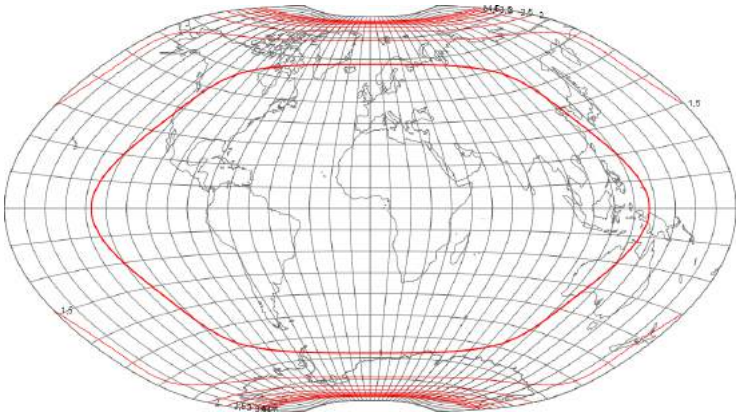


Figure 11: Maximum areal distortion curves of Ginzburg IV

4.3. Acceptance Index

Flex Projector provides visualization of acceptance indexes. Areas with acceptable angle and area distortions are shown on the projections. These regions are delimited by curvilinear regions, with 67 to 150% areal distortion and angular distortion below 40 degrees.

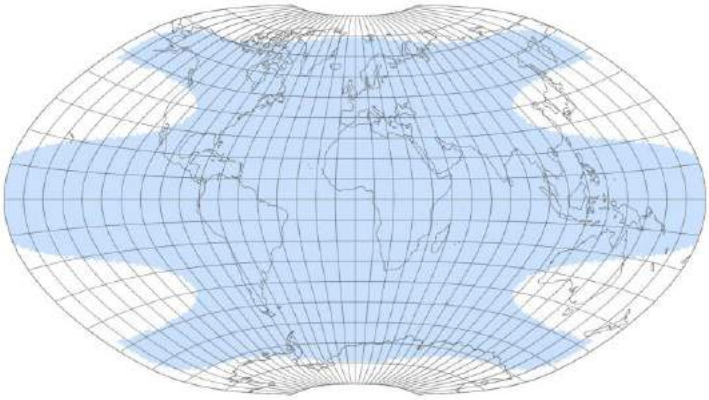


Figure 12: Acceptance Index of Ginzburg IV

5. Conclusion

Depending on the purpose of the map, some deformations can be designed with acceptable boundaries. Deformations of map projections vary according to the properties of the intermediary surface. Ginzburg projections have been produced in several different ways, taking care that the deformations occurring in angle, area and length elements are at minimum levels. Before the technological tools were used frequently, these projections were obtained by cartometric processing methods. With the rapid spread of technology in mapping, computer software developed to design map projections easily has made it possible to recreate some of the projections produced in the past with new methods. The Flex Projector program was developed with inspiration from the Robinson projection defined by table values. Projections of Ginzburg IV, V and VI, like the Robinson, can be easily implemented on the program because they are defined with table values. It is possible to design new projections by making adjustments on the famous world map projections registered in the library. In addition, it allows the generation of old or new projections with specific parameters.

The Flex Projector encourages the user to develop appropriate projection parameters, get into the solution process to get the right result, and improve the knowledge about map projections. Ginzburg projections, which are designed automatically in the Flex Projector program, have been designed by different people in different ways before. The design of Ginzburg projections according to this work are almost identical to the previous designs both graphically and as distortion values. Other projections that are not included in the library of the Flex Projector software can be similarly design.

References

Capek, R. (2001). Which is the Best Projection for the World Map, Proceedings of the 20th International Cartographic Conference, Vol:5, pp.3084-3093, Beijing, China.

Ginzburg, G.A., Salmanova, T.D. (1957). Atlas dlja vybora kartograficeskich projekcij, (Atlas for the selection of cartographic projections) Trudy CNIIGAiK, Vol:110, Geodezizdat Moskva, 239pp. (Russian)

Ginzburg, G.A. (1952). Matematiceskoje obosnovanie kart komplexnych mirovyh geograficeskich atlasov, (Mathematical principles of geographical maps in mixed world atlases Trudy CNIIGAiK, Vol:91, Moskva, 1952 (Russian)

İpbüker, C., Özşamlı, C., Yanalak, M. (2002). Ginzburg IV Projeksiyonu, Harita Dergisi, No. 127, 2002, s. 34-47, ISSN: 1300-5790, Harita Genel Komutanlığı (General Command of Cartography).

Jenny, B., Patterson, T., Hurni, L. (2008). Flex Projector–Interactive Software for Designing World Map Projections, ETH Zurich, Switzerland.

Jenny, B., Patterson, T., Hurni, L. (2010). Graphical design of world map projections, International Journal of Geographical Information Science, 24: 11, 1687-1702.

Clement J.J., (2003), *Imagistic Simulation in Scientific Model Construction*., Proceedings 25th Annual Conference of the Cognitive Science Society'in İçinde, (Alterman R., Kirsh D., Ed.), Boston, Massachusetts, USA., ss.67-72.

Jenny, B., Patterson, T. (2013). Blending world map projections with Flex Projector, Cartography and Geographic Information Society, Virginia, USA.

Press, W. H., Flannery, B. P., Teukolsky, S. A., Vetterling, W. T. (1989). Numerical Recipes, The Art of Scientific Computing, Cambridge University Press, Cambridge.
URL1< http://atlas.selcuk.edu.tr/1205633/sunular/hproj_sunu01.pdf>
URL2< http://akademi.itu.edu.tr/buker/DosyaGetir/42154/KartProj_DersNotlari.rar>
URL3< http://www.flexprojector.com/>
URL4< http://map-projections.net/single-view/ginzburg-4:green-stf
URL5< http://map-projections.net/single-view/ginzburg-5:green-stf>
URL6< http://map-projections.net/single-view/ginzburg-6:green-stf.>

The problem of representativeness of hydrometeorological observation network and its effect on calculation of basin water potential

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Abstract

Sustainable water resources management in the catchment scale primarily requires an accurate determination of potential of the water resources. In this context, in order to calculate the hydrological water budget with less uncertainty, it is important to have a representative hydrometeorological observation network in the basin, which provides reliable estimates of the hydrological cycle components at basin scale. Based on this fact, Geographic Information System (GIS) will help construction of a decision support mechanism of the water resources management. Precipitation is the main source of water resources potential. To estimate the spatial distribution of precipitation over hydrologic basin, some approaches are developed based on different methods. However, these different methods give different. In the meantime, the relation between the elevation and precipitation and snow melt affect the calculation of the water resources potential. In this study, following the spatial distributions of the precipitation in Cankurtaran and Çay sub-catchment in Akarçay Basin by using GIS, runoff values calculated by curve number method are compared with the measured runoff. Precipitation dependency on elevation and the snow melt effect on calibration runoff are demonstrated and finally the importance of the hydrologic representativeness of the hydrometeorological network will be emphasized.

Keywords
Hydrometeorological observation network, water potential, GIS, sustainability

1. Purpose

Within the content of the doctorate thesis “Groundwater Body Delineation with Approach of Interactive Systems to Sustainable Groundwater Management, Case Study: Akarçay Basin”, it has been noticed that observed precipitation was less than sum of both calculated potential evapotranspiration and calculated runoff. In that case, it has been stated that only precipitation value shouldn’t be considered for calculation of basin water potential especially groundwater aspect. Otherwise component of water budget doesn’t reflect real situation. So, it is important to be emphasized that the problem of representativeness of hydro meteorological observation network and its effect on calculation of basin water potential.

2. Method

Interpolation technique on Geographic Information System (GIS) was used to calculate spatial precipitation distribution in the Basin. Second component of water budget, potential evapotranspiration (ETp), was estimated with Thornthwaite Method. For actual evapotranspiration (ETa), Thornthwaite-Mather Method was preferred. Finally, SCS-CN technique is one the best way to estimate run off, this method was carried out.

3. Results

Akarçay Basin, 7333 km^2, is located 30^0 00’ - 31^0 49’ east longitude and 38^0 10’ - 38^0 58’north latitude. Main river in the basin is Akarçay River. It falls into the fourth Strahler Order according to 1/100000 scale (Figure 1). Because the basin has no connection to sea, rivers discharge to Eber and Akşehir Lakes. The closed basin has continental climate. Annual total average precipitation and average temperature are 442.5 mm and 11.3 ºC respectively for 1929-2015. Altitude of basin is between 952 m and 2610 m.

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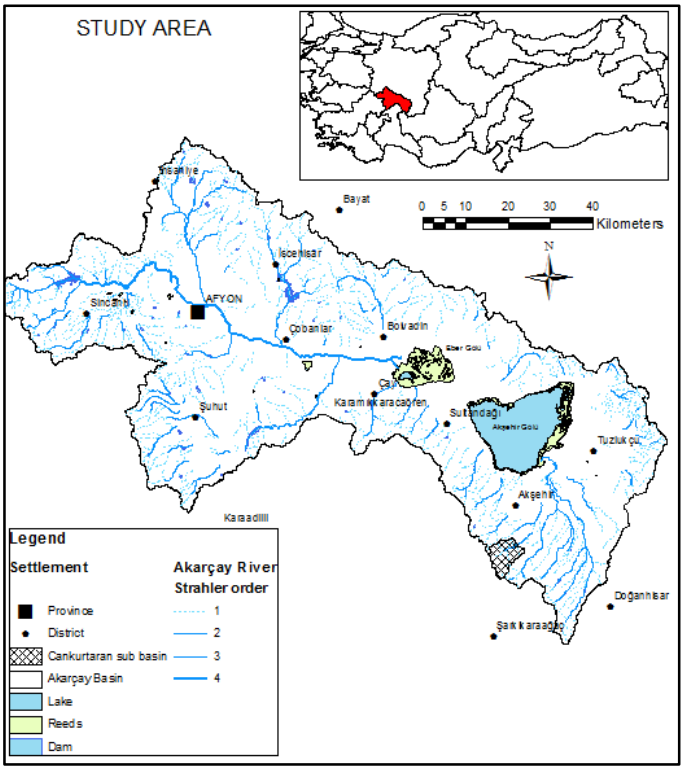

Figure 1: Study Area

At the same time, closed basis is a depression basin and Afyonkarahisar province is located on the basin. Basin is surrounded by Sakarya Basin, Konya Kapalı Basin, Antalya Basin and Büyük Menderes Basin. Study area is located at the Sultandağ Mountains which is bordering the south east of the basin. Records of Cankurtaran stream gauge station numbered D11A015 has been used. In order to determine the sub-basin of the Cankurtaran station, Digital Elevation Model (DEM) which has 10 m x 10 m cell size was created. Sub-basin was determined thanks to ArcHydro Program. Later, output of the program was checked with topographical map and it was calculated that the Cankurtaran sub-basin has 44.8 km^2 water catchment area (Figure 2).

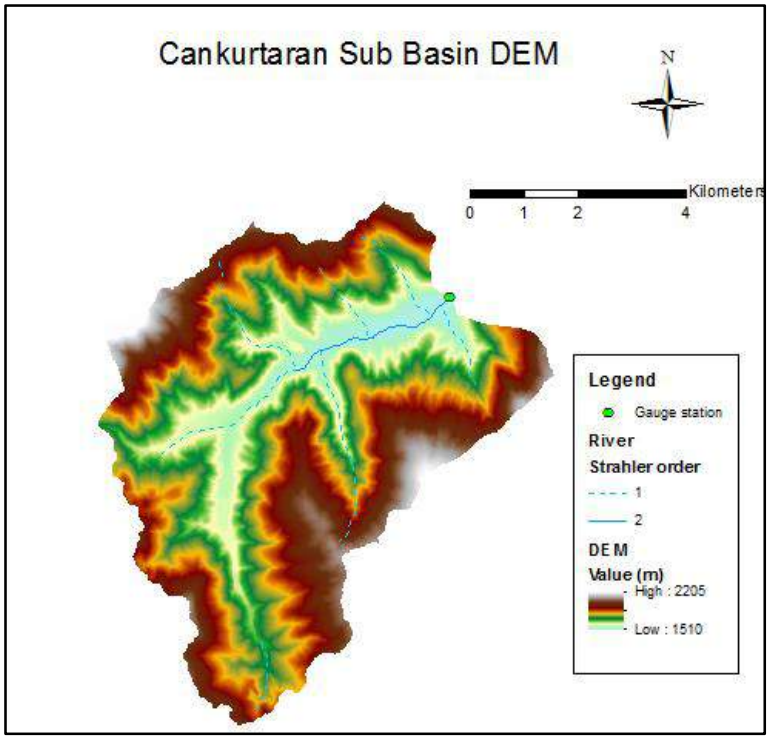

Figure 2: DEM of Cankurtaran sub-basin

There are 3 hydrometeorological stations in the sub-basin. Snow thickness, precipitation and stream discharge are observed (Table 1).

Table 1: Stations in the sub-basin

	Elevation (m)
Stream gauge station (SGS)	1502
Meteorological station (MS)	1550
Snow station (SS)	1590

It can be seen at the Table 1, elevation of meteorological station is 1550 m. Because maximum elevation of sub basin is 2205 m (Figure 2), elevation-area graph was formed whether it represents sub-basin or not (Figure 3).

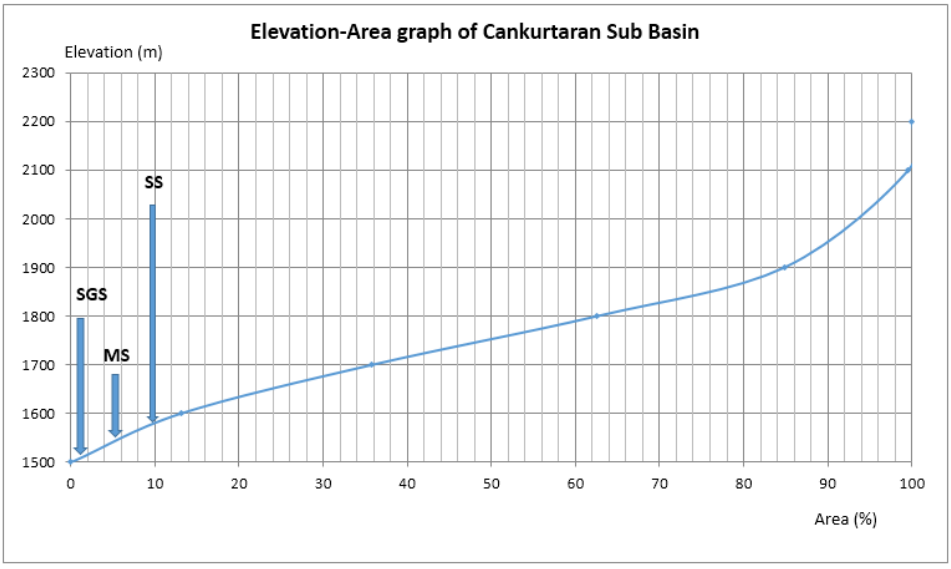

Figure 3: Elevation-area graph of Cankurtaran sub-basin

It is clear that approximately 95 % of sub-basin was not represented as meteorological according to Figure 3. Maximum precipitation was observed in December as 99 mm and annual total average precipitation is 690.2 mm for 1980-2001 (Figure 4). Stream discharges have been recorded since 1966. Annual average flow is 1 m^3/s. Maximum discharge is observed in April as 4.6 m^3/s (266 mm) while minimum is recorded in August as 0.026 m^3/s (Figure 4).

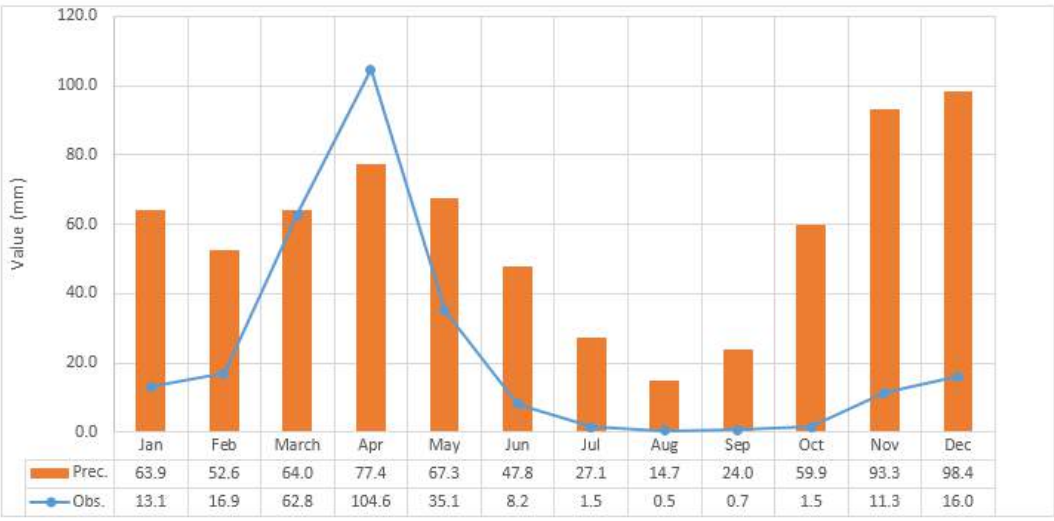

Figure 4: Monthly precipitation and observed runoff of Cankurtaran station

Water potential was calculated for Cankurtaran sub-basin. As mentioned before, annual total average precipitation and average temperature are 690.2 mm and 11.8 ºC respectively. By means of Thornthwaite Method, ETp was calculated monthly. As for ETg, it was estimated by using Thornthwaite-Mather Method. ETp and ETa are 695 mm and 434.1 mm respectively as seen at Table 2

Table 2: ETp and Eta

	Jan	Feb	March	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Preci. (mm)	63.9	52.6	64.0	77.4	67.3	47.8	27.1	14.7	24.0	59.9	93.3	98.4	690.2
Temp. (°C)	1.1	2.4	5.9	10.9	15.4	19.3	22.4	22.2	18.2	12.8	7.5	3.0	11.8
ETp (mm)	1.8	5.0	20.0	47.0	82.2	111.2	135.9	125.9	86.4	50.5	22.3	6.8	695.0
Eta (mm)	1.8	5.0	20.0	47.0	82.2	111.2	48.7	14.7	24.0	50.5	22.3	6.8	434.1

SCS-CN method was performed to calculate runoff. SCS has developed a method of combining the effects of soils, watershed characteristics, and land use into a single parameter. This parameter is the runoff curve number (CN) and represents the hydrologic soil cover complex of a watershed. A single runoff CN can be developed for a watershed with a single land use and one soil type, and for a watershed with a combination of soils and land uses (SCS 1989).

SCS estimates direct run off originated from precipitation but surface and sub-surface flow is determined by CN (SCS, 1972). Precipitation and runoff relation used in SCS method is expressed by following formula;

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S}$$

S value;

$$S = \frac{25400}{CN} - 254$$

Q = run off (mm)
P = precipitation (mm)
S = maximum retention after runoff begins (mm)
CN = curve number

S is controlled by the rate of infiltration at soil surface or by rate of transmission in the soil profile or by the water storage capacity of the profile (SCS, 1972).

Soils are classified into hydrologic soil groups to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. Hydrologic soil groups, A, B, C, and D, are the element that is used in determining runoff curve number. While group A soils have low runoff potential and high infiltration rates, group D soils have high runoff potential (SCS, 1972).

The combination of hydrologic soil group and cover type information results in a hydrologic soil cover complex. The CN indicates the runoff potential of a hydrologic soil cover complex. The higher the CN, the higher the runoff potential (SCS, 1989).

Özer (1990) has developed curve number for Turkey hydrologic soil groups and land use in Turkey. Digital data used for soil type was produced by abolished General Directorate of Rural Services. These data, both curve number produced by Özer and soil type determined by Rural Services, have been used.

CORINE programme was used for land use. The programme aims to build standard databases in order to determine environmental policy, to manage natural resources rationally and to assess data standardized. It has 5 main classes such as artificial surfaces, agricultural areas, forests and semi-natural areas, wetlands and water bodies (http://corine.ormansu.gov.tr /corineportal/nedir.html). CN is 82 by considering land use (Figure 5) and soil group (Figure 6).

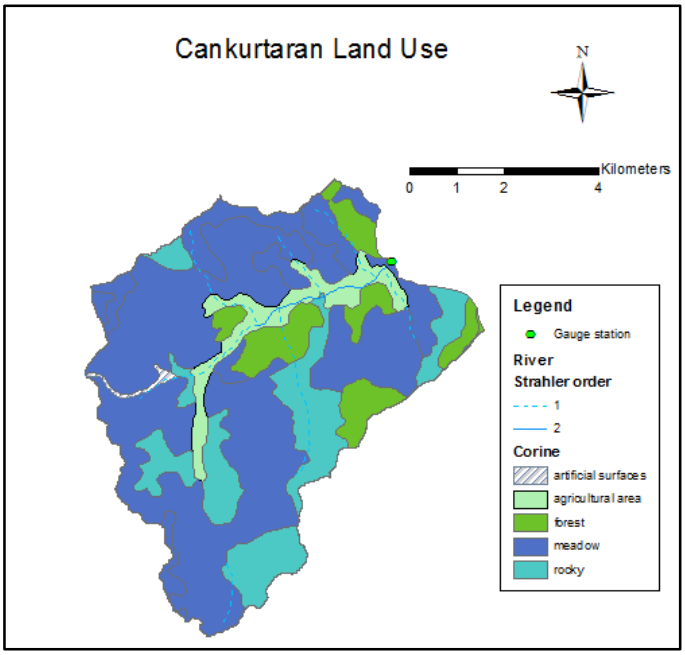

Figure 5: Land use of Cankurtaran sub-basin

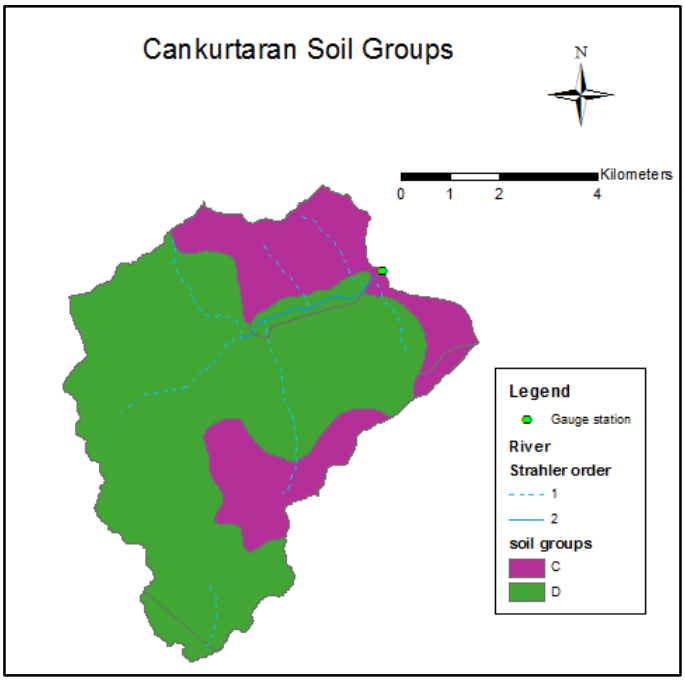

Figure 6: Soil groups of Cankurtaran sub-basin

Annual runoff was estimated 278.7 mm when we evaluate CN as 82 (Table 3).

Budget is;

$$\text{Precipitation} = \text{ETa} + \text{Runoff} + \text{Infiltration}$$

$$690.2 \text{ mm} < 434.1 \text{ mm} + 278.7 \text{ mm} + \text{infiltration (Formula 1)}$$

It can be seen in Formula 1, even if we do not consider infiltration, precipitation is less than sum of calculated ETa and calculated run off in yearly scale. It can't be possible. In order to clarify that, calculated and observed runoff are compared to precipitation. Even if we don't consider ETa, observed runoff is higher than precipitation in April and is almost equal in March, (Table 3), (Figure 7).

Table 3: Calculated and observed runoff

	Jan	Feb	March	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Preci. (mm)	63.9	52.6	64.0	77.4	67.3	47.8	27.1	14.7	24.0	59.9	93.3	98.4	690.2
Cal. runoff(mm)	25.6	17.7	25.7	35.9	28.1	14.5	3.5	0.2	2.4	22.7	48.9	53.2	278.7
Observed Runoff (mm)	13.1	16.9	62.8	104.6	35.1	8.2	1.5	0.5	0.7	1.5	11.3	16.0	272.3

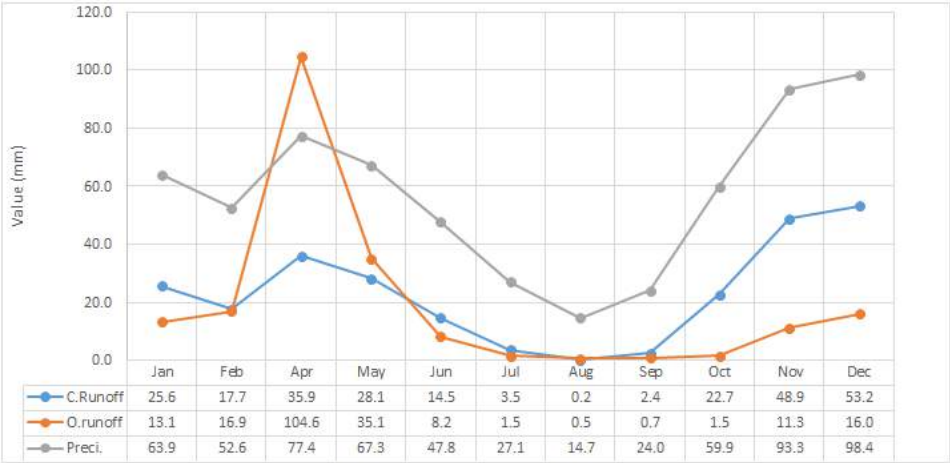

Figure 7: Comparison of precipitation, calculated and observed runoff

For calibration, new expected precipitation in April is searched. To obtain it, 30 mm is added.

4. Conclusions

- With the help of the elevation-area graph, it has been seen that meteorological station doesn't represent 95 % of basin.
- According to observed records, runoff is higher than precipitation in April.
- Because there is no recharge from out of sub-basin, observed precipitation values don't reflect the real precipitation rate.
- It is thought that added precipitation in April is originated from the relation between precipitation and elevation and also snow melt.
- It is important that while calculating water potentials, hydrometeorological stations should represent the basin.
- Stream gauge stations need to be extended.

References

Apaydın A., 2004, Çakıloba-Karadoruk Akifer Sisteminin Beslenme Koşullarının Araştırılması.
ESRI, Maidment D. (Ed.), 2002, Arc Hydro GIS for Water Resources.
ESRI, 2010, Arc GIS Desktop Help.
H.Ü., 1985, Genel Hidrojeoloji Laboratuvarı Ders Notları.
http://corine.ormansu.gov.tr/corineportal/nedir.html
Merwade V., 2010, Watershed and Stream Network Delineation.
SCS Hydrology Training Series, Module 104, 1989, Runoff curve number coputations.
SCS National Engineering Handbook, Section 4, 1972, Estimation of direct runoff from storm rainfall.

Cemetery Information System: A Case Study in Sivas City

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Abstract

The Cemetery Information System (CIS) is one of the most important service areas offered by the local governments in our country to citizens. In this respect, many municipalities are striving to provide more efficient and effective service by trying to provide these services with the help of information technology. Many municipalities, mainly Ankara, Izmir, Bursa, Denizli, Eskişehir and Konya municipalities, provide these services with web-based GIS. In this study, it is aimed to collect all the existing data in Sivas Municipality Cemetery Directorate in a common database, to create digital maps of cemeteries, to integrate the death certificates obtained from the Provincial Health Directorate and other related non-geographical data, to make them inquirable and analyzable, and to present them to the citizens for use on the internet. With this work, citizens will be able to access the information of their relatives died in the cemetery via internet, they will be able to see the locations and photographs of the graves on their screens and get the maps showing the locations of the graves. In addition, the citizens who want to visit the graves of their relatives will be able to easily find the graves. Thus, they will be able to get better quality and more efficient service by Sivas Municipality.

Keywords
GIS, Web-based GIS, Cemetery Information System

1. Introduction

Nowadays, there is a very rapid flow of population around the world from rural to urban areas. This movement causes rapid urbanization and urbanization problems and therefore requires regular urbanization planning (Morova, 2006). This necessity reveals the importance of the concept of regular urbanization needs, planning, urban management and information systems. In order to provide more qualified services in the cities, they need accurate and rapidly accessible data/information within an effective decision support mechanism. It has emerged that data need to be gathered in a single platform in order to effectively provide local government services such as transportation, technical infrastructure, control of social facilities, planning and social assistance. Local governments needed to create "knowledge management" and "management facilities" in order to be able to provide their services effectively and directed them to create their own location based information systems in order to have the city. Urban Information System (UIS), known as the application of GIS at the urban level, has begun to be preferred to local administrations in this sense (Kocaman, 2012).

Another concept that is as important as the birth and life events of people in nature is death. As a result, the necessity of managing the cemetery areas in cities correctly and effectively has increased the importance of the Cemetery Information System (CIS) in the UIS. CIS; fast, economical and planned decision support system by using the latest technologies for business and operations related to the management and use of cemeteries, which is one of the main offices of all municipalities (Kocaman, 2012). CIS is a system that allows planning of new burial sites, which allows collecting, interrogating and analyzing all data (existing maps, burial documents, cemetery records, geographical / non-geographical information, death documents etc.) found under the Directorate of Cemetery under a single roof (Ankara Büyükşehir Belediyesi, 2017; Bursa Büyükşehir Belediyesi, 2017; Denizli Büyükşehir Belediyesi, 2017; İzmir Büyükşehir Belediyesi, 2017; Eskişehir Büyükşehir Belediyesi, 2017; Konya Büyükşehir Belediyesi, 2017). With the help of this system citizens, information about their deceased relatives; they can be accessed from the interactive kiosks kept in the entrance doors of the cemeteries, as well as on the internet. They can see the locations of the graves on the screen and take the map output showing the short path routes. The printed output of the Cemetery Directorate and other related units used in the burial process is also prepared automatically by this system (Kocaman, 2012).

Information can be shared with internal and external institutions via CIS. Statistical information about the deaths of the deceased persons, such as the reasons of medical mortality, male and female ratios, age groups, etc., are presented to the user with graphic or tablelay. Cemetery, door, island, parcel, road, green area, grave sites and family cemetery planning can easily be done and documents for allocation of places can be given (Kocaman, 2012). In this study, tens of thousands of dead records were entered into the database through the designed system which is in the cemeteries of the Sivas municipality and all the new and existing cemeteries to be created, and the locations of the graveyards were transferred to the GIS environment by using related software. With this study, it is aimed to realize the following processes in a GIS-based environment as a whole.

- Presentation of the municipal services required by the age,
- Shortening time required for finding burials searched and providing the use of effective time for visitors and municipality personals

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- Obtaining output of the optimum path by the optimum path analysis and the main points in the cemetery on the map,
- Decreasing of confusion and workload due to visitor intensity on special visit days (Fridays, special days etc.)
- Geographical planning for future burials in the cemeteries,
- Providing online information for staff and citizens via internet.

2. Study Area

Sivas province was chosen as the study area (Fig. 1). Funeral procedures are mainly carried out in the Yukarı Tekke Cemetery, and funeral procedures and other services are put into practice in cemeteries located in different regions. In this context; there are seven different cemeteries in directorate of the cemeteries. Names of these cemeteries are Yukarı Tekke, Halfelik, Aydogan, Çayboyu, Uzuntepe, Esenyurt. It is also served to the Non-Muslim Cemetery, also known as Maşatlık.

The sum of the total reconstruction area of Yukarı Tekke Cemetery and the area projected as grave is 840.000 m². 400.000 m² of this area was buried with funeral burial. It is envisaged that about 80,000 tombs will be built in the city blocks to be constructed the rest of the 440,000 m² area without the planned roads and social areas. The Yukarı Tekke Cemetery area, which has been subjected to about 2,000 burials per year according to the statistics, will have met the need of the province for the next 40 years (if not an extraordinary situation). In total there are 55,000 registered graves. It is estimated that there are around 25,000 unnamed anonymous graves. Thus, the total number of burials is around 80,000.

Figure 1: Study area

3. Materials and Methods

In the scope of this study, the process steps described in Figure 2 were carried out.

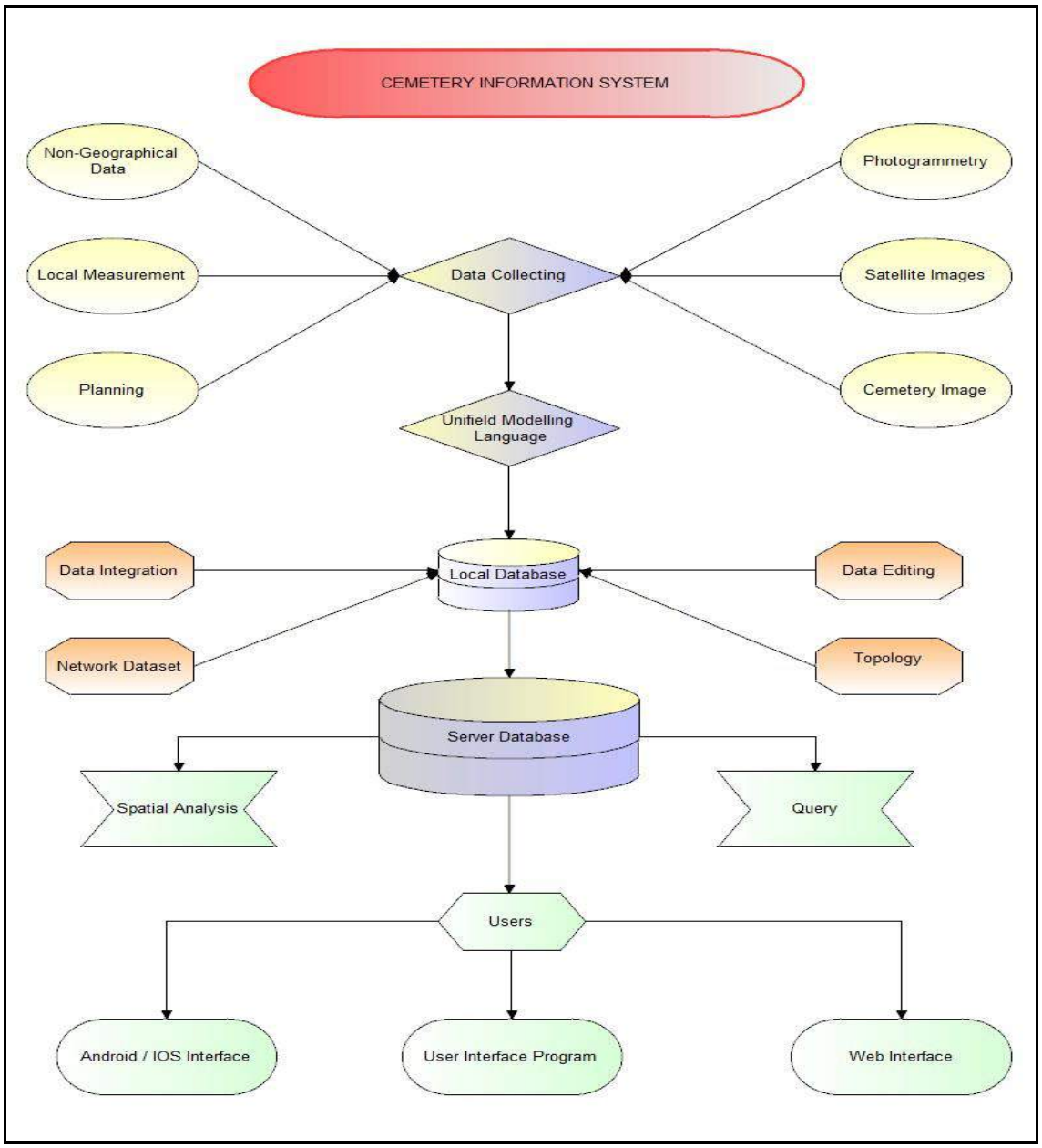

Figure 2: Workflow chart developed for this study

The system architecture is organized by examining existing data in the municipality. Afterwards, database design and general framework were performed by UML (Unified Modeling Language) diagrams. Feature classes such as the cemetery borders, the owner, the city block, the structure, the road, the parcel were created in the database. In addition, the metadata of existing data is organized and integrated into the system. On the other hand, ortho-images of 2007, 2012, 2016 and 2017 of the study area were obtained. Data integration for missing data has been put into practice on the field and the accuracy of the data has been tested.

ArcGIS software was used in the study. The topological rules required for each of feature classes have been applied. The network structure of the data defining the topological associations is established (Network dataset). Thus, the existing geographical and non-geographical data integrated in the GIS environment are queryable and analyzable (Fig.3). After transferring all data to the database, the metadata of each feature class and table were defined in the relevant fields (Fig.4).

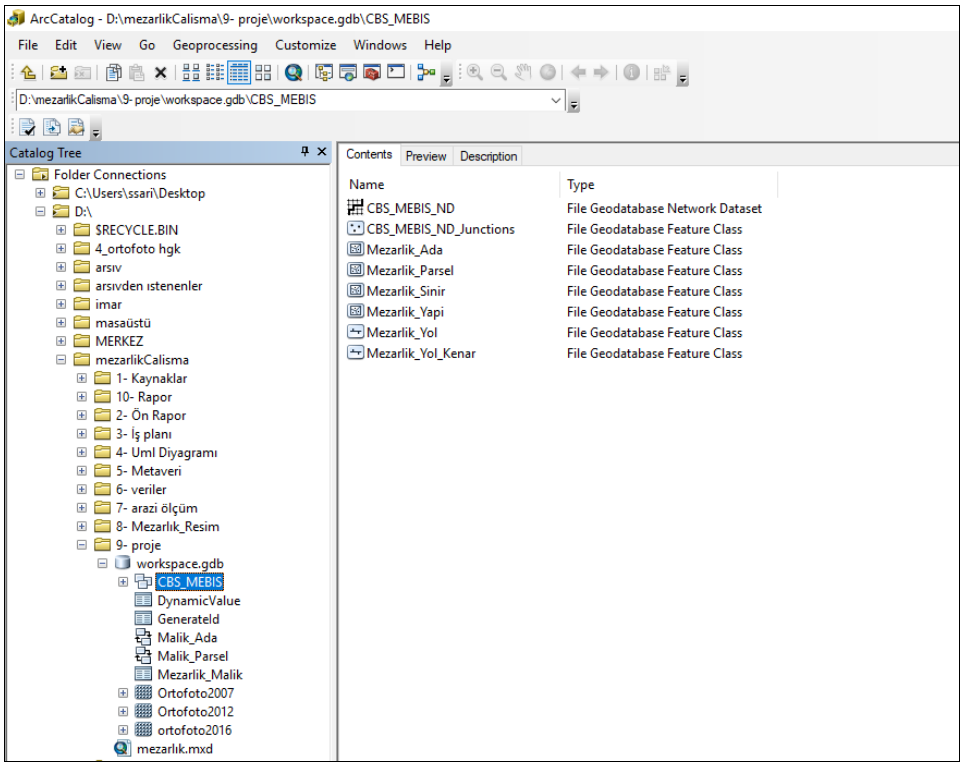

Figure 3: Feature classes and tables created on ArcGIS software

Sivas Belediyesi-Bilgi İşlem Müdürlüğü-CBS Şefliği

Tags
Mezarlik Bilgi Sistemi

Summary
Sivas ilinde ikamet eden vatandaşlarımızın yakınlarının mezarlarını ziyaret ettiklerinde rahatlıkla bulabilmeleri, Mezarlık kayıtlarının Cbs ortamında düzenli ve güncel tutulması amaçlanmaktadır.

Description

	Sivas Belediyesi Mezarlik Bilgi Sistemi	
	Metaveri	
1. Verinin Kimliği	Veri Kaynağının Adı	Sivas Belediyesi-Mezarlik Bilgi Sistemi
	Veri Kaynağının Özeti	KBS
	Veri Kaynağının Tipi	File Geodatabase
	Veri Kaynağı Hakkında Detaylı Bilgi	Sivas Belediyesi Web Sunucuları
	Veri Seti Tanımlayıcısı	MEBİS
	İlişkili Veri Kaynağı	SDO.CBS_MEBİS
	Telif Hakkı Sahibi	Sivas Belediyesi
	Veri Kaynağının Dili	Türkçe
2. Sınıflandırma	Veri Setinin Kullanım Amacı	Mezarlik Kayıtlarının Tutulması
	Servis Tipi	Web- Android
3.Anahtar Kelime	Anahtar Sözcükler	Sivas-Mez-Bel-Cbs
	Tanımlı Anahtar Kelimeler	Sivas-Mez-Bel-Cbs
4. Coğrafi Konum	Coğrafi Sınırlar	39,756 K-39,770 K ila 37,034 D-37,044 D
	Coğrafi Grid Bölgesi	Zone 36
5.Veri Standardı ve Referans Bilgileri	Temel Standardı	Sivas Belediyesi CBS veri altyapısı
	Uygunluk Derecesi	TUCBS
	Ölçek Uygulama Düzeyi	1/1000
	Referans Sistemi	ITRF_1996 / TM_36
	Konumsal Sunum Tipi	Web Sunucular Üzerinden
6. Zamansal Bilgi	Yayımlanma Tarihi	2012
	Güncelleme Tarihi	2017
	Üretim Tarihi	2007
	Güncelleme Aralığı	Haftalık
7.Coğrafi Veri Kalitesi ve Geçerlilik	Veri Kökeni	Arazideki Cors-Tr ile Ölçüm yapılmıştır.
	Tematik Doğruluğu	±10 Cm
	Mantıksal Tutarlılık	
	Konumsal Doğruluk	±10 Cm
8. Veri Kullanım Hakkı / Dağıtımı	Erişim ve Kullanım Koşulları	Sivas Belediyesi Bilgi İşlem Müd. izni ile
	Kamu Erişim Kısıtlamaları	Yok
	Veri Setinin Formatı	File Geodatabase
	Veri Sorumlusu	Sefa SARI
	Veri Sorumlusunun Rolü	Mekânsal İşlemler Sorumlusu
9. Metaveri Referans Bilgileri	Metaveri Tarihi	08/03/2017
	Metaverinin Güncellendiği Tarih	08/03/2017
	Metaveri Sorumlusu	Sefa SARI
	Metaveri Standart Adı ve Sürümü	
	Metaveri Dili	
	Metaveri Karakter Seti	
	Metaveri Dosya Tanımlayıcısı	

Figure 4: Metadata created on the system

4. Results and Discussion

As a result of these studies, CIS, which was created in ArcMap, was published on the internet with the help of a platform independent user interface program developed within this study. The web page is currently available at "http://mezarlik.sivas.bel.tr/mezarlik/" (Fig.5). The query samples are given in Fig. 6 and Fig. 7.

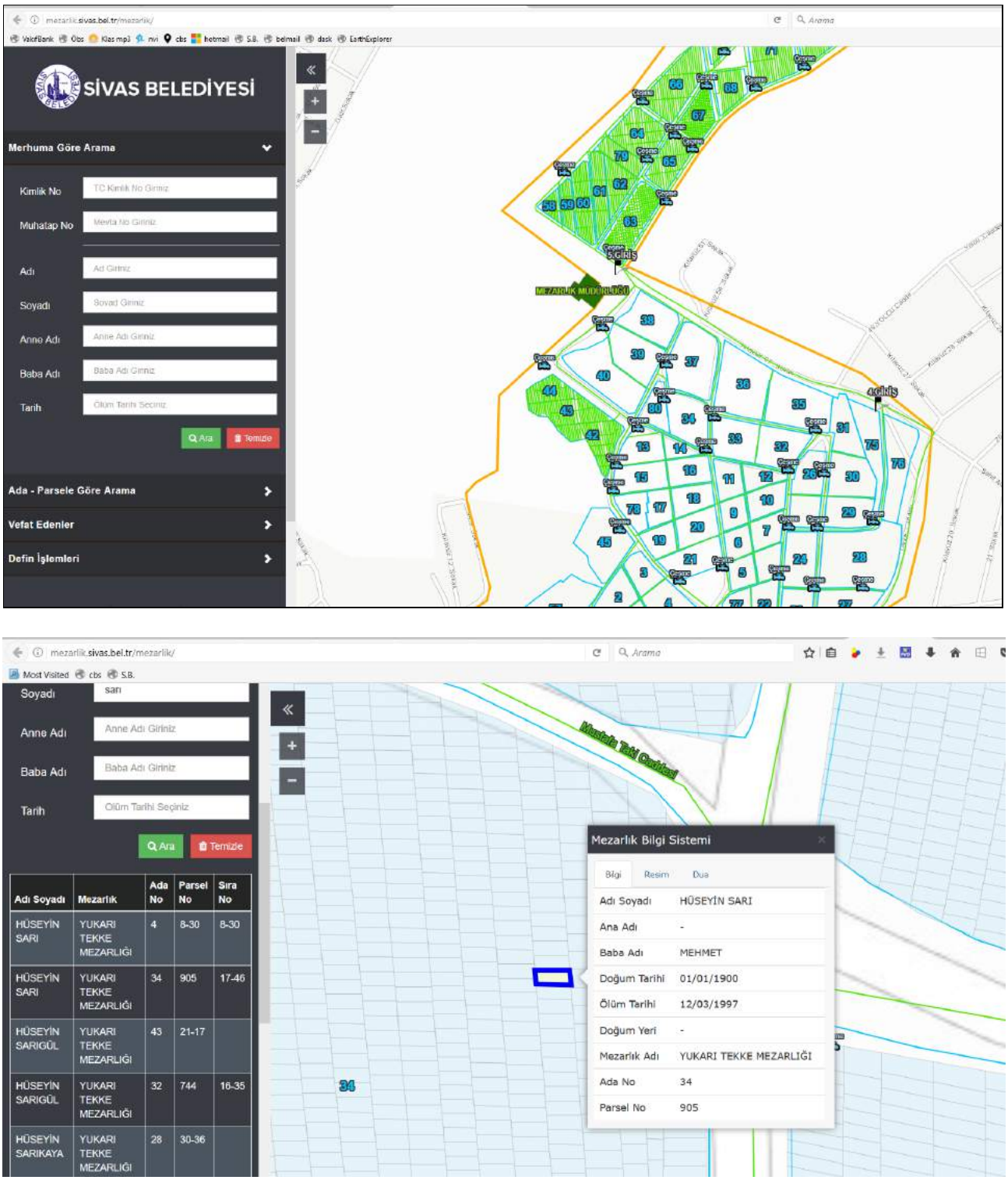

Figure 5: Platform-independent web environment

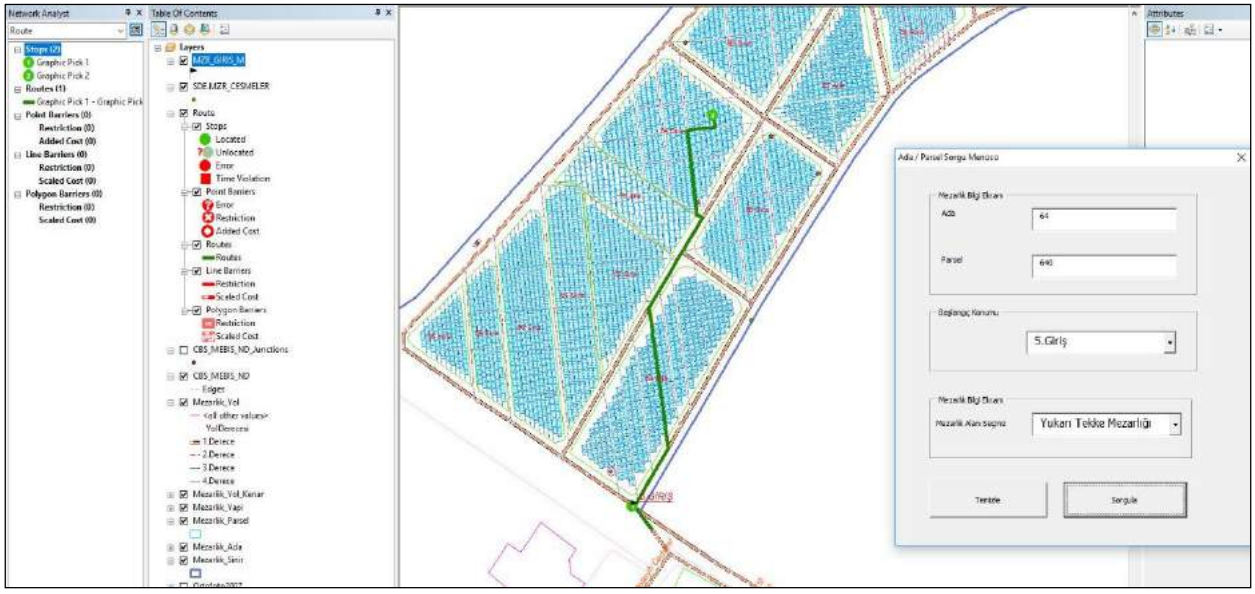

Figure 6: Query by user-interface program developed on ArcGIS

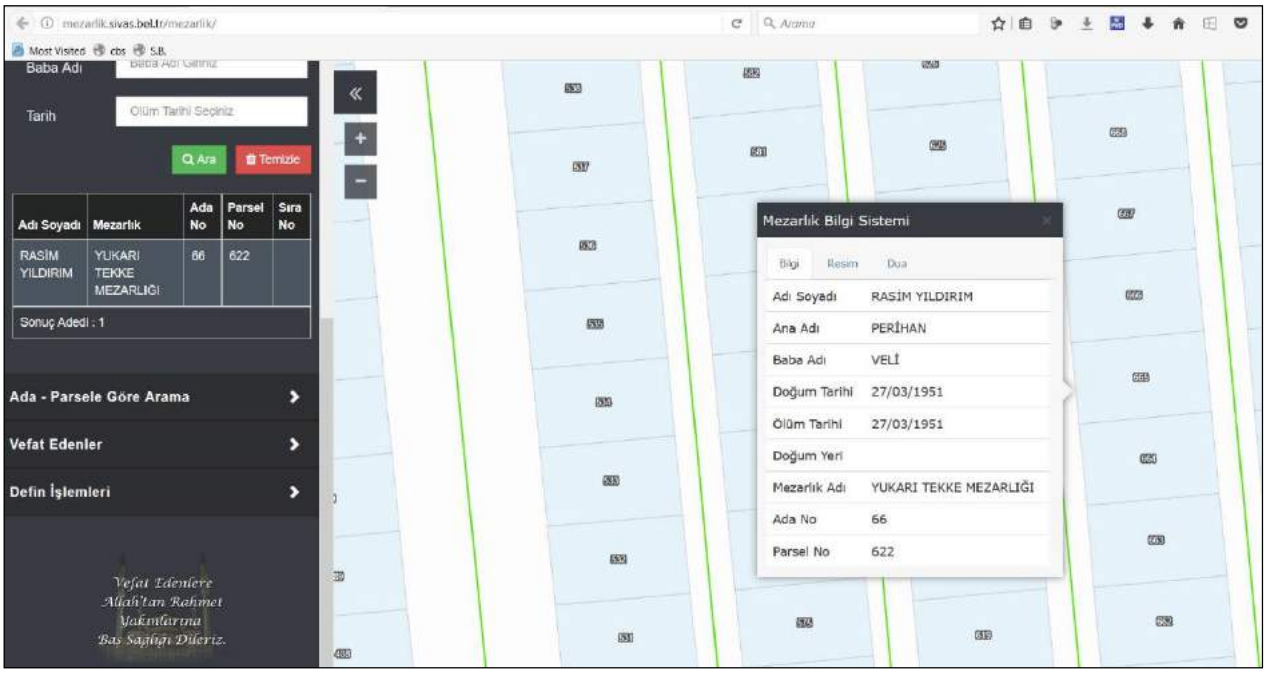

Figure 7: Query grave on the web environment

5. Conclusions

The aim of CIS, which has different versions in many local governments in our country, to provide better quality services to the citizens, to satisfy the religious and spiritual needs of the people living in the city, to ensure that they are satisfied with the services without difficulty, and to provide facilities for decision makers in planning. With this study, cemetery works which is one of the most important, complex and indispensable activities in municipalities have been solved with the help of GIS and presented to the service of citizens. One of the most important features of this work is the development of a platform-independent web-based application.

In the future, this service is planned to be offered in the mobile environment (Android), and work is continuing in this direction. On the other hand, it is aimed to enrich the existing system with different works such as estimates of the present and future of the past years, creation of disaster scenarios and planning of collective burial areas. It is also thought to place kiosks within the cemetery.

Acknowledgement

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References

Kocaman S, (2012), Akıllı Kent Haritaları, Yüksek Lisans Tezi, Afyon Kocatepe Üniversitesi, Afyon

Morova N, (2006), Kent Bilgi Sistemi ve Uyg., Yük. Lisans Tezi, Süleyman Demirel Üniversitesi, Isparta.

Güngör V, (1999), CBS'de Ağ Analizi, Yüksek Lisans Tezi, İstanbul Teknik Üniversitesi, İstanbul.

Bünyan FÜ, (2006), CBS'de Multimedya, Yüksek Lisans Tezi, Selçuk Üniversitesi, Konya.

Ankara Büyükşehir Belediyesi Mezarlık Bilgi Sistemi. (2017), http://mebis.ankara.bel.tr/ , [Accessed 20 May 2017].

İzmir Büyükşehir Belediyesi Mezarlık Bilgi Sistemi, (2017), http://cbs.izmir.bel.tr/CbsUygulamalar/MezarlikBilgiSistemi/, [Accessed 20 May 2017].

Denizli Büyükşehir Belediyesi Mezarlık Bilgi Sistemi, (2017), http://mezarlik.denizli.bel.tr/, [Accessed 20 May 2017].

Konya Büyükşehir Belediyesi Mezarlık Bilgi Sistemi, 2017, http://konmeb.konya.bel.tr/main.aspx, [Accessed 20 May 2017].

Bursa Büyükşehir Belediyesi Mezarlık Bilgi Sistemi, (2017), http://mbs.bursa.bel.tr/SearchKiosk.aspx, [Accessed 20 May 2017].

Eskişehir Büyükşehir Belediyesi Mezarlık Bilgi Sistemi, (2017), http://www.eskisehir.bel.tr/e_belediye_mezarlik.php?menu_id=33, [Accessed 20 May 2017].

GIS Use in Assessment of Risky Areas in Natural Disasters: The Example of Adana Province

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Abstract

Disaster can be defined as a set of events that occur with natural or human causes and cause economic and environmental losses that affect people's social lives. Natural disasters include earthquake, volcanic eruption, landslide, rock and avalanche, storm, hurricane, flood; nuclear and chemical accidents in technological disasters; human disasters can be seen as examples of forest fires, epidemics and war. The magnitude of an accident is measured by casualties, injuries, structural damage and social economic losses caused by an event. Potential hazards awaiting disaster-related communities are predominantly the concept of a risky area. Risky areas can be determined by collecting historical data on the data related to natural disasters, analyzing them, conducting various spatial analyzes and evaluations

Keywords
Natural Disaster, Risky Area, CBS, Spatial Analysis

1. Introduction

In order to be able to determine risky areas quickly and efficiently, it is necessary to carry out multi-faceted researches on disasters and to analyze these data together. In particular, taking into account the positional relationships between the data in the determination of risky areas and disaster-related plans; the Geographic Information System (GIS) has a very important position in terms of enabling density analyzes and evaluations to be made. GIS; It includes the process of submitting the data of the earth to the users by means of transferring the spatial information and attribute information to the computer environment, classifying these data, comparing them with each other, analyzing, updating and bringing them to the visual situation such as maps, graphics and tables as desired. In this respect, GIS provides tremendous advantages in disaster management issues, which aim to determine where impacts are most affected by disasters, and to reduce or eliminate impacts.

1.1. Material and Method

Regarding the study topic, statistical information about the natural disasters in Adana province was obtained from the website of the Disaster and Emergency Management Presidency (DEMP-AFAD) on the basis of counties. Chronological data on disasters such as earthquakes, severe winds, forest fires, river floods, heavy rainfall, floods, floods have been adapted to the ArcGIS software environment by taking spatial information into account for making historical data available in the Geographic Information System environment. By using density interpolation method which is a spatial and geostatistical analysis tools and field interpolation which is one of the special interpolation methods on this data, risky areas in terms of natural disaster have been determined on the basis of counties.

1.2. Density Analysis

The places where the features with dot or line layers are gathered are determined by density calculation. Density maps are usually generated from point type data and the output layer is created by circular search applied to each pixel. In order to calculate the value of each cell in the output layer of the research field, the lengths to be searched are determined. Density is found by means of calculations called "simple" or "kernel". In the calculation of the Simple Density, the points and lines falling into the search field are aggregated and divided by the size of the search field. Kernel Density computation is similar to simple density computation, but it is done within the framework of points and lines that are centered around the center of the search field cells and gain more weight than the edges (ArcGIS User Guide, 2003).

1.3. Areal Interpolation

Interpolation is the computation of the function necessary to calculate the new data by computing the new data with reference to the data at certain points (Lam, 1983; Kahaner et al., 1989). Interpolation described above is a definition made for point data, which may need to be used especially in geographical information systems, such as population distribution, meteorological data, soil quality, etc. Areal interpolation is the solution to this problem.

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Areal Interpolation is the process of generating information from a region (source region) to another region (target region) using some deterministic stochastic processes (Goodchildand Lam, 1980).

2. Application

This study will be about the feasibility of the methods used to determine the weaknesses of the communities mentioned above for Adana Province. In relation to this issue, data have been extracted from the website of AFAD Institution on https://tabb-analiz.afad.gov.tr In Turkey, earthquake, flood, fire etc. they have used the database service of natural disasters, but there is not much detail about the information in this server. These data are used in the following;

- Earthquake
- Tornado
- Forest fire
- River flood
- Severe rainfall
- Hail
- Grassland bushes fire
- Extreme snowing
- Flood
- Landslide

The data on the borders of the province of Adana are obtained from the Adana Metropolitan Municipality. The CORINE data, which generally shows the classification of the land such as agricultural areas, non-irrigated agricultural lands, fruit garden properties, etc., provided from General Directorate of Forestry. The data, Regarding the land situation and the agricultural land specifies the irrigation sources, provided from the Provincial Directorate of Agriculture. For Adana Province, Environmental plan data was downloaded as raster data in 1 / 100000 scale from the web site which is provided by the General Directorate of Environment and Urban Planning and accessed from https://atlas.gov.tr. Raster data has been digitized in the software environment of NetCAD.

This data has been adapted to the ArcGIS software environment to make it workable in the Geographic Information System environment. necessary datum transformations have been made. After this digitization;

- Protection areas for sea turtles
- Turtle nesting area
- Natural and ecologically protected area
- Protected sites
- Precision sensitive areas
- Wetland ecological impact areas
- Wildlife conservation / development areas
- Organized industrial Zone
- Energy production and storage area
- Free zone
- Storage areas for fuel products
- Culture and tourism protection and development sub-region
- Wetland area absolute protection border
- Rural settlements
- Urban settlements

Data has been obtained by means of digitization as a vectoral. In the ArcGIS software environment, columns of tables in the database related to this data are arranged (Figure 1).

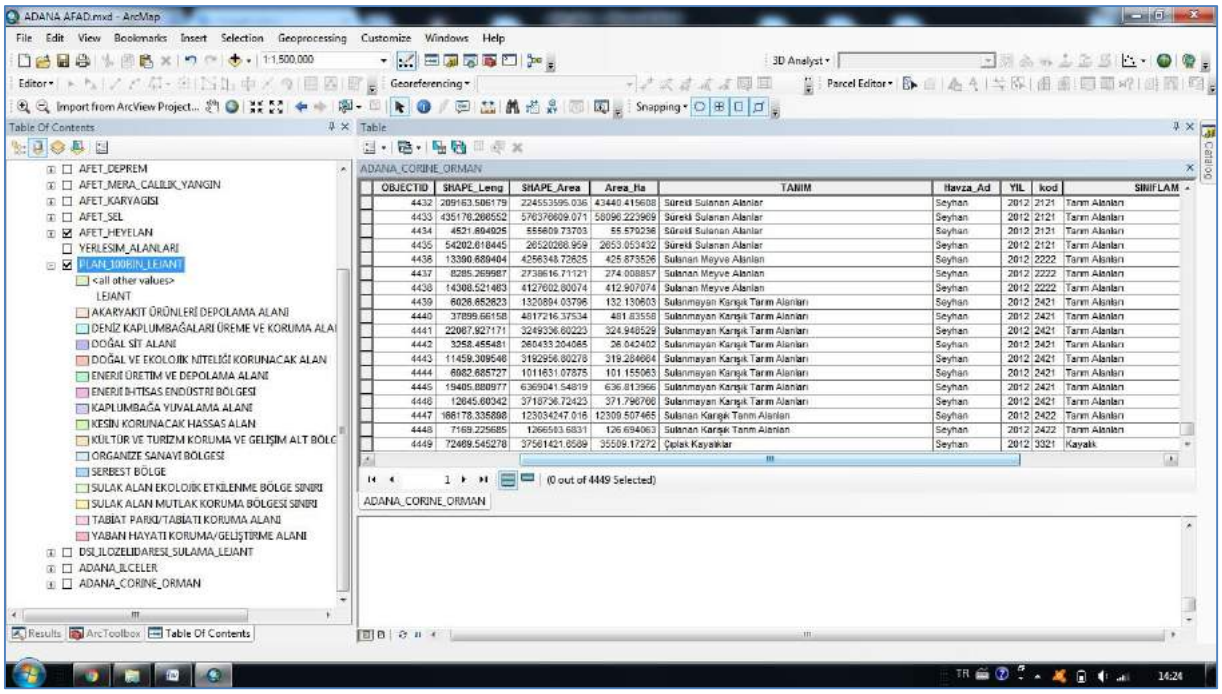

Figure 1: Disaster risk infrastructure

For example, the following table area structure is appropriate for the table structure for disaster data (Figure 2);

- County Name
- Disaster Type
- Repetition
- Number of Damaged Buildings
- Number of Buildings Destroyed
- Number of affected people
- Number of dead
- Number of Injuries
- Damaged Agricultural Land Amount
- Explanation

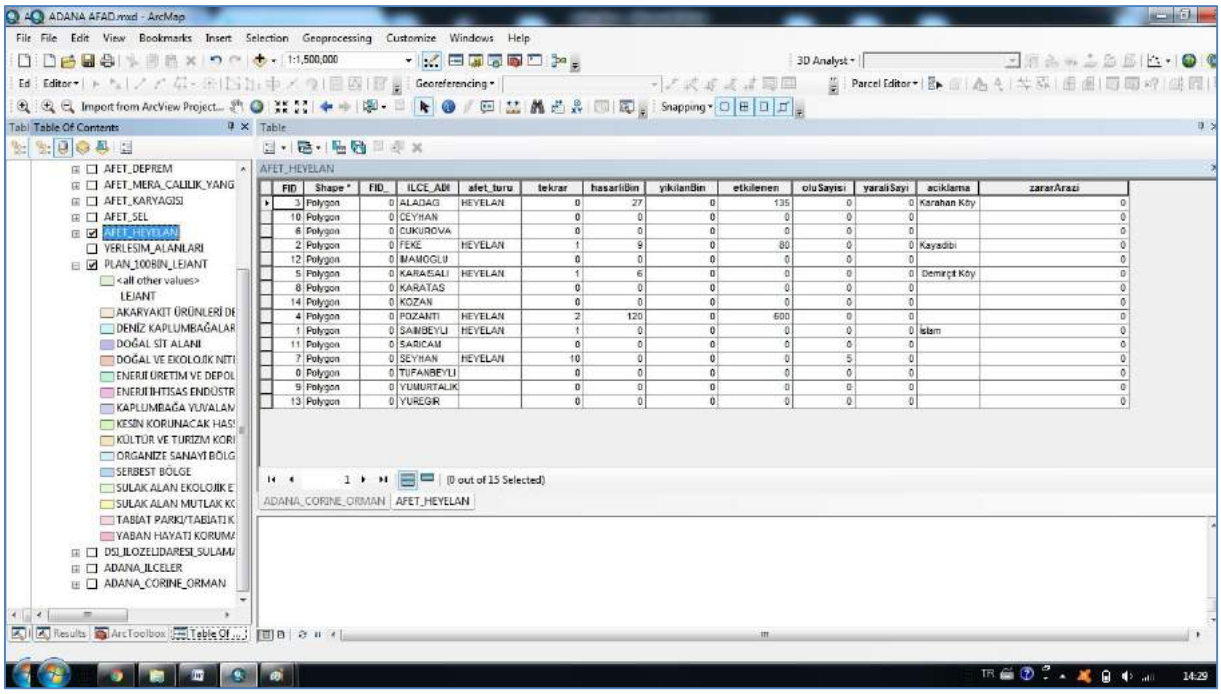

Figure 2: Disaster column information

The data consist of point and area data. For example, earthquake related data are in the form of point data since they are transferred to the over-the-center records. As can be seen in Figure 3, earthquakes that took place between 1900 and 2016 in Adana province appear in the ArcGIS environment together with their magnitude.

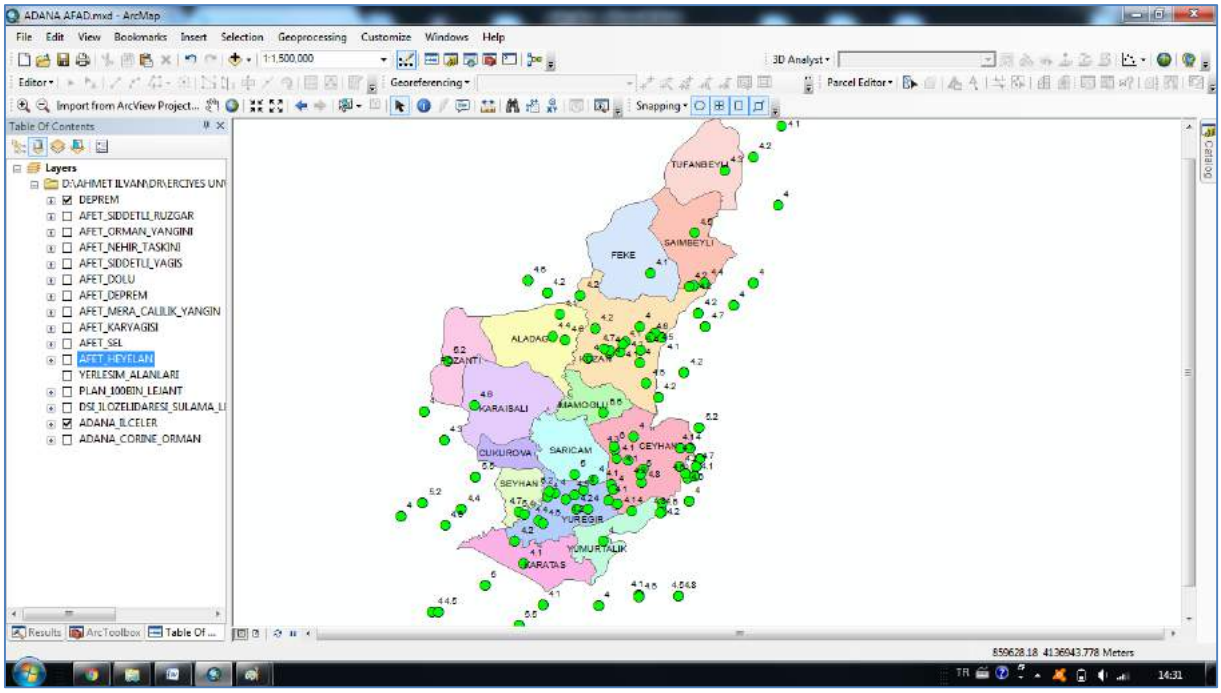

Figure 3: Point distribution of earthquakes in Adana province

When point interpolation is performed on these data, risky areas in terms of earthquake are seen in Figure 4. Places that are brown and red show places with large earthquake magnitude, light blue and blue places with small earthquake magnitude.

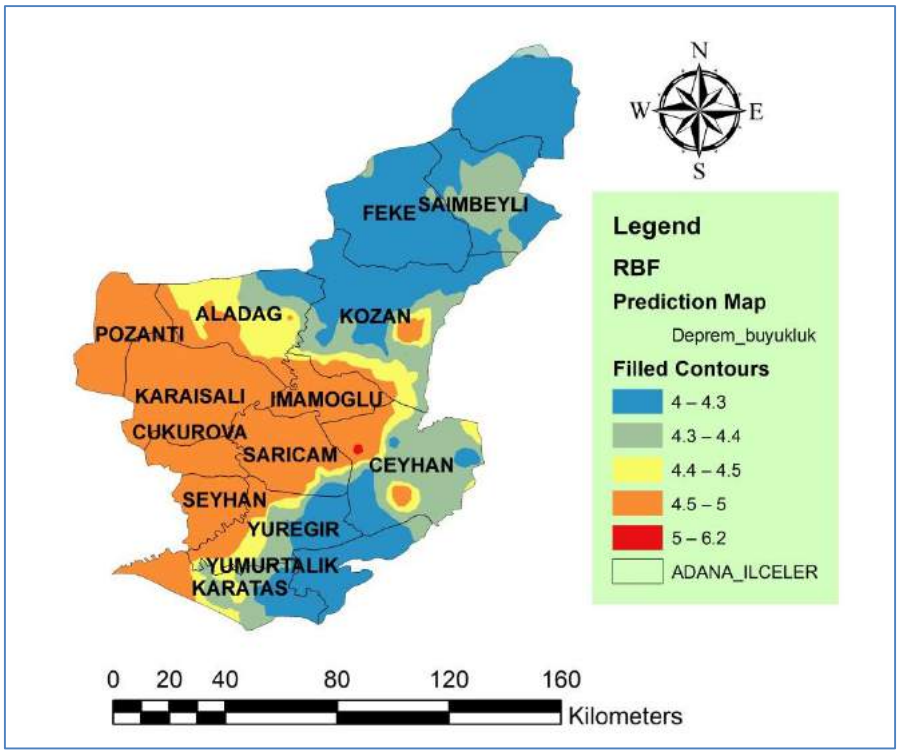

Figure 4: Adana province earthquake map

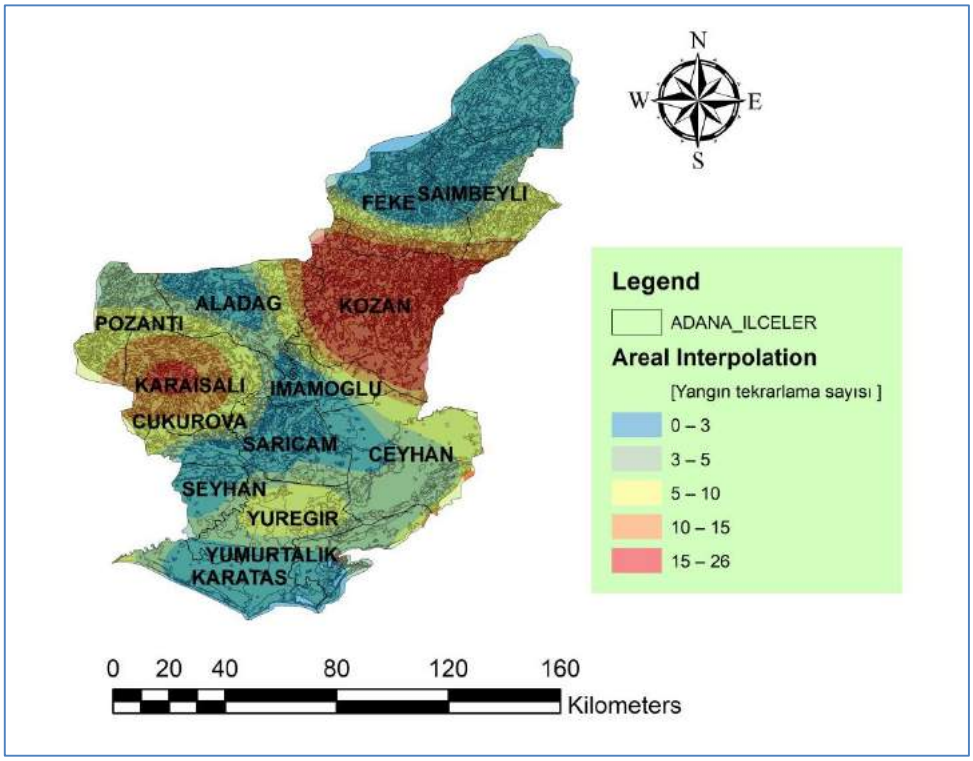

Figure 5: Adana province fire occurrence frequency map

In Figure 5, a query about forest fires was made and the states of forest fires were visualized. Here, as it is understood from the legend, the map is analyzed in such a way, considering the fire situation, the number of fire repairs and the damage caused by the fire. For example, there were 26 forest fires in the Kozan county, and 4 times in the damaged forest fire in Ceyhan. According to this data, it is necessary for the authorities to work on what kind of measures will be taken in this issue in the repetitive Kozan county. In addition, using the Adana province disaster data, violent wind maps, full and precipitation maps, and flood maps can be produced in a similar way.

3. Conclusion and Evaluation

When earthquake data are evaluated together with the settlement layer and the earthquake layer, it is seen that the earthquakes with large magnitudes are found more frequently in the Ceyhan county. In addition, an analysis of forest fires was carried out to visualize the forest fires according to the cases. When analyzed according to the fire situation, number of repetitions of fire and damages caused by the fire, it was determined that the fire was mostly in Kozan county. It has been determined that the Ceyhan county has been damaged mostly due to the analysis processes made according to the disaster data such as earthquake, forest fire, wind intensity, flood. It is necessary for the AFAD institution to carry out more comprehensive investigations on disasters in the Ceyhan county and to take measures in the framework of disaster management.

As a recommendation, due to the data obtained from various institutions are not detailed defined more localized, this situation causes reduce and limited the analysis accuracy. Therefore, institutions need to create geographic information systems that they can use for various purposes such as emergency action plan, hazard / risk mapping. The obtained data should be archived in such a way as to contain detailed and spatial information that can provide healthy and effective results.

References

Kahaner, D.,Moler, C. and Nash, S., (1989). *Numerical Methodsand Software*, PrenticeHall, EnglewoodCliffs, NJ, USA.

Lam, N. S. N., (1983), *SpatialInterpolationMethods: A Review*, TheAmerican Cartographer, 10:129–149.

Goodchild, M.F., & Lam, N.S.N. (1980). *Areal Interpolation: A Variant of the Traditional Spatial Problem*. Geo-Processing (1), 297-312.

ArcGIS User Guide 2003

https://atlas.gov.tr

https://tabb-analiz.afad.gov.tr

GIS Modeling of the Tangible and the Intangible Cultural Qualities of the Istanbul Land Walls

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Abstract

The definitions, approaches and methods -that are required for the inclusion of intangible cultural qualities in the site management processes for conservation purposes-, have not been produced yet. Within the scope of this study, a method for the evaluation of intangible cultural qualities in the site management processes is proposed, and this method is exemplified for the Land Walls World Heritage Site. The main goal of this study is to develop a method in order to relate the tangible and the intangible heritage, and to transform the knowledge created by this new method into an alternative site management approach. As methodology, firstly, the intangible cultural qualities of the Land Walls are examined. Secondly, these qualities are integrated to the site management processes by relating the intangible qualities to the tangible ones like location, the traces on structures and cultural routes, and, finally, proposals for inclusion of the intangible qualities in the site management processes by means of a Geographical Information System (GIS) database are developed. The originality of the project stems from the definition and documentation of the intangible cultural qualities and their inclusion in the site management methodology by relating them to the tangible qualities of the heritage site.

Keywords

GIS, The Istanbul Land Walls, World Heritage Site, Site Management, Intangible Heritage.

1. Introduction

UNESCO inscribed the Istanbul Land Walls and their surroundings as a World Heritage Site (WHS) as one of the four Historic Areas of Istanbul in 1985. In the statement of the Outstanding Universal Value (SoOUV), the site was described as “the area along both sides of the Theodosian Land Walls [447 AD] including remains of the former Blachernae Palace” (UNESCO World Heritage List 2013).

In October 2011, Istanbul Metropolitan Municipality adopted the Historic Peninsula Site Management Plan (SMP), which includes the guidelines regarding the management of all of the four Historic Areas of Istanbul WHSs. However, the responsible authorities have not implemented or complied with the Historic Peninsula SMP and its conservation measures for the Land Walls WHS. Therefore, the existence of a SMP has not proven to be effective for the conservation of the Land Walls WHS. As stated by Herb Stovel (p.106), there is a “need to look beyond the mere presence of formal management instruments or controls as indicators of management effectiveness”.

Despite the fact that the SMP and SoOUV focus mainly on the definition and conservation of the tangible characteristics of the heritage site, this paper argues that the inclusion of intangible cultural qualities in site management decision making processes may go beyond “the mere presence of formal management instruments” (Stovel 2004, p.106) and may result in a more effective management system. GIS modeling of the intangible cultural qualities is proposed as a methodology serving for this purpose.

2. Material and Method

Within the scope of this study, first, the intangible cultural qualities of the Istanbul Land Walls are examined. Secondly, these qualities are integrated to the site management processes by relating the intangible qualities to the tangible ones like location, the traces on structures and cultural routes, and, finally, the methods that will enable the inclusion of the intangible cultural qualities in the site management processes by means of GIS database and its analysis are discussed.

Intangible cultural qualities may consist of a wide range of qualities like social and cultural values that the societies produced in different environmental scales, the meanings that cultures attributed to a place, to the spirit of place and feelings, traditions and techniques, the transmission of traditional knowledge and crafts, the methods that are learned with knowledge, skill and creativity, the handcrafts tradition produced by these methods, land use patterns, oral traditions and narratives with the language as a carrier for the transmission of intangible cultural heritage, site specific performances, societal practices, rituals, festivities and practices related to nature and universe.

Physical signifiers of intangible cultural qualities, however, may be physical remains revealing past land use, monuments, places or buildings which have different meanings for different cultures, depictions in literary or artistic works, the places where historic events happened, a road or a route, or areas with spiritual or religious connections. As pointed out above, Istanbul Land Walls World Heritage Site, which is taken as a case study, inscribed to the World Heritage List in 1985 as one of the four Historic Areas of Istanbul.

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In the statement of the Outstanding Universal Value, the area was confined as the area on two sides of the Land Walls built during the reign of Theodosius II (401-450 AD) and the Blachernae Palace (Kıvılcım Çorakbaş 2017). The originality of the project stems from the definition and documentation of the intangible cultural qualities and their inclusion in the site management methodology by relating them to the tangible qualities, within the scope of the documentation, interpretation and presentation of the heritage sites for conservation purposes. When the management of Land Walls and their surroundings are considered, it is an original approach to examine the tangible and the intangible data that emerges from various historic periods of this heritage site by the help of GIS (Kıvılcım Çorakbaş 2017).

As methodology, a method that is based on the principles of integrated conservation approach and which utilizes the opportunities provided by GIS for creating a database and for analyzing it is utilized. By systematically examining and documenting the intangible cultural qualities and connecting them with place, this method provides new site management approaches. According to this method,

(1) Literature review leading to the determination of the intangible cultural qualities of the Land Walls World Heritage Site is carried out,

(2) the physical signifiers of the intangible cultural qualities are searched and documented by the help of photographic or photogrammetric methods;

(3) with the data obtained from these two resources, a database of "intangible cultural qualities" is formed;

(4) and all the data acquired are analyzed by the help of GIS modeling and processed to be used as a database for site management purposes (Kıvılcım Çorakbaş 2017).

Janke (2010) defines the methodology of multicriteria GIS analysis as follows: "Multicriteria analysis in a vector data model (discrete point, line, and polygon representations) often involves Boolean operators such as AND or OR. An AND operator (intersection) can result in rigid solutions e a variable meets the criterion or it does not. An OR operator (union) is very liberal e results will be included even if a single variable meets the criterion. Multicriteria analysis in a raster data model (continuous grid-based representations) allows more trade-off among variables e a low score on criterion can be offset by a high score on another. GIS data model selection can lead to different optimal solutions. For the aforementioned reasons, most researchers prefer using a combination of data models to control the degree of substitutability among criteria."

The assessment of the intangible cultural characteristics is performed in accordance with multicriteria analysis. GIS modeling of the heritage site contains layers, which represent the tangible and the intangible characteristics of the site. The layers that are formed for representing the tangible characteristics of the heritage site are:

- The buildings:
  - the Land Walls,
  - the gates of the walls,
  - the towers,
  - the monuments around the walls,
  - other buildings like residences or commercial buildings,
- The urban voids:
  - cemeteries,
  - vegetable gardens,
  - urban parks,
- Architectural details on the walls:
  - inscriptions on the walls,
  - reliefs,
  - re-used architectural elements (spolia).

On the other hand, the layers that are formed for the purpose of representing the intangible characteristics of the heritage site are as follows:

- Intangible characteristics derived from visual resources:
  - old maps,
  - gravures,
  - paintings,
  - photographs (Figure 1),
  - moving images (videos, documentaries, films etc).
  - Intangible characteristics derived from written resources (Figure 2),
  - quotations from various types of written resources,
  - place names,
- Routes defined in written or visual resources.

Figure 1: A recent photo of the northern part of the Land Walls (Photograph by Figen Kıvılcım Çorakbaş, 2016).

3. Results and Discussion

The overall database includes over 150 quotations, around 200 old photographs, videos and gravures, circa 25 old maps and over 250 new photos. In order to be able to interpret the content for site management purposes, it is proposed to come up with themes ad to group the tangible and intangible cultural qualities of the heritage site in themes. Six themes, that are related to the spirit of place of the Land Walls were determined by examining the GIS database:

1. The legacy of the empire,
2. Being on the fringe,
3. The recovery after wars and earthquakes,
4. Spirituality and religion,
5. The green and the blue of the city,
6. Walking along the Land Walls.

These themes are considered to be the tools to provide a basis for decision making processes for the site management purposes. They are the themes pointing out the cultural significance of the site, and they are reached only if the intangible characteristics of the site are taken into consideration. The GIS modeling of both the tangible and the intangible characteristics on the same database provides a chance to the site manager to locate the culturally significant locations / routes in the heritage site.

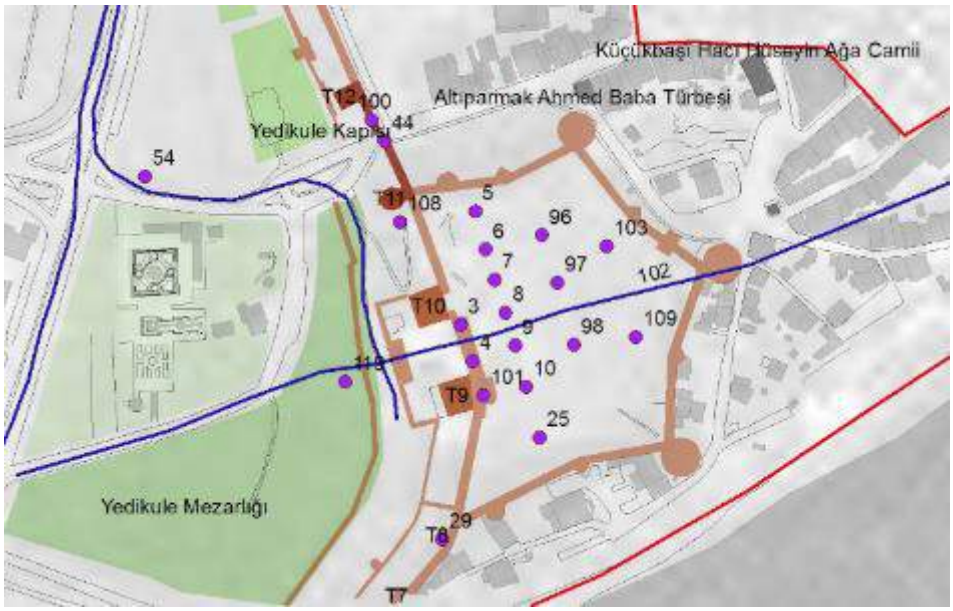

Figure 2: An image of the GIS modeling of the intangible characteristics of the heritage site. The purple dots represent the quotations from related written resources. The quotations themselves are linked to the dots as text files. The lines represent the routes.

4. Conclusions and Suggestions

To conclude, the GIS modeling has a great potential both in relating the tangible and the intangible characteristics of a heritage site and in widening the base on which the site management decisions are made. The method developed needs to be studied further in terms of designing appropriate interfaces for the site management staff and for the other stakeholders; who can continuously contribute to the updating data and increasing the amount of data.

Acknowledgements

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References

Janke J. R., (2010), *Multicriteria GIS modeling of wind and solar farms in Colorado*, Renewable Energy 35 (2010) p. 2228-2234.

Kıvılcım Çorakbaş, F., Aksoy, A., Ricci, A., (2014), *A Report of Concern on the Conservation Issues of the Istanbul Land Walls World Heritage Site with a Special Focus on the Historic Yedikule Vegetable Gardens*, Unpublished Report.

Kıvılcım Çorakbaş, F. (Project Coordinator), (2017), "Somut Olmayan Kültürel Niteliklerin Coğrafi Bilgi Sistemleri (CBS) Aracılığıyla Alan Yönetimi Sürecinde Değerlendirilmesi, Örnekleme: İstanbul Kara Surları Dünya Miras Alanı", Unpublished Project Report funded by TÜBİTAK, Project No.115K225.

Stovel, H., (2004), *Approaches to Managing Urban Transformation for Historic Cities*, in The Conservation of Urban Heritage: Macao Vision, Proceedings of the Conference held at the Macao Cultural Centre, Macao S.A.R., 10-12 Sept. 2002, Macau: Instituto Cultural do Governo da Regino Administrativo Especial de Macau, p. 103-120.

UNESCO World Heritage List. (2013), Historic Areas of Istanbul. http://whc.unesco.org/en/list/356 [Accessed 1 October 2013].

Detecting Suitable Areas for Wind Power Plant by the use of GIS: A Case Study of Sivas Province

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Abstract

In our country, the amount of energy required together with the growth of the industry and the population is increasing rapidly. In contrast, the majority of the energy used is derived from fossil sources that have polluting effects, limited quantities and are largely imported from foreign countries. Therefore, the need for renewable energy has inevitably arisen due to factors such as reduction of external dependency on energy and minimization of pollutant effects of fossil resources. One of the renewable energy sources is the wind energy. Wind energy is of great importance because of its low levels of environmental pollution and noise, having no negative effect on natural plant cover and human health and also being an endless source. Nowadays, with the development of technology, wind turbines should be placed in suitable areas in order to get the best results. In this study, the fundamentals of wind energy (wind speed, capacity factor, slope, proximity to highways, energy transmission lines, fault lines, dam, lake, stream and forestry area etc.) and the impact values of these parameters are discussed and the possible locations of wind power plants that can be established for Sivas province are presented in Geographical Information Systems (GIS) environment.

Keywords

Geographical Information Systems, Site Selection, Wind Power

1. Introduction

Along with the rapid growth of the population in the world, the energy demand also increases. Because of the limited fossil energy resources, new alternatives for energy production have begun to be used. Administrations began to focus on renewable energy sources, both clean and unlimited. Fossil fuel burning increases emissions, damaging the environment both locally and globally (Zerrahn, 2017). On the other hand, wind energy is one of the most affordable, clean, most advanced and commercially viable energy sources in the world that can be abundantly found in renewable energy sources all over the world (Köse et al.,, 2004). As a result, electricity generation from wind energy has become widespread in the world. For example, as of 2014, 10% of total electricity production in Germany is covered by wind energy (BMWi, 2015).

In our country, studies and projects about wind energy are being made for the selection of wind turbines. Turkey is a country with windy regions. The highest value in terms of annual wind speed and power density at a height of 10 m was determined at Marmara Region with 3.29 m / s and 51.91 W / m². The lowest value is in the Eastern Anatolia Region with a speed of 2.12 m / s and a power density of 13.19 W / m² (Gençoğlu, 2002). According to REPA wind speed data of the Ministry of Energy and Natural Resources, the total installed capacity of the wind power plant that can be installed in Sivas province is 1642.48 MW. In addition, the province with the highest wind potential in Turkey is Balıkesir with 13827.36 MW and Sivas is in the 20th place. There are currently three wind power plants in Sivas. These are Kangal, Konakpınar and Karaçayır wind power plants. Kangal has 101 MW capacity, Konakpınar has 12 MW capacity and Karaçayır is 10 MW capacity.

Wind energy, power generation level fluctuates continuously throughout the year, so it cannot always generate power (Calderon et al., 2011). For this reason, choosing the right location for the plant is critical. The choice of location for the wind turbine requires that multiple targets be balanced and a comprehensive set of factors assessed, with the appropriateness of a particular field being determined (Bennui et al., 2007).

In this study, the fundamentals of wind energy (wind speed, capacity factor, slope, proximity to highways, energy transmission lines, fault lines, dam, lake, stream and forestry area etc.) and the impact values of these parameters are discussed and the possible locations of wind power plants that can be established for Sivas province are presented in GIS environment.

2. Material and Method

The study area includes the province of Sivas, which is 28488 km². Most of Sivas Province is located in Central Anatolia Region. Eastern Anatolia and the Black Sea Region are also found in the territory. A large part of the province's territory includes Kızılırmak, some of Yeşilırmak and Fırat basins. According to the geographical coordinate system it is between 40° 27' 58" - 38° 43' 32" N latitudes and 35° 52' 55" - 38° 42' 09" E longitudes (Figure 1).

In the preparatory phase of the study, both the subject matter and the field work are reviewed. The data used are: streams, dam, lake, energy transmission lines, fault lines, roads, forest, wind speed, elevation, capacity factor, settlement and slope.

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Figure 1: Study area

Each of these data was analyzed by giving weight points. The weight scale is based on the works of Sarpong and Baffoe (2015), Özşahin and Kaymaz (2013) and Nişancı et al (2010) (Table 1). Within the scope of the calculation criteria determined in Table 1, study area is divided into five categories, which are very suitable, appropriate, medium, bad and very bad. 1 classification score means very bad and 5 means very suitable.

Table 1: Factors influencing the selection of turbine site

Factor	Weight	Restricted Areas
Stream	0.05	
Dam – Lake	0.05	Dam – Lake
Energy Transmission Line	0.09	
Fault Line	0.05	Areas 500 m from the fault line
Roads	0.10	Areas 100 m from the road
Forest	0.05	
Wind Speed	0.21	Areas where the wind speed is lower than 6.5 m / s
Elevation	0.03	
Capacity Factor	0.22	Areas below thirty percent of the capacity factor
Settlement	0.10	500 m to residential areas
Slope	0.05	Areas where the slope is more than 30 percent

Streams are one of the factors affecting locating wind power plants. The stream data was obtained from the ASTER GDEM digital elevation model. The streams were then subjected to the Euclidean Distance process. Stream classification score is given below table 2 and the map of Euclidean distance is given in figure 2.

Table 2: Stream, dam – lake classification score

Class Values (m)	Stream Classification Score	Class Values (m)	Dam – Lake Classification Score
0-500	1	0 - 500	1
500-1000	2	500 - 1000	2
1000-2000	3	1000 - 1500	3
2000-3000	4	1500 - 2000	4
3000 and more	5	2000 and more	5

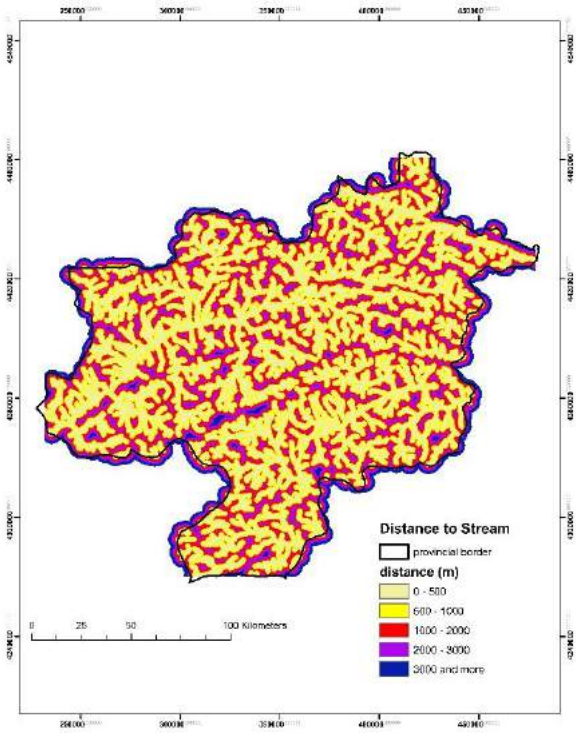

Figure 2: Stream map

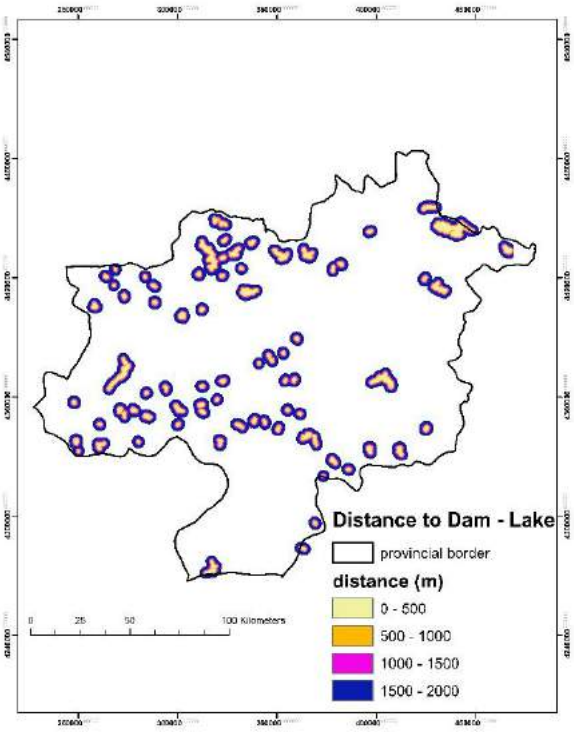

Figure 3: Dam – Lake map

Another factor affecting turbine site selection is lakes and dams. The dam and lake data were obtained by digitization through the base map (ArcGIS version 10.2.2, 2014, Esri). Then, the vector data is subjected to the Euclidean distance process. Dam – lake classification score is given above table 2 and the map of Euclidean Distance is given in figure 3.

Energy transmission lines are another factor for site selection of wind power plants. The close proximity of the wind turbines to the energy transmission line means that the cost is also reduced. The energy transmission line data was obtained by digitizing the map made by the General Directorate of Renewable Energy of Turkey. Then, the vector data is subjected to the Euclidean distance process like in the dam and lake data. Energy transmission lines classification score is given below table 3 and the map of Euclidean Distance is given in figure 4.

Another criteria for selecting the location of the wind turbines is the fault lines. A wind power plant close to the fault line will present a hazard in case of a possible earthquake. The North Anatolian Fault Zone (KAFZ) is 1200 km long and is a fault zone that forms the boundary between the Eurasian - Anatolian plates. Sivas is situated on the North Anatolian Fault Line region. Fault lines data was obtained by digitizing the Mine Technical Search of Turkey fault line map. Fault lines classification score is given below table 3 and the map of Euclidean Distance is given in figure 5. Areas within 500 meters of the fault lines are considered restricted and are not subjected to weighted overlay.

Table 3: Energy transmission, fault line classification score

Class Values (m)	Energy Transmission Line Classification Score	Class Values (m)	Fault Line Classification Score
4000 and more	1	500 - 1000	1
3000-4000	2	1000 - 2000	2
2000-3000	3	2000 - 3000	3
1000-2000	4	3000 - 4000	4
0-1000	5	4000 and more	5

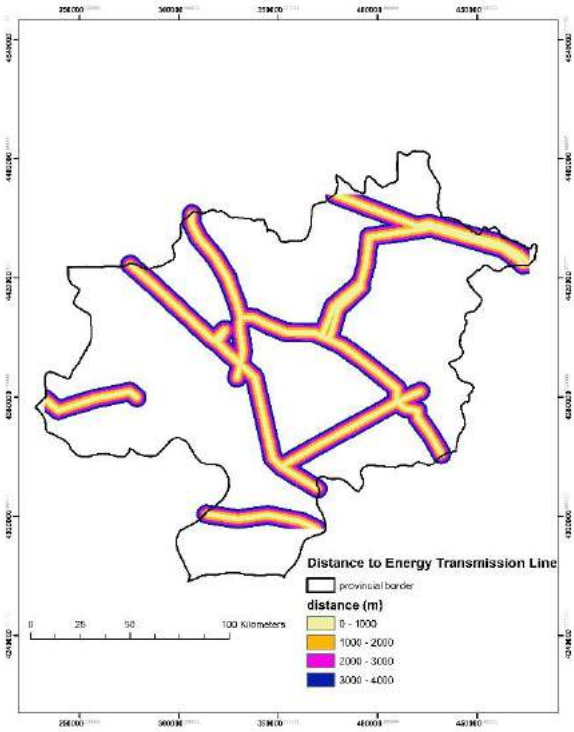

Figure 4: Energy transmission map

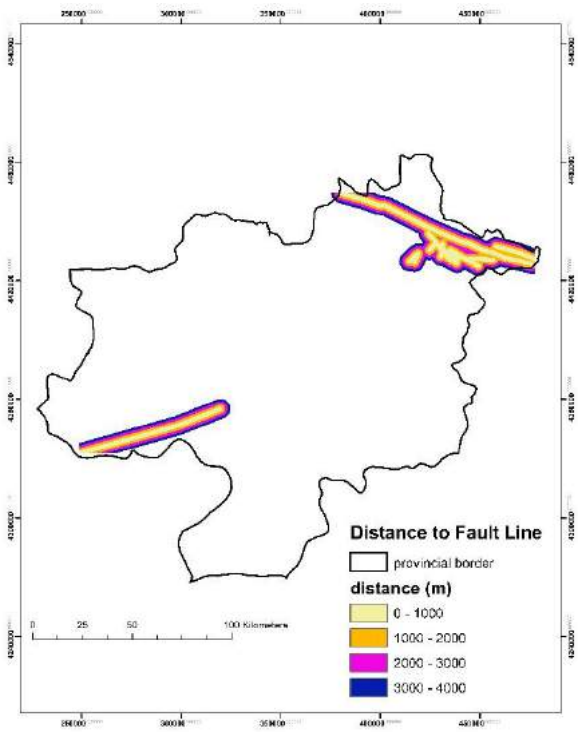

Figure 5: Fault line map

Another factor affecting turbine site selection is roads. Proximity to the roads reduces both the cost of installation of the turbines and facilitates intervention in case of a possible failure. The road data was obtained for digitizing the open street map (ArcGIS version 10.2.2, 2014, Esri). Then, the vector data is subjected to the Euclidean distance process. Road classification score is given below table 4 and the map of Euclidean Distance is given in figure 6. Areas within 100 meters of the roads are considered restricted and are not subject to weighted overlay.

While wind energy does not harm the ecosystem, the construction of wind turbines should not harm the environment also. Therefore, considerations must be taken not to destroy natural elements such as forests when site selection is made. The forest data was obtained by digitizing the map produced by the General Directorate of Forestry of Turkey. Then, the vector data is subjected to the Euclidean distance process. Forest classification score is given below table 4 and the map of Euclidean Distance is given in figure 7.

Table 4: Roads, forest classification score

Class Values (m)	Roads Classification Score	Class Values (m)	Forest Classification Score
4000 and more	1	0 – 500	1
3000-4000	2	500 – 1000	2
2000-3000	3	1000 – 1500	3
1000-2000	4	1500 – 2000	4
100-1000	5	2000 and more	5

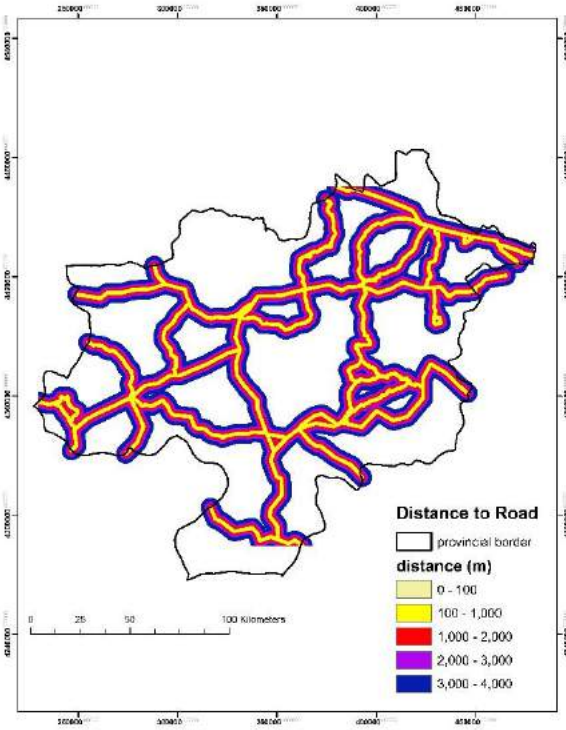

Figure 6: Road map

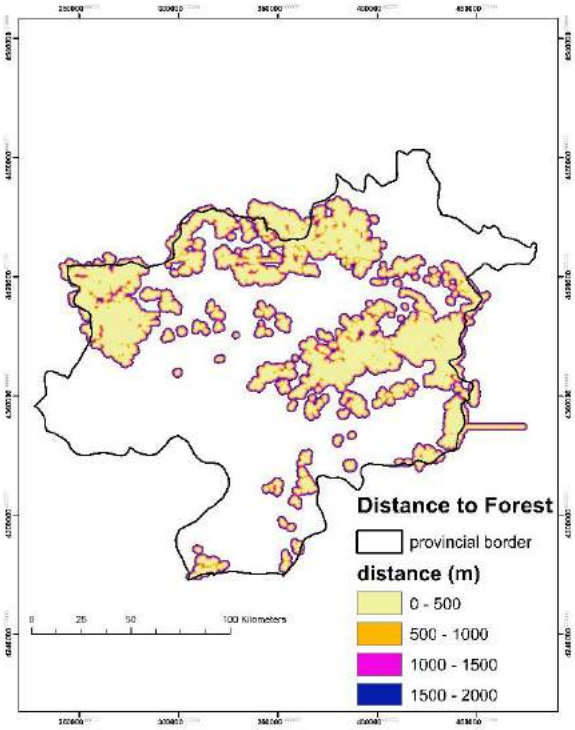

Figure 7: Forest map

One of the most important criteria for an economic wind power plant is the wind speed. The wind data is derived from the map of wind speeds produced by the General Directorate of Renewable Energy of Turkey. The wind at the torch height of a wind energy project turbine suitable for establishing a wind energy facility with wind speed should be regular and sufficient (Sarpong and Baffoe, 2015). According to the Directorate General for Renewable Energy of Turkey, the wind speed for an economic wind power plant installation must be 7 m / s or higher. Wind speeds below 7 m/s are not counted for weighted overlay. Wind speed classification score is given below table 5.

Capacity factor is another significant factor affects selecting suitable area for wind power plant. According to the General Directorate of Renewable Energy of Turkey, a 35% or more capacity factor is required for investment in an economic wind power plant. The capacity factor indicates a distribution parallel to the distribution of wind speed and wind power density (Özşahin and Kaymaz, 2013). The capacity factor data is derived from the map of capacity factor produced by General Directorate of Renewable Energy of Turkey. Areas where capacity factor below 30% does not participate for weighted overlay. Capacity factor classification score is given below table 5.

Table 5: Wind speed, capacity factor classification score

Class Values (m/s)	Wind Speed Classification Score	Class Values (%)	Capacity Factor Classification Score
7	1	30	1
8	2	35	2
9	3	40	3
9.5	4	50	4
10	5	60	5

For efficient energy generation, wind turbines must be located in open areas and on higher elevations than the surrounding area, preferably, elevations greater than 100 m (Sarpong and Baffoe, 2015). Considering that the lowest height in Sivas is 563 meters, it is understood that the elevation does not constitute any obstacle to the selection of the location of the wind power plant. The elevation data was obtained from ASTER GDEM digital elevation model. The elevation classification score is given below table 6 and its map is given below figure 8.

Gradual slops cause an increase in wind speed and road accessibility. The construction of a wind power plant for gentle slopes is also more convenient. Slopes lower than 30° are considered suitable for site selection (Chaudhry, 2008). The slope data was obtained from ASTER GDEM digital elevation model. The slope classification score is given below table 6 and slope map is given below figure 9.

Table 6: Elevation, slope classification score

Class Values (m)	Elevation Classification Score	Class Values (degree)	Slope Classification Score
500 - 1000	1	25-30	1
1000 - 1500	2	20-25	2
1500 - 2000	3	10-20	3
2000 - 2500	4	5-10	4
2500 - 3015	5	0-5	5

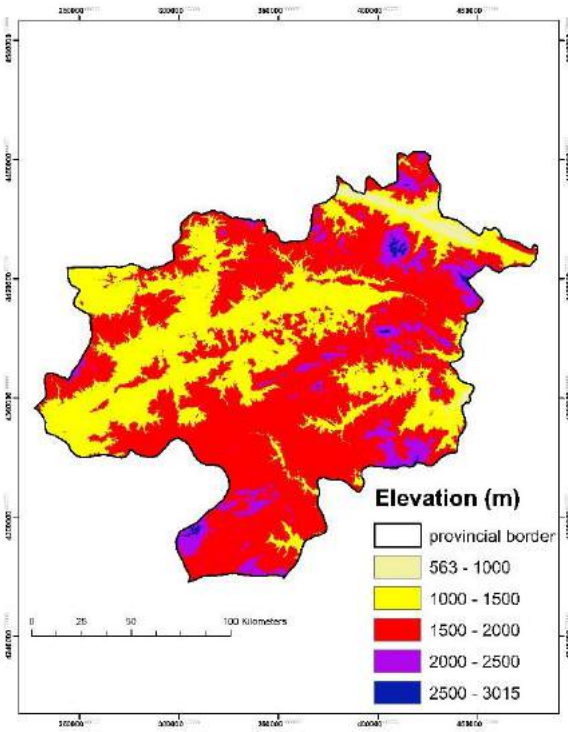

Figure 8: Elevation map

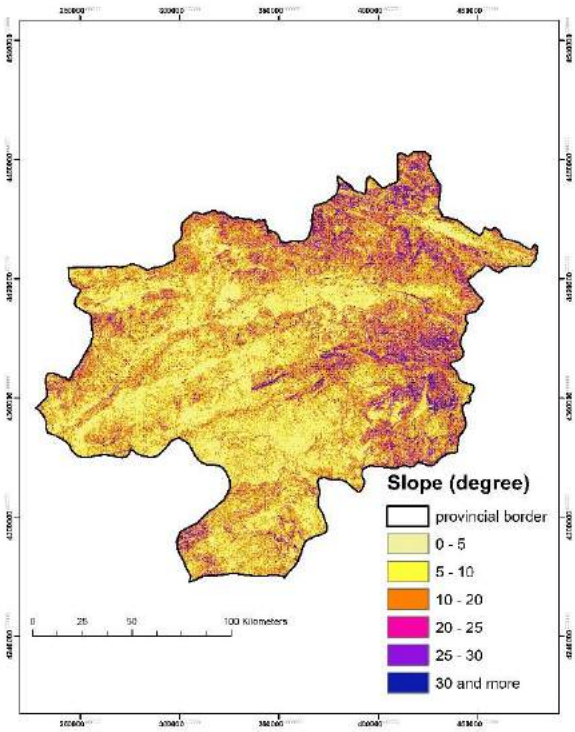

Figure 9: Slope map

The wind turbines should not be too close to the settlements because of the sound they produce. In wind power plants, low-frequency sounds emerge from the interaction of the turbine blades with the airflow. Noise levels up to 50 dB can be accepted (Moiloa, 2009). In addition, if the wind turbines are very close to the city, it causes shadow due to sunlight. The settlement data was obtained by digitization through the base map (ArcGIS version 10.2.2, 2014, Esri). Then, the vector data is subjected to the Euclidean distance process. 500 m buffer to residential areas are accepted as restricted and not subjected for weighted overlay. Settlement classification score is given below table 7 and the map of Euclidean Distance is given in figure 10.

After all these operations have been done, vectorial maps have been converted into raster data These raster maps were then subjected to weighted overlay processing, which is a multi-criteria-based decision-making method. Geographical information systems are disposed to handling vast amount of spatially related information, supplying the power to accomplish weighted overlay analysis by combining multiple thematic layers for area suitability mapping (Kaliraj et al., 2015).

Table 7: Settlement classification score

Class Values (m)	Settlement Classification Score
1000-2000	1
2000-3000	2
3000-3500	3
3500-4000	4
4000 and more	5

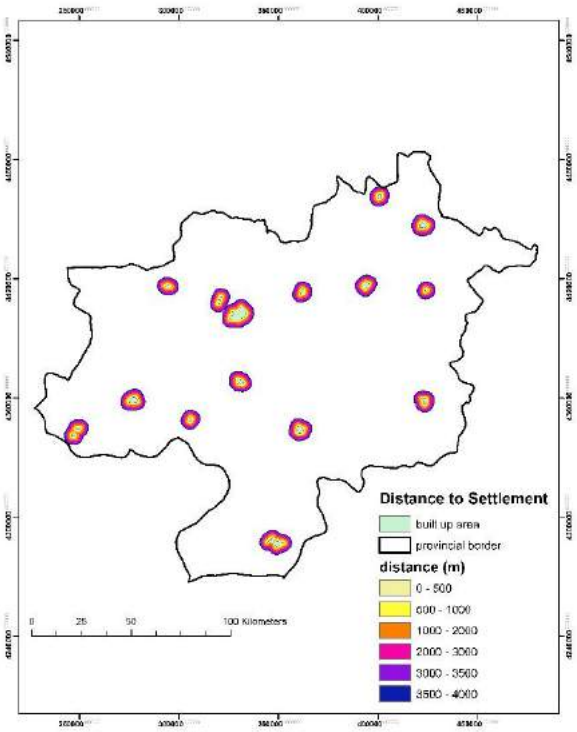

Figure 10: Settlement map

3. Results

There are many factors that affect the location of the wind power plant site (Laska, 2017). Economic, environmental, technical and geographical standards affect location choice (Noorollahi et al., 2016). These factors were evaluated in this study and appropriate areas were determined in the GIS environment. The eligibility grade was divided into 5 classes as restricted, suitable, fairly suitable, highly suitable, and extremely suitable and an evaluation was made (table 8). According to the results, area of 12715.27 km² is restricted, area of 1308.63 km² is suitable, area of 11120.44 km² is fairly suitable, area of 3330.20 km² is highly suitable and area of 13.45 km² is extremely suitable in order to construct wind power plant. Restricted areas are definitely the zones where the wind power plant cannot be built. The result map is given in figure 11 and figure 12. Looking at the existing wind power plants, it seems that they confirm the result map (figure 12). They are established in fairly suitable, highly suitable and extremely suitable areas.

Table 8: Suitable areas for wind power plant

Classification	Explanation	Area	
		km²	%
1	Restricted	12715.27	44.63
2	Suitable	1308.63	4.59
3	Fairly suitable	11120.44	39.04
4	Highly suitable	3330.20	11.69
5	Extremely suitable	13.45	0.05

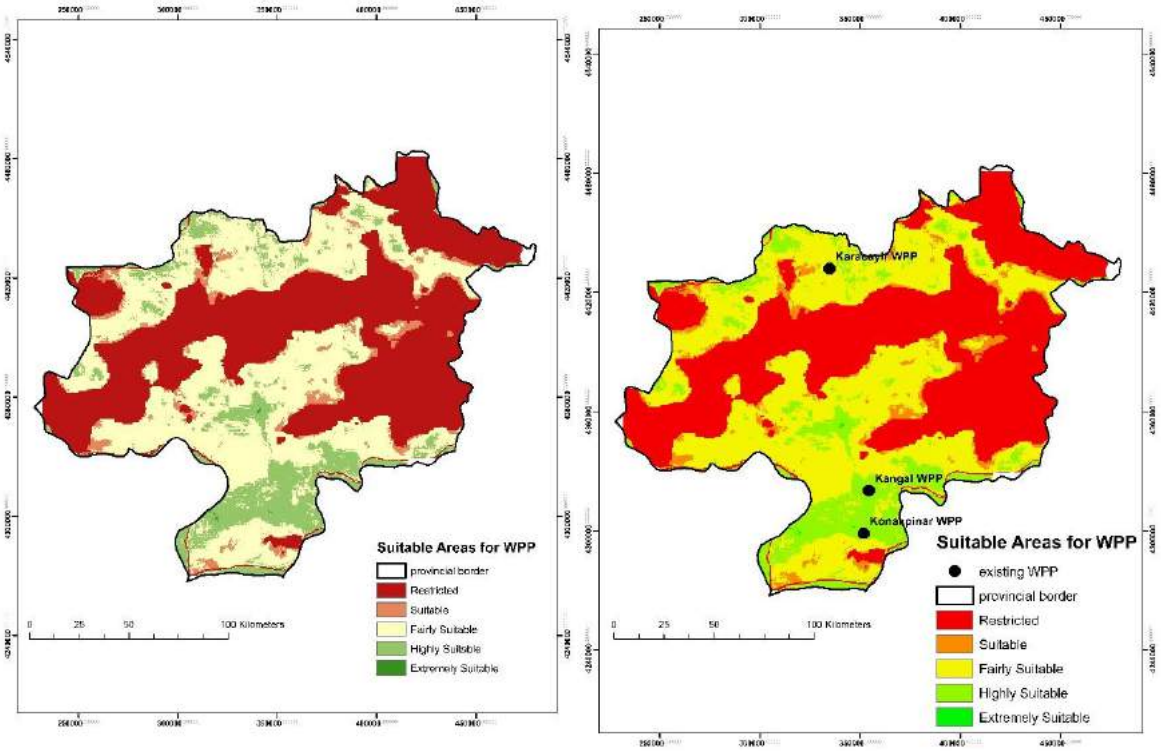

Figure 11 – 12: Result map

4. Discussions and Conclusions

Wind Energy Potential Atlas (REPA), which is undertaken by the Directorate General of Renewable Energy of Turkey, can be used for the detection of wind energy power plant potentials. However, in the preparation phase of this atlas, the distance to the roads, rivers, fault lines etc. are not taken into consideration, thus it is not sufficient for wind power plant site selection. Therefore, it is necessary to carry out GIS based studies by evaluating many criteria. As a result, land-use planning must be done for sustainable development and the number of existing plants in Sivas, which is rich in wind potential, should be increased. When this is done, the data used should be continuously updated in the GIS environment.

References

Bennui A., Rattanamanee, P., Puetpaiboon, U., (2007), S*ite Selection for Large Wind Turbine Using GIS*., International Conference on Engineering and Environment, Songkhla, Thailand, pp. 1-2.

BMWi., (2015), Zeitreihen zur Entwicklung der erneuerbaren Energien in Deutschland. Bundesministerium fur Wirtschaft und Energie. http://www.erneuerbare-energien.de/EE/Navigation/DE/Service/, [Accessed 23 February 2007].

Calderon M., Calderon A.J., Ramiro A., Gonzalez I., (2011), Evuluation of Hybrid Photovoltaic-Wind System with Hydrogen Storage Performance Using Exergy Analysis , Int. J. Hydrogen Energy, 36(10), 5751-5762.

Chaudhry R., (2008), *Using Multi-Criteria Evaluation to Determine Suitable Sites for Developing Wind Farms in Massachusetts*, Project Report, Clark University, Worcester, USA, 16ss.

Gençoğlu M.T., (2002), *Yenilenebilir Enerji Kaynaklarının Türkiye Açısından Önemi*, Fırat Üniversitesi Fen ve Mühendislik Bilimleri Dergisi, 14(2), 57-64.

Kaliraj S., Chandrasekar N., Magesh N.S., (2015), *Evaluation of multiple environmental factors for site-specific groundwater recharge structures in the Vaigai River upper basin,Tamil Nadu, India, using GIS-based weighted overlay analysis*, Environ Earth Sci, doi: 10.1007/s12665-015-4384-9.

Köse R., Özgür M., Arif E.O., Tugcu A., (2004), *The analysis of wind data and wind energy potential in Kutahya, Turkey*, Renewable and Sustainable Energy Reviews Volume 8, 277-288.

Laska G., (2017), *Wind Energy and Multi-criteria Analysis in Making Decisions on the Location of Wind Farms*., 7th International Conference on Engineering, Project, and Production Management, Bialystok, Poland, pp. 418-424.

Moiloa B.H.E., (2009), *Geographical information systems for strategic wind energy site selection*, Unpublished MSc Project Report, Vrije Universiteit, Netherland, pp. 22-26.

Nişancı R., Yıldırım V., Özçelik A.E., (2010), *Rüzgar Enerjisi Üretim Alanlarının Coğrafi Bilgi Sistemleri İle Belirlenme*si, III. Uzaktan Algılama ve Coğrafi Bilgi Sistemleri Sempozyumu Bildiriler Kitabı, 213-220.

Noorollahi Y., Yousefi H., Mohammadi M., (2016), *Multi-Criteria Decision Support System for Wind Farm Site Selection Using GIS*, Sustainable Energy Technologies and Assessments, 13, 38-50.

Özşahin E., Kaymaz Ç.K., (2013), *Rüzgar Enerji Santrallerinin (RES) Yapım Yeri Seçimi Üzerine Bir CBS Analizi*, TUBAV Bilim Dergisi, 6(2), 1-18.

Sarpong D., Baffoe P.E., (2015) *Selecting Suitable Sites for Wind Energy Development in Ghana*, Ghana Mining Journal, 16(1), 8-20.
Zerrahn A., (2017), *Wind Power Externalities*, Ecological Economics, 141, 245-260.

GIS as an Effective Control Tool in Local Governments

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Abstract

Local governments with limited economic resources can produce services that will provide maximum benefit; is possible with realistic and feasible planning as well as effective monitoring and control. Investments can only be monitored, supervised and managed effectively and efficiently; If verbal and graphical data in a secure and easily accessible common database. Investment Monitoring System (OSIMS) was established and has been developed. in Ordu for the purpose of providing coordination between the units, preventing redundancy and conflicts in the service, establishing an institutional archive for investments, accelerating decision making processes, presenting current and accurate information to the public and developing service-based dialogue and communication with citizens in Ordu. With the flexibility of the WEB, the Ordu Spatial Investment Monitoring System blended with the strengths and abilities of GIS, the ongoing and completed investments planned by the Ordu Metropolitan Municipality are recorded as spatial, the spatial distribution of investments, investment processes, instantaneous with the municipal employees and the citizens can be shared as. With Ordu Spatial Investment Monitoring System; The rich visual content associated with the location is presented to high-performance users from the WEB platform, accessible at any time, easily understandable by everyone, a progeny; all processes from idea phase to completion can be followed up on a monthly basis.

Keywords

Local Governments, GIS, PostgreSQL, PostGIS, QGIS, Geoserver

1. Introduction

Local governments with limited economic resources can produce services that will provide maximum benefit; realistic and feasible planning as well as effective monitoring and control.

If the investments can be monitored, supervised and managed effectively and efficiently only; attributional and graphical data can be stored in a secure and easily accessible common database.

The existing monitoring and evaluation infrastructure at the regional and provincial level should be developed to improve the performance and effectiveness of investments and implementations.

Development agencies and municipalities should be strengthened in order to pass on the misfortune of locality and locality in the presentation of public services. The specialization level of the staff working in the local administrations, especially the newly established metropolitan municipalities, should be increased and the capacities should be increased in project preparation, financing, implementation, monitoring and evaluation, financial management, participatory methods.

Ordu, has granted Metropolitan status the status by the Law No. 6360, emphasized the necessity in the National Strategy for Regional Development; Ordu Spatial Investment Monitoring System (*OSIMS*) has been developed with the aim of providing coordination between the units, preventing redundancies and conflicts in the services, establishing institutional archives for investments, accelerating decision making processes, providing up-to-date and accurate information to the public and developing service-based dialogue and communication with citizens.

Given by investments of *OSIMS*; a systematic structure that can be accessed, updated, and controlled in a straightforward manner, is rescued from the complex, unmanageable and uncontrollable mass of a data. The data is transformed into a computerized, hierarchical structure; updating and correctness of the information, a low-cost, sustainable system has been established. By providing the data via the local network / internet, the flow of information between the relevant units and between the municipality and the citizen can be easily provided.

With the flexibility of the WEB, the Ordu Spatial Investment Monitoring System blended with the strengths and abilities of GIS, the ongoing and completed investments planned by the Ordu Metropolitan Municipality are recorded as spatial, Investments spatial distribution processes, can be shared as with the municipal employees and the citizens.

1.1. System Basic Features

OSIMS is basically a triple structure consisting of central database, desktop and Web application. PostgreSQL and MySQL are used as database, CitySurf is used as desktop application, and Web application is developed in PHP language. For the geometric representation of investment data, point geometry is preferred because it is generic to cover all investments. The main features of OSIMS used as an effective data collection and presentation tool are;

- The main components of the application are the common central database, the geographic data server and the Web page.

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- Data can be entered both from the desktop application (CitySurf) and from the Web
- The data will be entered in the relevant Department.
- The data are updated monthly by the relevant Department.
- The data are represented by a different icon for each department chair.
- The Office is responsible for the accuracy and update of the data.
- Project Numbers are issued by the System Administrator.
- The System Administrator decides which of the projects to be input can be displayed on the Web and / or the Local Network.
- The responsibility of data security and data access is the responsibility of the Directorate of GIS Branch of the Computer Center.
- GBS Branch Directorate is responsible for creating new users and defining authority.
- Different authorization levels can be entered into the system for data entry and update jobs and transactions.
- Each unit can only enter and update data in its own authority.
- The application is open to all users via guest login with Web.

1.2.1 Data Entry and Inquiry Processes in OSIMS

OSIMS is basically a triple structure consisting of central database, desktop and Web application. PostgreSQL and MySQL are used as database, CitySurf is used as desktop application, and Web application is developed in PHP language. For the geometric representation of investment data, point geometry is preferred because it is generic to cover all investments.

1.2.2 Data Entry and Inquiry Processes in OSIMS

PostgreSQL database is used as well as all GIS applications developed and / or used by Ordu Metropolitan Municipality for data that can be collected and displayed by Ordu Spatial Investment Monitoring System (Project Database).

It has been an important challenge for the managers to produce jobs in different areas with different qualities and different priorities and different habits in their work. These services, which are produced in every field of life, have been created as a result of meetings and long efforts to transform each administration into a data sheet that it can easily adopt and use.

It is possible to enter data into OSIMS using both WEB and desktop application, to query the data input and to receive reports. The data are entered by authorized users and can be queried by all users again.

The authorized user completes the process by filling in the relevant field in the opened information window and uploading the project images after marking the investment point. The entered data is checked and approved by the related Department.

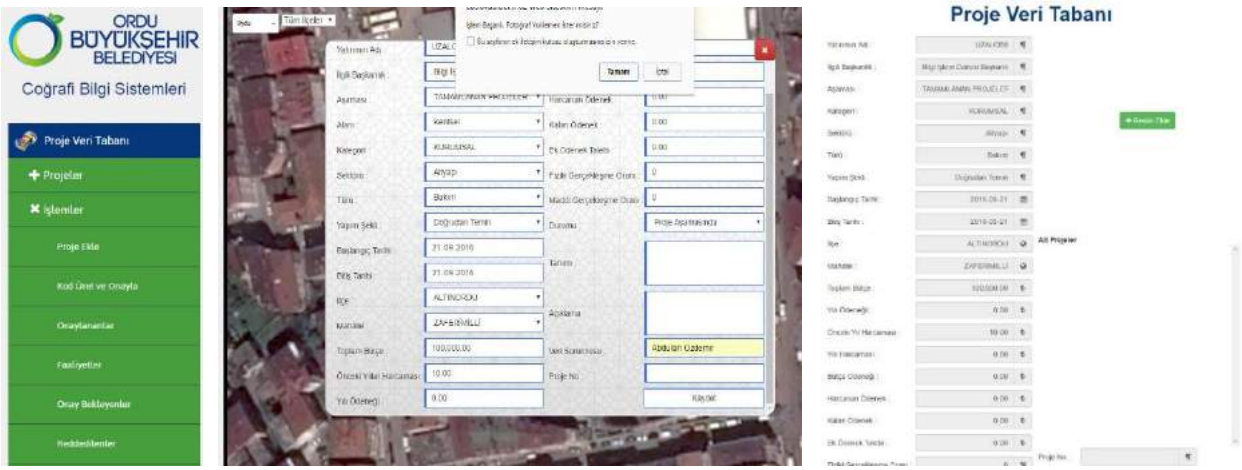

Figure 1: Data Entry Steps

Data approved by the relevant department chairperson is transferred to the System Administrator panel as a "Pending Code Approval" project. The System Administrator performs the necessary checks, approves or rejects it after deciding to display it on the Web or LAN. Approved data will be displayed and queryable on Web and / or LAN. The rejected data is transmitted automatically via the system together with the reason for rejection.

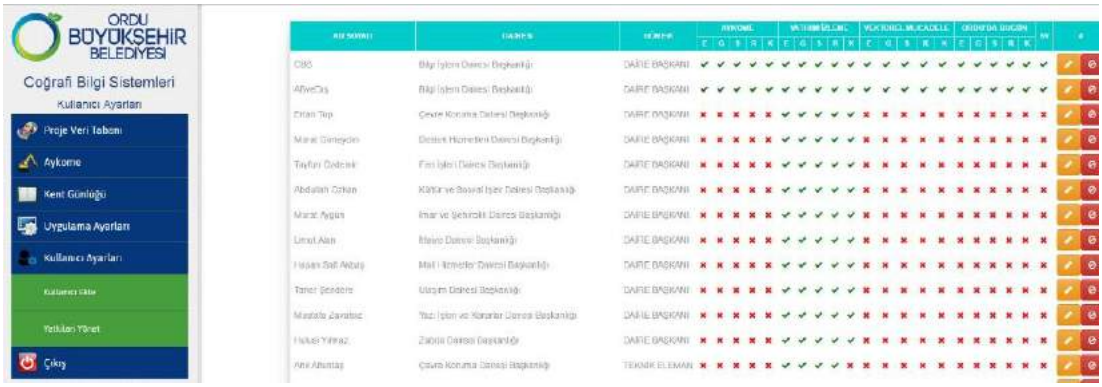

Figure 2: System Administrator Panel / Verify Screen

The data are checked and updated by the relevant department head for the third week of each month. The financial reports are presented to the Ordu Metropolitan Municipality General Secretary with simple and detailed reports taken during the last week of each month regarding the Activity and Projects. Records of data entry and last update date are kept by the system; The department is responsible for the correctness of the data and the update.

A project with an investment monitoring system; all processes from concept phase to completion can be monitored and reported on a monthly basis. OSIMS provides simple, detailed and financial reporting ability for users with great ease.

Figure 3: Simple Reporting Screen

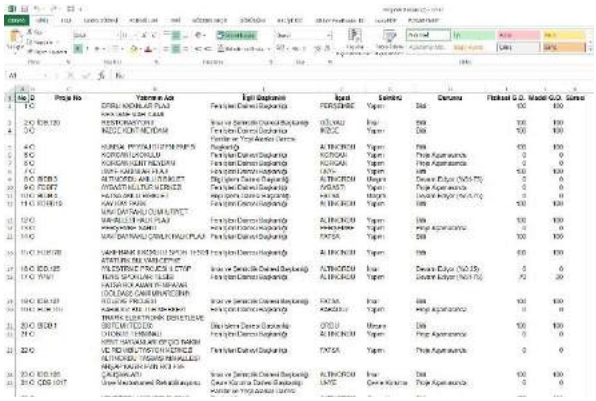

Figure 4: Detailed Reporting Screen

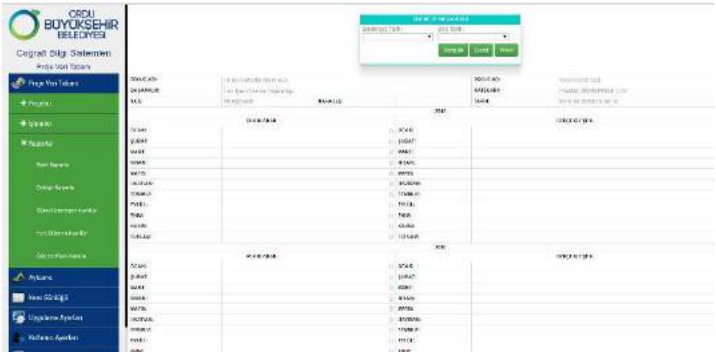

Figure 5: Payment Plan Report

Many administrative processes, such as new user definitions, user and / or authority changes, authority hierarchy, etc., can be easily performed with the powerful and flexible authorization panel of OSIMS.

All services provided by the Ordu Metropolitan Municipality can be shown on a single screen by the Ordu Spatial Investment Monitoring System and the services provided are categorized according to the situation of the business (Planned, Ongoing, Completed).

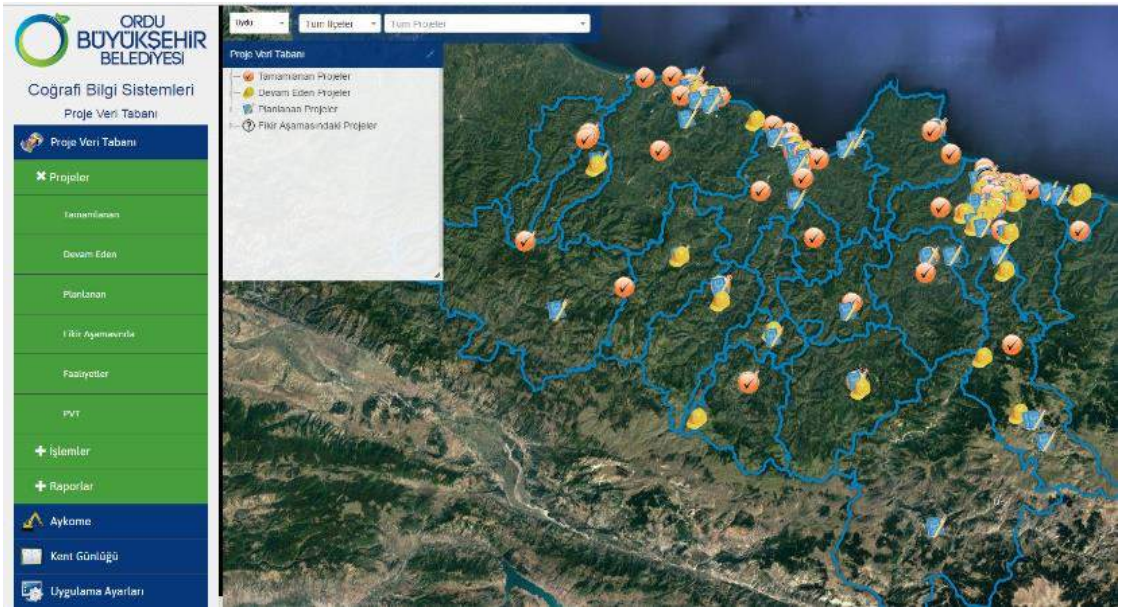

Figure 6: Status of Investments

Figure 7: Project Information Cards

Acknowledgements

Ordu Metropolitan Municipality sees GIS as tool which makes life easier, Ordu Spatial Investment Monitoring System, developed by, which a means to facilitate life, the rich visual content associated with the location is presented to high performance users from the WEB platform in a figure that is accessible at all times and easily understandable by everyone.

With the flexibility of the WEB, the Ordu Spatial Investment Monitoring System blended with the strengths and abilities of GIS, the ongoing and completed investments planned by the Ordu Metropolitan Municipality are recorded as spatial, Investments spatial distribution processes, can be shared as with the municipal employees and the citizens.

The activities, subprojects and projects with OSIMS are taken under the register of all processes from idea to completion. Archive of Ordu Metropolitan Municipality; information about the project, images, spatially, also stored in the database with project processes, can be queried and displayed, detailed reports can be obtained. In our country where the institutional memory culture is not fully established, it is considered that even in this respect, OSIMS is a very valuable application.

Spatial monitoring of investments facilitates the follow-up and supervision of projects, on the one hand, and facilitates decision-makers' work for new projects and enhances coordination between units. With OSIMS, all data related to our city is kept in a secure environment, and with the simultaneous sharing of data, the flow of information between the municipality and the citizen is facilitated from the planning to the presentation of the services.

References

1. TURKSTAT, National Strategy for Regional Development 2014-2023 (Ankara: TURKSTAT, 2014)

2. Erkan ERŞEN, "An Integrated Approach Based on Game Theory and Geographic Information Systems for Solution of Decision Problems" M.Sc. Thesis 2013
3. Bilal Eryılmaz, Restructuring Local Authorities, (İstanbul: Birlik Yayın, 1997
4. Ahmet YILDIZHAN, Change in Local Governments "Using Geographical Information Systems" Graduate Thesis, 2012
5. The Court of Accounts, Coordination of Infrastructure Activities in the Metropolitan Municipalities, Performance Audit Report (Ankara: 2008)
6. Halil İbrahim YUMRUTAŞ, "A GIS Based Decision Support System for the Prioritization of Urban Road Infrastructural Predictions: The Case of Fatih District", PhD Thesis, 2014
7. Ahmet YILDIZHAN, Change in Local Governments "Use of Geographic Information Systems" Graduate Thesis, 2012
8. Nermin ESER, "Urban Information System Implementation in the Implementation of Urban Services: Digital City Modeling for Ankara Altinova" MS Thesis 2009
9. TÜSİAD, Local Governments, Problems, Solutions, ed. Selçuk Yalçındağ (Istanbul: TÜSİAD, 1995) 21.

A GIS-based Method Suggestion for the Creation of the Urban Transportation Database of Turkey

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Abstract

Although urban transportation plans have been made in our country since the 1970s, there are no decisive legislation concerning the nature of these plans. In this study, a database is proposed for the construction and follow-up of urban transportation plans, and the establishment of a central information system to make the overall performance evaluation of the urban transportation plans in our country and the suggestion of the administrative arrangements that should be made in order to keep this system alive. In order to obtain maximum benefit from spatial relationships, the database design was developed within the framework of the Geographic Information System (GIS). The most important point in GIS is to design the database so that it can respond to the inquiries and it should be done in the fastest way. When creating the data model, it has also been considered that the data can be used by different users, institutions, can be archived, can provide all the statistics needed to evaluate the plans and data transfer between different applications used in transportation planning is lossless. Hence, the modeling tools and their representation are based on the ISO / TC 211 standards and the INSPIRE Data Definition Template in order to comply with national and internationally prepared or other data model studies. Thus, it is thought that this study will contribute to transportation planning as a concrete step on the creation of the "urban transportation database" which is specified in detail in various jurisdictional and commission reports.

Keywords
INSPIRE, GIS, database, urban transportation

1. Introduction

Urban transportation planning can be defined as addressing the city's current and future accessibility problems, considering the economic and geographical potentials and the boundaries of the city. It also puts forward solutions for both spatial and operational aspects.

Urban transport has become more and more important nowadays because of the increasing population living in urban areas. This, also increasing the demand for travel and their economic, social and environmental impacts such as air pollution, traffic congestion, energy consumption, noise and natural environment damage. Transportation plans, however, are inheretly long-term and costly. The proposed policies and the infrastructure investments they require are spread over time, and sometimes those investments became the starting point of the next plan, not the end of the existing plan. The fact that the preparatory stages of these long-term plans are also long-lasting, thus increasing the ability to reflect trends, past-based benefit-loss statistics will help these plans more fruitful.

The objectivity in performance evaluation is one of the most important things for these plans. However, in order to do that the data should be consistent and stable. Stability indicates the ability to analyze data collected for a particular region at any time with a fixed method, while consistency indicates that multiple regions should be comparable to the same statistic in the universe. In order to achieve stability and consistency, some standards need to be established for data.

Naturally, the transportation plans are the geometric representation of the city. Therefore, geographical references should be taken into account when creating the standard for the plan, which inevitably leads to Geographical Information Systems (GIS). The database proposed in this document is a part of GIS.

In this study, which is a database structure for use in urban transportation plans in Turkey and suggests an administrative solution that can handle it, both the current situation in our country and the situations in other countries are examined. The examinations made were based on what data was used, how often, by which method, by whom, and how it was stored and presented rather than the nature of the transportation plans.

2. Material and Method

Evaluation of the data to be collected within the scope of transportation planning only in terms of attributes or only vector data will not be able to respond to the final needs of the users. So, the data is designed to be kept in the geographic database so that the attribute and vector data are combined.

While it is sufficient to store geographical information in simple files for a small GIS project, it is necessary to use a database management system for data production, storage and operation in GIS projects where medium to large scale, multiple users are located.

Database management systems used in GIS are relational database structure. The data is stored in tabular form in such databases. The tables contain fields and records. Columns are units in which data are kept separately from each other.

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The records are the lines in the table. The lines store the information in the tables. Some fields are defined as primary keys and records are sorted according to the defined key. Unique keys prevent the same information from being entered in different rows on the same column, and ensure that there is no null information in that column. Relationships between the tables are made through the common areas on the tables. The primary key and the foreign key are used when establishing relationships. A reference key refers to the fact that the column that provides the unique record in a table is found as a normal column in the other table. The most important features of relational databases are as follows;

• Access and operations can be performed faster in relational databases that provide indexing opportunities through key fields.
• The data in the different tables can be connected to each other using the keys and the query language can be used
• Each data recording is stored only once. This ensures effective and efficient storage of the data.
• By setting field properties, associating and linking tables, and applying data integrity rules, the reliability of the data can be increased.
• Permission to access the database is allowed within the authority of the user.
• The relational model is a standard. Depending on the rules of the relational model, it is possible to easily transfer the data to other relational database systems.

In terms of content, INSPIRE principles has been the main focal point while preparing the urban transportation database. INSPIRE is a spatial data infrastructure created for use in the European Union's environmental policies and policies that may affect the environment. The INSPIRE principles underlying this study are as follows:

• Data should only be collected once and kept where it can be maintained in the most efficient manner
• Seamless spatial information from different sources across Europe can be combined and shared by other users and different applications.
• Information collected at a level / scale should be shared at all levels and scales, detailed in sub-scale studies, generalized for strategic purposes
• The geographical information required for good governance at all levels should be readily and transparently prepared.
• It should be easy to find out what geographical information is available, how it can be used to meet a specific need, and under what circumstances it can be obtained and used.

3. Results and Discussion

Within the scope of the study, firstly the legislation and statistics on transport planning in Turkey and then in the United States have been examined. When legislation is being examined, the arrangements made about definitions, obligations and plan contents related to transportation planning are examined. In terms of statics, it is researched whether there are regular statistical methods that can be used in urban transport planning.

3.1. The Urban Transportation Plan in Turkey

When the legal regulations on urban transportation plans are investigated, the earliest regulation was the Metropolitan Municipality Law No. 5216 dated 2004. With this Law, the metropolitan municipalities are authorized to make transportation master plans, but the definition and contents of this plan were not included in the law.

Based on this law, the Transportation Coordination Center (UKOME) was designated as the institution responsible for transportation plans at the Metropolitan Municipalities Coordination Centers Regulation issued in 2006, and the land development plan was shown as the frame of the transportation plan.

Based on the Energy Efficiency Law issued in 2007, the Regulation on Procedures and Principles for Increasing Energy Efficiency in Transportation, which was prepared in 2008, complies with the Law No. 5216 on transportation plans. In this regulation, urban transportation plans are defined as "transportation plans prepared in coordination with upper and lower scale plans of the city, which provide sustainable development that minimizes transportation demand according to urban, spatial, demographic, topographic, functional, social, economic characteristics and needs". Again in this regulation, the Ministry of Transport, Maritime Affairs and Communictaion and the Ministry of Interior have been designated as the responsible authorities for taking measures about the "electronic road routing system, travel demand management, traffic management, modal transport, urban transportation plans, public transportation, monitoring of fuel consumption and traffic signaling systems". In addition, Article 10 of this regulation sets out the basic framework of urban transport planning schemes, stating that the municipalities that have a population more than 100.000 people, should prepare urban transport master plans.

With the Regulation on the Construction of Spatial Plans, which was last published in 2014, the "transportation master plan" reached its final definition in a wider frame.

"Taking into consideration the needs and demands of transportation and sustainable development according to the spatial, social and economic characteristics of the city; determining the details about the transportation system of the urban environment, transportation network, standart and the capacity of transporatation modes and their distribution, road, water and air transportation and the integration of these transportation modes, the transfer stations and storage centers of these transportation modes, freight corridors, public transportation routes and the parking places, pedestrian roads, accessibility and traffic issues where necessary, emphasizing and prioritizing mass transportation, suggesting short and long term solutions to the problems of transportation modes; a plan with its reports that can be prepared in coordination with the city's upper and lower scale plans when necessary"

However, in this Regulation, the transport master plans are separated from the spatial planning stages, and neither the production scale nor the requirements for the transport plans are specified.

With respect to institutional structuring, among the existing legislation, only Law No. 5216 requires the establishment of the UKOME, and its main task is explained as "coordination of all transportation services within the city". Aside from this, no standard has been set, nor has it been pointed out in a national administration that will enforce sanctions against municipalities that do not comply with these standards.

3.2. Statistics on Road and Railway Transportation in Turkey

National level statistics that can be used in urban transport planning are published by the General Directorate of Security, General Command of Gendarmerie, General Directorate of Local Authorities affiliated to the Ministry of Interior; Transportation, General Directorate of Highways of the Ministry of Maritime Affairs and Communications and State Railways of the Republic of Turkey. The statistics are summarized in Table 2.1.

Table 1: The urban road and rail transport statistics that are published in Turkey

Institution	Theme	Frequency	Method	Content
General Directorate of Security	Road Motor Vehicles	Annual	Administrative records	• Number of Road Motor Vehicles by Type and Use • Number of Road Motor Vehicles by Kind of Fuel Used • Number of Road Motor Vehicles by Model Years • Number of Road Motor Vehicles
General Directorate of Security, General Command of Gendarmerie	Road Traffic Accident Statistics	Annual	Administrative records	• Number of Traffic Accidents and Results • Registered Motor Vehicles and Motor Vehicles Involved in Traffic Accidents by Type of the Motor Vehicle • Road Traffic Accident Faults of Causes
General Directorate of Highways	Highway Inventory	Annual	Administrative records	• Highway lengths • Surface types
General Directorate of Local Authorities	Highway Inventory (Village Roads)	Annual	Administrative records	
General Directorate of Highways	Highways Financial Statistics	Annual	Administrative records	
General Directorate of Highways	Navigations and Transportation on Highways	Annual	Survey	The navigation and the freight and passenger transportation on state roads, provincial roads and motorways.
General Directorate of Highways	Traffic and transportation survey of highways	Seasonal	Survey	• Traffic section map • Traffic volume map • State roads AADT values • Vehicle-km, passenger-km, ton-km
General Directorate of Railways	Railway statistics	Monthly	Administrative records	Passenger Transport on Railways

Traffic and transportation information mentioned in Table 1 is obtained by KGM by traffic counts on motorway, state and provincial roads. Traffic counts are made every year on state roads and every 3-5 years on provincial roads. In addition, short-term non-program counts are also made for new investments if needed.

In addition to the statistics set out in Table 1, particularly metropolitan municipalities also provide statistics for their cities in their annual reports and on their internet sites. However, there are no statutory obligations on the publication or the standards of these statistics that are issued by the municipalities, nor are they regularly presented statistics similar to "Traffic and Transportation Information" regularly provided by KGM.

3.3. The histrory of urban transportation plan in United States of America

The history of urban transportation planning in the United States, which has stareted around 1950s, is a very detailed journey that includes plan construction techniques and processes. This section will cover the starting points that form the current understanding of planning.

At the beginning of the 1900s, with the first use of motor vehicles in cities, a new era began in the morphological, economic and social structure of cities. Although the effects of this new era were immediately felt, from the planning point of view, a step was not taken until 1950, especially on the urban scale. After the Second World War, the prosperity increased and the use of cars began to spread in cities. This caused traffic congestion in the city. In 1954, for the first time, the National Committee on Urban Transportation was established. This committee worked for four years and prepared an urban transport planning guide for local governments. A further 17 guidelines have been published for better practices at urban transport planning.

At 1962, while the urban transport planinng processes at the metropoliten areas were going well, urban transportation planning in small-scale urban areas did not occur at the desired level due to lack of qualified personnel. The American Municipal Association, the American Association of State Highway Officials, and the National Association of County Officials had come together to discuss how urban transport planning could proceed in areas that have population less than 250,000. After, they started a program to help those less populated municipalities.

With the 1962 Federal Road Assistance Act, the urban transport plan became mandatory for the first time. This law obliges state and local governments to undertake a comprehensive transport planning study in order to benefit from federal assistance for any city with a population of more than 50,000. Thanks to this law, until June 1, 1965, the last day of the law, transportation plans were started to be made in all 224 urban areas available at that time.

Following the outbreak of the law, the Bureau of Public Roads (BPR) has also begun to work on how this law will be implemented. As a result of the work done, the Bureau decided that this mandatory work with the 1962 law should be realized with 3C (continuning - continuing, comprehensive - cooperative - business association) planning process and directed local administrations like this. He also helped local governments by publishing the following 10 guidelines on how technical planning should be.

- Calibrating and Testing a Gravitv Model for Anv Size Urban Area, July 1963.
- Calibrating and Testing a Gravitv Model for a Small Computer, October, 1963.
- Traffic Assignment Manual, June, 1964.
- Population Forecasting Methods, June, 1964.
- Population, Economic, and Land Use Studies in Urban Transportation Planning, July, 1964.
- The Standard Land Use Codinq Manual, Januray, 1965.
- The Role of Economic Studies in Urban Transportation Planning, August, 1965.
- Traffic Assignment and Distribution for Small Urban Areas, September, 1965.
- Modal Split- Documentation of Nine Methods for Estimating Transit Usage, December, 1966.
- Guidelines for Trip Generation Analvsis, June, 1967.

In the United States, the above briefly summarized guides have been revised up to date or redefined under new headings.

3.4. Transportation Databases in USA

The data collection has a parallel process with the legislative situation in USA. At the present time, there are two main datasets which are primarily used in transportation planning. These are named as Census Transportation Planning Package (CTPP) and National Household Travel Survey (NHTS). In addition to these there are other datasets related to financial aspects and geometry of highways. In this article, National Transit Database (NTD), which supplies financial anad operational information about trnasit services in USA and Highway Performance Monitoring System (HPMS), which stores geometry, and the related statistics about the highway network is also analyzed.

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3.4.1. Census Transportation Planning Package

It is one of the most used transportation data in USA today by transportation planning units. It is collected by the Population Bureau from 15% to 25% of the households from 1960 to the present day.

Initially, the Highway Research Board (HRB) Committee on Transportation Information Systems and Data Requirements, established by the Bureau of Highway Research in 1960, began negotiating with the Bureau of Population and posting questions about the work trip to the 1960 census questionnaire. Since then, the data is collected decennially. After 2000, the data is collected under American Community Survey (ACS).

3.4.2. National Household Travel Survey

Another study aimed at periodically presenting comprehensive data on travel and transportation to transport planners and policy makers in the United States is the National Household Travel Survey. This survey was initiated in 1969 to obtain national travel information patterns covering all types of travel and modes of transport made in urban or rural areas. This work, funded by the Federal Road Administration, was designed to include all journeys, travel destinations, and all modes of transport for people aged five years or older. It includes information about household data, demographic data, information on motor vehicles used by households, availability and use of public transport, driver information, information on all journeys made within 24 hours, trips made to more than 75 miles (120 km) within 14 days, and the geographical location of workplaces.

3.4.3. National Transit Database

The national public transport database program was initiated by the US Congress to collect relevant information and statistics on public transportation systems in 1974 for use by central funds for distribution. All private and public agencies and institutions that use the financial assistance provided by the Federal Transit Administration must provide data to this database in accordance with the law. Currently, approximately 660 institutions and organizations providing public transportation services in urbanized regions send data using the internet-based reporting system.

3.4.4. Highway Performance Monitoring System

The basis of this information system was laid in 1978 and continued to be updated up to the day. All the highways which are above a certain level of function (priority level) are collected in this system. All information related to a wide range of roads such as physical and financial conditions, artifacts, traffic signs, signatures, traffic counts are entered into this database annually. Thus, it is possible to create the transportation policies of the country, admit new technologies easily and allow the investments made.

4. Conclusion and Suggestions

In order to plan the transport system of the future and to create efficient transportation policies, it is highly important to have a database and an administrative structure to maintain that database. In this section, firstly a database structure will be propsed and then the administrative approach to maintain this database will be presented.

While the urban transport database was being developed, the proposal database was collected in three main groups.

- Basemaps
- Public transportation data
- Counts and surveys

The first group, the base map, covers all the transportation related items in the city. Roads, traffic signs, intersections, urban residential areas, traffic analysis zones, etc. The tables in this group and the attributes they contain are shown in Figure 1.

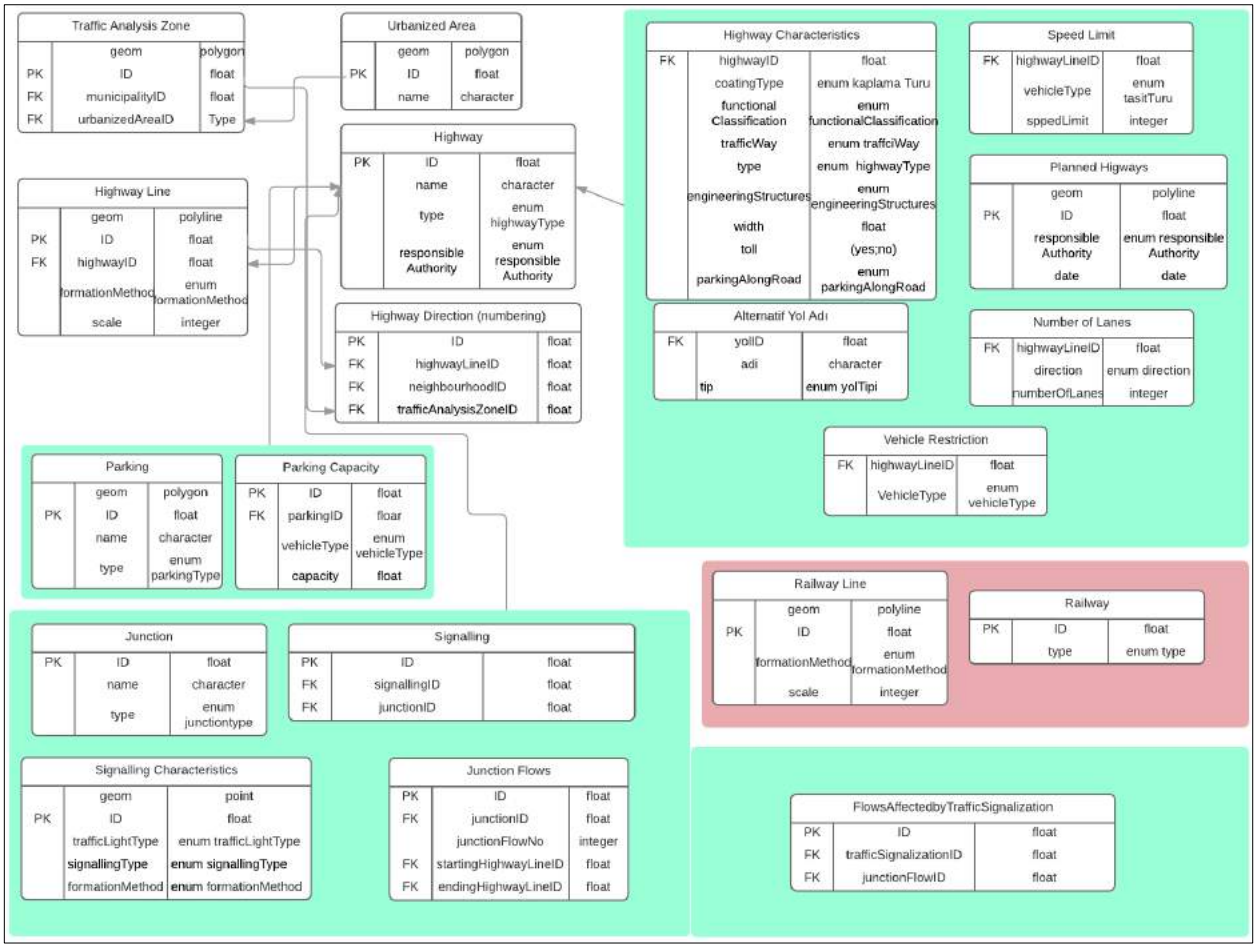

Figure 1: Basemaps

Public transport data in the second group includes physical and financial information of public transport for all modes of transport in the city, statistics on the routes, operators, line numbers, stops, stop types, taxi stops, statsitics are all included here. The tables in this group are shown in Figure 2.

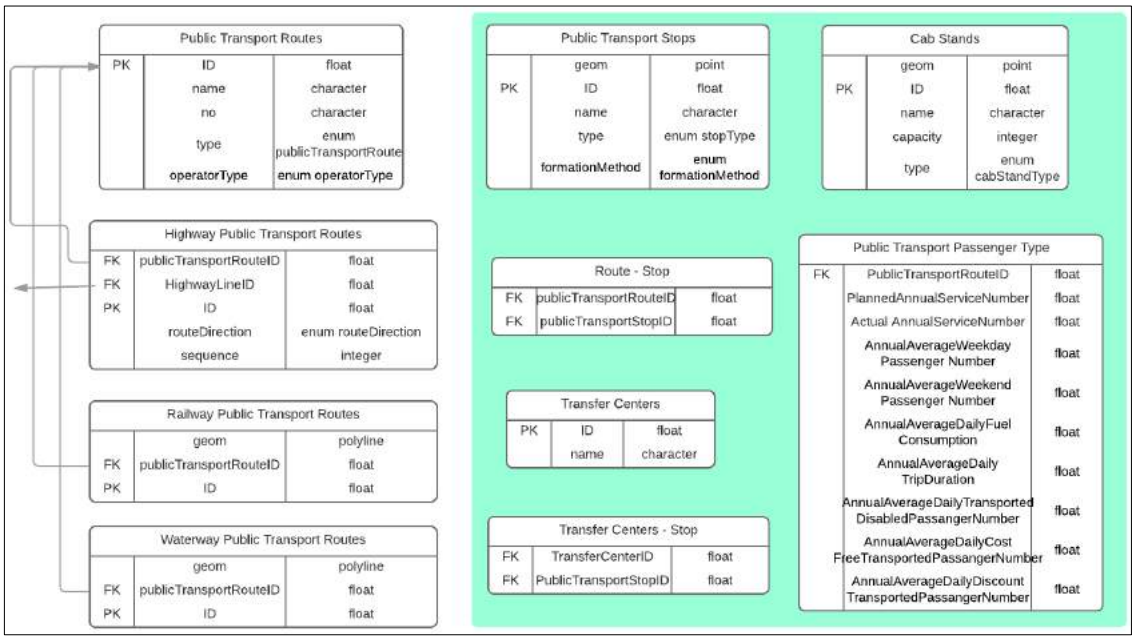

Figure 2: Public transport database

The third and the last group consists of traffic counts and questionnaires (Figure 3).

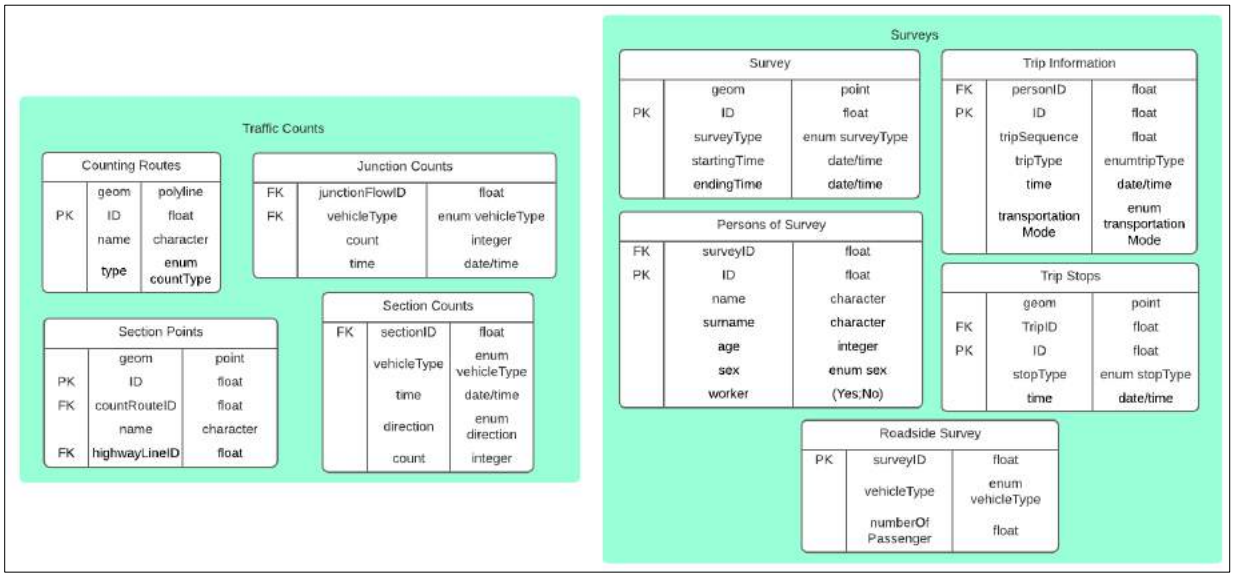

Figure 3: Traffic counts and questionnaires database

In this study, despite the fact that it provides a database on transportation, methods of collecting data, topological rules have not been studied. Basically, it has been shown what information should be found in the urban transport database and with which basic attributes. Similarly, how the stored data will be presented and shared will be determined within the scope of future work.

The datum of this project is International Terrestrial Reference Frame (ITRF1996) and its projection is the Transversal Mercator (TM) projection, also referred to as the Gauss-Krüger projection.

In order to ensure that the data model described above is updated, it is necessary to transfer information from the relevant institutions and all competent authorities to this data model. The required legislation must be both binding and compelling in this respect. The establishment of an Urban Transport Authority responsible for urban transportation plans and the maintenance of the database under the responsibility of this single administration will be of great benefit both in terms of quality and continuity. Collection of these data on regular basis from all competent institutions will help to prevent information misuse and improve the distribution of resources. One other mission of this authority would be to guide, help, and teach the local goverments to make their own transport plans as it was done in USA fifty years ago. At the basis of all these well-intentioned predictions lies the explanation of the importance of transportation planning to local governments.

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6. References

Highway Performance Monitoring System Field Manual, Office of Highway Policy Information, 2016, Office of Management &Budget (OMB) Control No: 2125-0028.

http://ctpp.transportation.org/Pages/5-Year-Info.aspx [Accessed 31 October 2017].

https://www.transit.dot.gov/ntd/ntd-data [Accessed 31 October 2017].

INSPIRE Data Specification on Transport Networks – Technical Guidelines, INSPIRE Thematic Working Group Transport Networks, Thursday, April 17, 2014 https://inspire.ec.europa.eu/id/document/tg/tn [Accessed 18 October 2017].

National Household Travel Survey: User's Guide, 2011, U.S. Department of Transportation, Federal Highway Administration. http://nhts.ornl.gov/2009/pub/UsersGuideV2.pdf [Accessed 31 October 2017]

Weinberger, P. Z., (2016), *National Datasets; How to Choose Them*, Proceedings How to Use Them, European Transport Conference.

Weiner, E., (1997), *Urban Transportation Planning in the United States: An Historical Overview*, Technology Sharing Program Research and Special Programs Administration, US Department of Transportation, Washington, DC.