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Cadastral Data Model with Geographic Information System For Marine Areas: A Case Study of Trabzon

Coğrafi Bilgi Sistemleri ile Deniz Alanları İçin Kadastral Veri Modeli: Trabzon İli Örneği

Abstract

In Turkey, spatial data is needed for a sustainable environmental management of its marine and coastal areas. In the contemporary age, which is also called "Information Age", data/information acquisition and analysis are prerequisites for rapid, precise and economical decision making. Marine areas have intensive information sets including sea bed, sea surface and coastal areas. A vast variety of spatial data such as deep discharge lying through the sea bed or pipelines (oil, natural gas, transportation), sand extraction areas for sand ships, secure routes and holding areas or anchorage for petroleum tankers, fishing areas, conservation areas for sea ecosystem are required for a sustainable marine and coastal management. In the context of marine, there are different legal arrangements for different foundations or government bodies. For an effective management, extensive information sets must be effectively analyzed. For an ideal management of marine coastal and areas, in addition to the previous terrestrial surveying activities, it is evident that surveying and registration of marine areas will be carried out in the future. The registration of marine and coastal areas and related rights and boundaries similar to terrestrial areas is a legal, social and economic requirement requiredwhich is important for a sustainable marine and coastal management. The aim of the present study was to design a basic mapping coverage and develop a cadastral data model for planning marine areas with the support of information technologies for a sustainable management of marine area and Geographic Information System (GIS) of marine areas.

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Öz

Türkiye'de deniz ve kıyı alanlarında sürdürülebilir bir çevre yönetimi için konumsal veriye ihtiyaç vardır. Bilgi çağı olarak adlandırılan günümüzde veri/veri edinimi ve analizi, hızlı, hassas ve ekonomik karar vermenin ön şartıdır. Deniz alanları deniz yatağı, deniz yüzeyi ve kıyı alanları olmak üzere yoğun veri setlerine sahiptir. Deniz tabanından geçen derin deşarj sistemi ya da boru hatlar (petrol, doğal gaz, ulaşım), kum gemileri için ayrılan kum çıkarma alanları, petrol tankerleri için güvenli geçiş güzergâhları ve bekleme alanları, avlanma alanları, deniz ekosistemi için koruma alanları gibi birçok konumsal veri sürdürülebilir bir deniz ve kıyı yönetimi için gerekli olan verilerdir. Denizel alanlara yönelik yönetişim bağlamında farklı kurumlar için yasal düzenlemeler vardır. İyi bir yönetim yoğun bilgi setlerinin en iyi bir şekilde analizini gerektirir. İdeal bir denizel alan ve kıyı yönetimi için günümüze kadar yapılan karasal ölçümlerin yanında gelecekte denizel alanların ölçümü ve kayıtlarının da gerçekleştirileceği açıktır. Denizel ve kıyı alanlarının da karasal alanlar gibi kayıt altına alınması, kullanım haklarının ve sınırlarının belirlenmesi hukuki, sosyal ve ekonomik bir gereklilik olduğu kadar sürdürülebilir bir deniz yönetimi için de gereklidir. Bu çalışmanın temel amacı, denizel alanların sürdürülebilir yönetimi ve denizel alan CBS için, temel harita altlıkları ve denizel alanların planlanmasına yönelik konumsal veri modelinin bilgi teknolojileri desteği ile tasarlanmasını sağlamaktır.

Introduction

Seas and oceans cover approximately two-thirds of the earth's surface, which makes marine and coastal areas one of the most important areas which are associated with each other and humanity areas of common living areas. Approximately two-thirds of the world's population lives in coastal

areas. Marine and coastal areas are of great importance for the welfare of a country, communities and regions. These areas contribute immensely to the improvement of social, economic and natural functions. Turkey is surrounded by seas on three sides: the Black Sea to the north, the Aegean Sea to the west and the Mediterranean Sea to the south. The total length of Turkey's coastline is 8.333 km. Therefore, the coasts are one of the country's most important natural resources. The effective management of this resource, which is under the pressure of population due to urbanization, industrialization, tourism and secondary housing, is extremely important.

Turkey has an important inland sea called Marmara located between the Black Sea and the Aegean Sea and it is connected to these seas by two important straits: the Istanbul Strait in the north and Canakkale Strait in the south (Figure 1).

Figure 1. Turkish Coasts

The importance of coastal and marine areas as a valuable economic resource is increasing day by day (Widodo, 2003). This is considered in the framework of the sea in the area of economic, environmental and social impacts are increasing. Historically, ocean tenure has been held by the country with the largest naval fleet and desire to control and/or use its coastal waters. The sense of nationalism to secure or extend domain has stimulated a series of claims, dividing the ocean, the living marine resources within, and sand and mineral resources in the seafloor (US Department of State, 1996). Technological advances in mapping, such as the Global Positioning System (GPS), geographic information system (GIS), and electronic charting display systems (ECDIS) have enhanced and complicated the development of ocean boundaries to delimit these claims . Today, mariners have the ability for price positioning, causing the dead reckoning and paper navigation charts to become ancient history. Advances in the mining technology have increased the commercial viability of offshore mineral extraction, which in turn has increased the pressure for accurate seafloor mapping. In the past, the majority of the mining operations was conducted for oil, gas, and sulfur. Today, offshore sand has become a high demand resource for beach renewal projects. Depleted marine resources and the increased threats posed by man-made pollutants are forcing many countries to increase law enforcement and initiate a comprehensive planning in the offshore environment. As a result, the need for accurate, useable, and accessible digital marine boundaries and defining territorial claims has become more apparent for businesses that are directly involved in ocean (Fowler and Treml, 2001).

The concept of Marine Cadastre is attracting interest from an ever growing number of scientists. Most of the similarities and differences between the marine cadastre and its equivalent land units are due to the fact that any marine environment has unique characteristics that are not applicable to the terrestrial environment, hence, they are not applicable to the land register and cadastre, although many of the components used in the cadastre, rights, etc. and scientific and applied research and other components, are of equivalent status both in the sea and in the ocean (Binns et al., 2004: 22).

Geographic data and analyses play a critical role in determining suitable locations for the protection of marine resources. Geographic information technologies have improved in both sophistication and ease of use over the last decade, granting non-technical participants the ability to visualize and interpret geographic data (Merrifield at al., 2013: 70). GIS includes software, hardware, data and procedures to store, visualize and analyze spatial information for the purpose of decision making (Nyerges et al., 2006: 712). In general, the use of GIS is limited to those with advanced training, as software packages are too complex for a casual user to learn and utilize in a reasonably short time period. Therefore, the reliance of the traditional GIS software in public planning often marginalizes the average nonspecialists involved in the decision-making processes (Sieber, 2006: 496). In addition, enabling access to geographic information and technology raises a number of issues related to community empowerment, data access, public participation, and the incorporation of local knowledge into expert driven systems (Harris and Weiner, 1998: 69).

The management of national marine ecological resources constant improvement of scientific methods and information the researchers of the marine community. These improvements must come in the form of better information and better access to information. Thus, the marine community must develop standard methods of data management and analysis, which provide rapid dissemination of data, easy comparability of research findings, and simple means to carry out complex analysis (Lord-Castillo et al., 2009). Coastal and marine areas have a great value for the welfare of the country, communities and the regions. These areas contribute a great deal for improving the living standards of social, economic and natural functions (Widodo, 2003). The marine cadastre systems are used in various countries with GIS. In general, GIS is used in sustainable studies and projects around the world (Tok et al., 2013). In the USA, Ocean Planning Information System (OPIS) which is a prototype marine cadastral information system was develeoped by the the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center. The Australian and New Zealand Land Information Council (ANZLIC) has recommended that the Australian Spatial Data Infrastructure (ASDI) incorporate spatial information regarding all of Australia, including the marine environment. This would go a long way to aiding the creation of a seamless 'on-land off-shore' cadastre for the country. In New Zealand, the Land Information New Zealand (LINZ), which is a government department responsible for land titles, geodetic and cadastral survey systems, topographic information, hydrographic information, managing Crown property and a variety of other functions, was developed. Studies on marine cadastre are also conducted in Canada and South Korea. In Turkey, the concept of Marine Cadastre is quite recent. There are no studies conducted directly on this subject although there are many regarding marine areas. These studies conducted have mainly focused on the shoreline changes and the coastal line of the edge. This scope of work is ensuring that the design of basic mapping coverage and cadastral data model for planning marine areas with support of information technologies for sustainable management of marine area and GIS of marine area.

1. Cadastre

Cadastre (also spelled as cadaster), which uses a cadastral survey or cadastral map, is a comprehensive register of the real estate or real property's metes-and-bounds of a country. A cadastre commonly includes details of the ownership, the tenure, the precise location (some include GPS coordinates), the dimensions (and area), the cultivations if rural, and the value of the individual parcels of land. Cadastres are used by many countries around the world, some in conjunction with other records, such as a title register. In most countries, legal systems have been developed around the original administrative systems and use cadastre to define the dimensions and locations of land parcels described in legal documentations. The cadastre is a fundamental source of data utilized in disputes and lawsuits between landowners (URL-1, 2014).

According to FIG Cadastre 2014, Cadastre 2014 is a methodically arranged public inventory of data concerning all legal land objects in a certain country or district, based on a survey of their boundaries. Such legal land objects are systematically identified by means of some separate designation. They are defined either by private or public law. The outlines of the property, the

identifier together with descriptive data, may show for each separate land object the nature, size, value and legal rights or restrictions associated with the land object. In addition, Cadastre 2014 and 2023 contain the official records of rights on legal land objects. Cadastre 2014 and 2023 give the answers to the questions of where, how much, who and how (Kaufmann and Steudler, 1998).

On cadastre studies should also be included related to the water footprint of the fields detection. The sea, lake, dam lakes, rivers, and the river mouth which are under the sovereignty and disposal of the state can be rented to private and legal persons to benefit from them. In future studies, general water that surrounds the coast must be taken under the scope of cadastre as it is foreseen that such leases will become widespread in Turkey (Bıyık and Karataş, 2002).

1.1. Marine Cadastre

There are two definitions for marine cadastre:

Marine cadastre is a system that enables the boundaries of maritime rights and interests to be recorded, spatially managed and physically defined with regard to the boundaries of other neighboring or underlying rights and interests..

Marine cadastre is a marine information system, encompassing both the nature and spatial extent of the interests and property rights, with respect to ownership, various rights and responsibilities in the marine jurisdiction. As a cadastre parcel on earth is considered three-dimensional, marine cadastre and marine environment can be considered three-dimensional as well (Nichols et al., 2000: 421).

The concept of what constitutes a cadastre varies according to each jurisdiction. A marine cadastre is an even more vague concept for the administrators of marine rights in various national jurisdictions. These administrators prefer using the term "marine information system" (Sutherland, 2005).

2. Requirements of Marine Cadastre

In developing countries, due to the rapid development of the industry and urbanization, the use of the marine areas is under the threat. Therefore, it is a requirement for the marine areas to be planned in a way to provide multiuser purposes. In Turkey, both domestic and foreign tourists are drawn to marine and shore areas. This is usually over the summer months and is referred to as marine tourism. Total shore length in Turkey's is approximately 8300 km. and these shores serve many different purposes including accommodation facilities (hotels, holiday resorts, etc.), yacht tourism and summer houses (Erbas, 2013).

Additionally, inland waters and marine aquaculture are rapidly evolving industries in Turkey. In the past and today, through allocation and usage rights are given to applied "fish trap (stake net, ill-gotten gain (cast), cage fishing areas, ports and barge port" areas. In this context, the first trout farm was established in 1970s and first sea bass and sea bream enterprises in 1985s. In 2004, it was reported that there were 1301 enterprises in inland waters and 358 enterprises in marine aquaculture. This value's contribution to the national economy was $350 million (Erbas, 2013).

National and international oil and natural gas pipelines pass under the sea in Turkey. There are pipelines passing underneathe the Black Sea, Aegean Sea, Western Anatolia and Thrace. Turkey's shores and marine areas are used for a variety of activities making marine cadastre inevitable in Turkey.

In Turkey, the administration and management of the marine areas by using the spatial information is inadequate. On the other hands, the data produced by the institutions of the marine administration and management are not real time and do not possess the sufficient accuracy. In addition, intuitional conflicts arise due to the marine areas being used for many different purposes. In this context, the marine cadastre provides the marine spatial information system, facilitating a systematic determination of the tenure rights on the marines and the registration of these rights (Erbas, 2013). Therefore, the implementation of marine cadastre, shown in Figure 2, is of great importance.

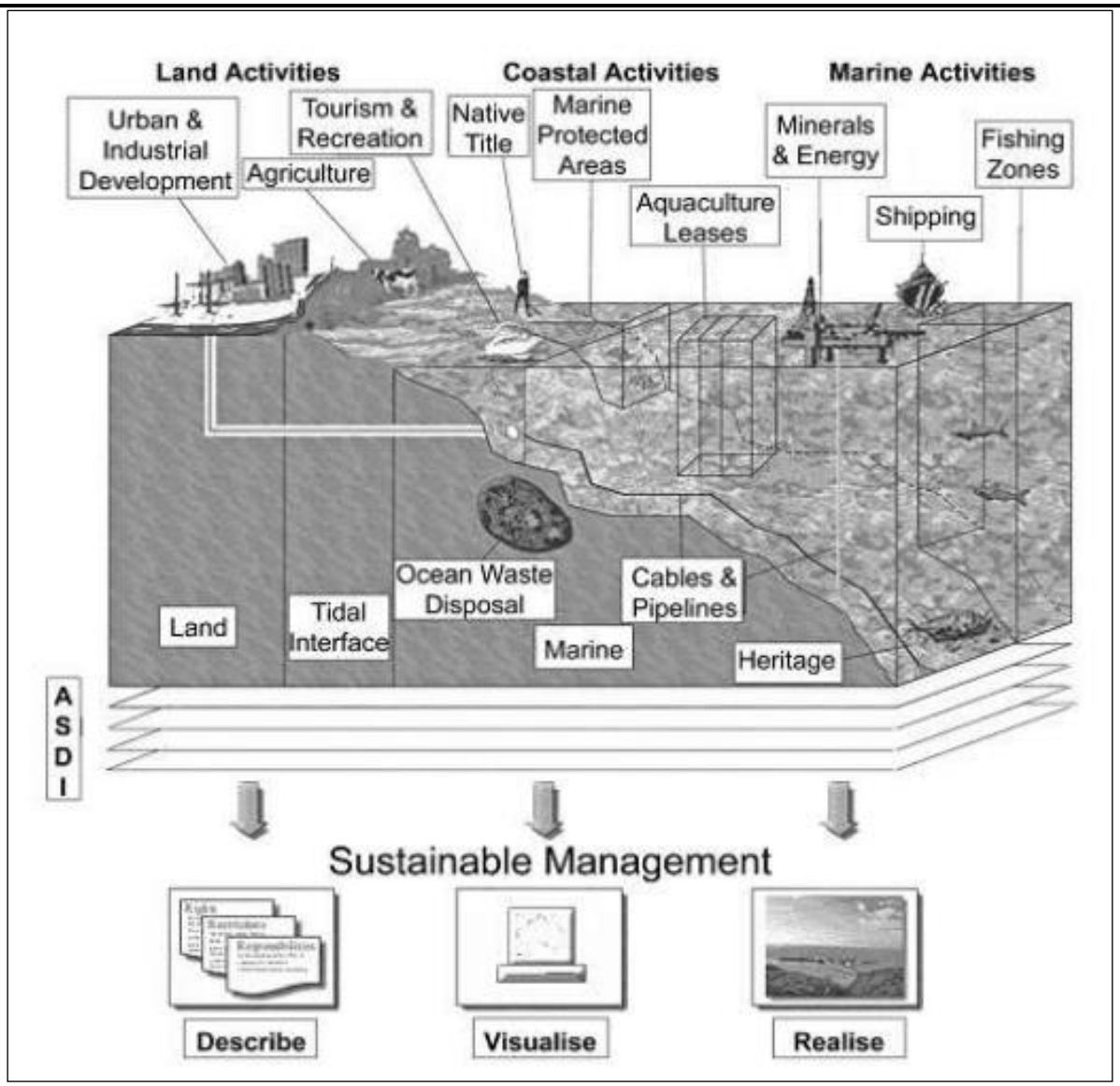

Figure 2. The Diagram of The Concept of Marine Cadastre (Ng'ang'a, 2001)

3. Cadastral Data Model for the Marine Area

In this study, the district of Trabzon located in the eastern Black Sea region of Turkey was selected as the research area (Figure 3). Trabzon covers a total area of 4685 km2, has a population over 250.000 and is the third largest city in the Black Sea region. Trabzon's altitude is 37m. and it receives an average annual rainfall of 760 mm. The coastal region shows distinct geographical features. The mountain ranges in the Black Sea run parallel to the coast, especially in the eastern part, limiting the size of the coastal area to extreme minimums. In recent years, the pressure on the coastal areas has further increased with various initiatives in tourism and industrialization. Thus the sustainable management of coastal and marine resources of the Black Sea region is required. However, in Turkey, although there are many studies on the management of coastal areas, studies conducted in relation to marine cadastre are limited. In this context, a cadastral data model for the management of the coastal areas in Turkey is required.

Figure 3. Study Area/Trabzon (Erbas, 2013)

3.1. Current Situation Fish Farms

There are six fish farms established on the sea in Trabzon. In 2012, this number increased to nine when other three permissions were obtained. In the study area, fish-farm for license areas with areas of application has not been the same and the spatial information is incorrect. Both fish -farms' spatial information and their usage areas were determined using satellite images (Figure 4).

Figure 4. Five Fish-Farms between Yomra and Arsin Districts in Trabzon (Erbas, 2013)

For the present study, fish farms, cargo ships anchorage areas and sand extraction areas were determined on the satellite images and processed into a database (Figure 5). Generally, their spatial information and their usage areas were found to be incorrect as their coordinate systems and datum could not be exactly determined.

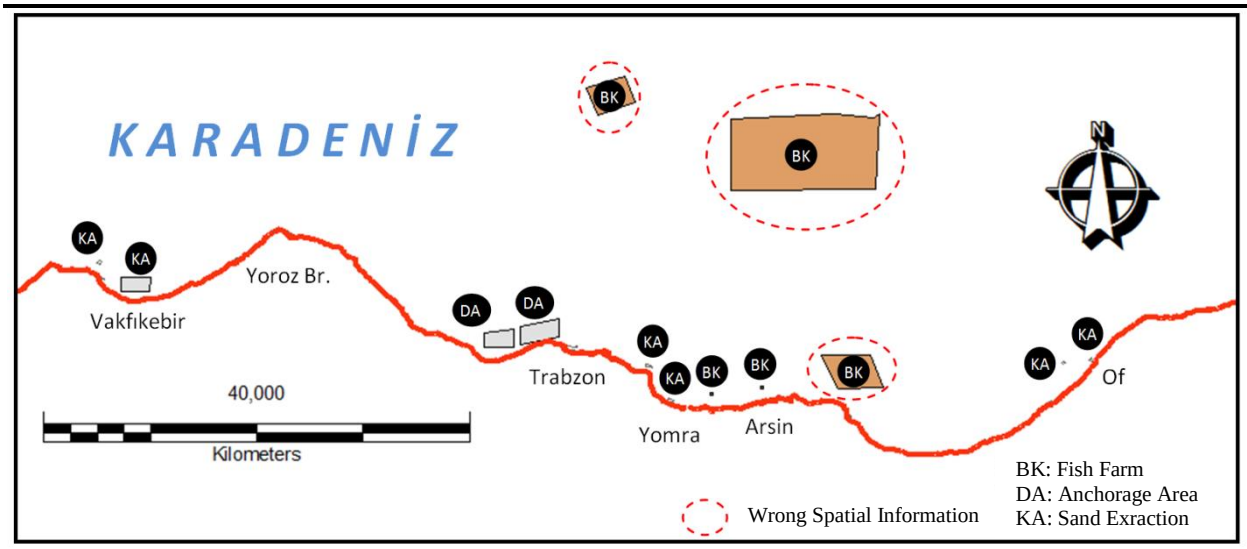

Figure 5. Use of Marine Areas in Trabzon (Erbas, 2013)

3.2. Marine Areas Artificial Structures and Fill Areas

There are no registered structures made of fill areas in Turkey. Structures such as piers, harbors, shelters, berthing areas, breakwaters, bridges, culverts, retaining walls, light, location, boathouse, and etc. don't survey due to made by fill areas. In Trabzon, a total area of 841ha. have been filled and have not been surveyed (Figure 6). Furthermore, artificial structures have not been surveyed either. However, all fill areas and artificial structures must be surveyed (Figures 7-8). However while these areas is surveying, only they have to register to state. So it is not private property.

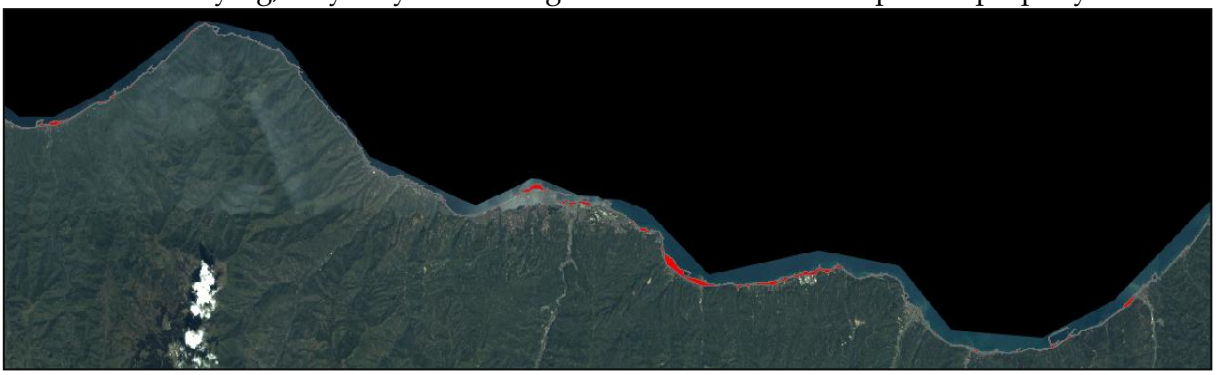

Figure 6. Fill Areas Were 841 Ha between 1975-2011 (Erbas, 2013)

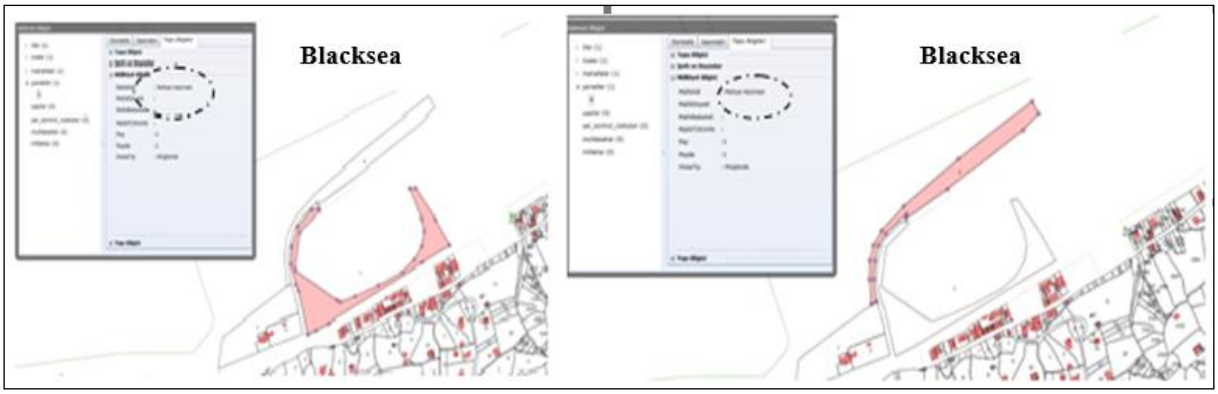

Figure 7. Surveying breakwater (right) and fishing harbor and docks (left) (Erbas, 2013)

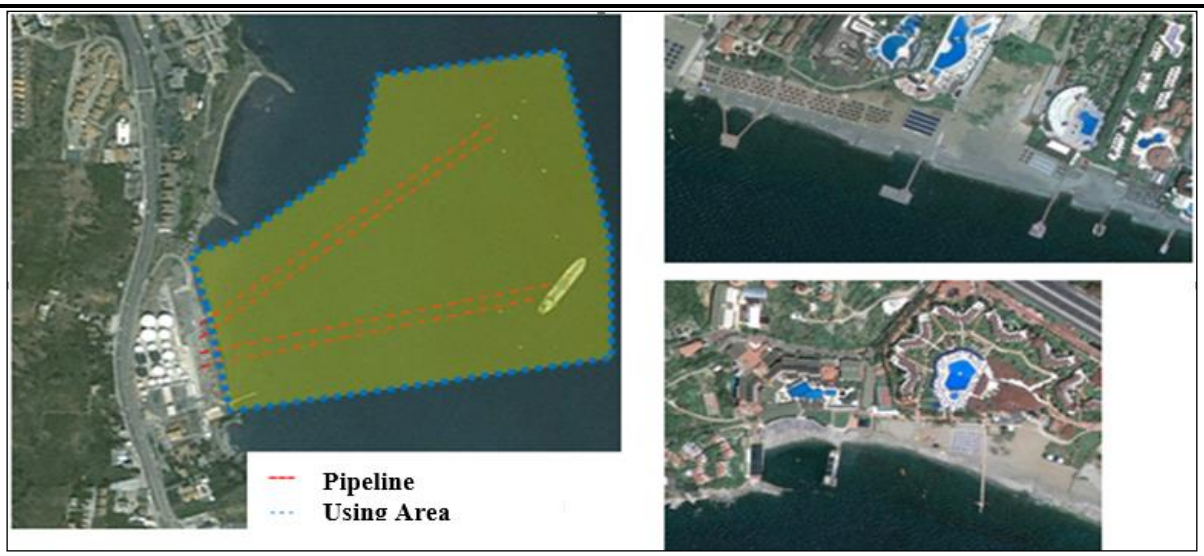

Figure 8. Surveying Petrol Pipeline and Using Area (Erbas, 2013)

A survey was conducted with experts to determine if there was a need for marine cadastre in Turkey. When asked the question to experts about requirements of marine cadastre, at the rate of 71% required were answered by experts in Turkey (Figure 9).

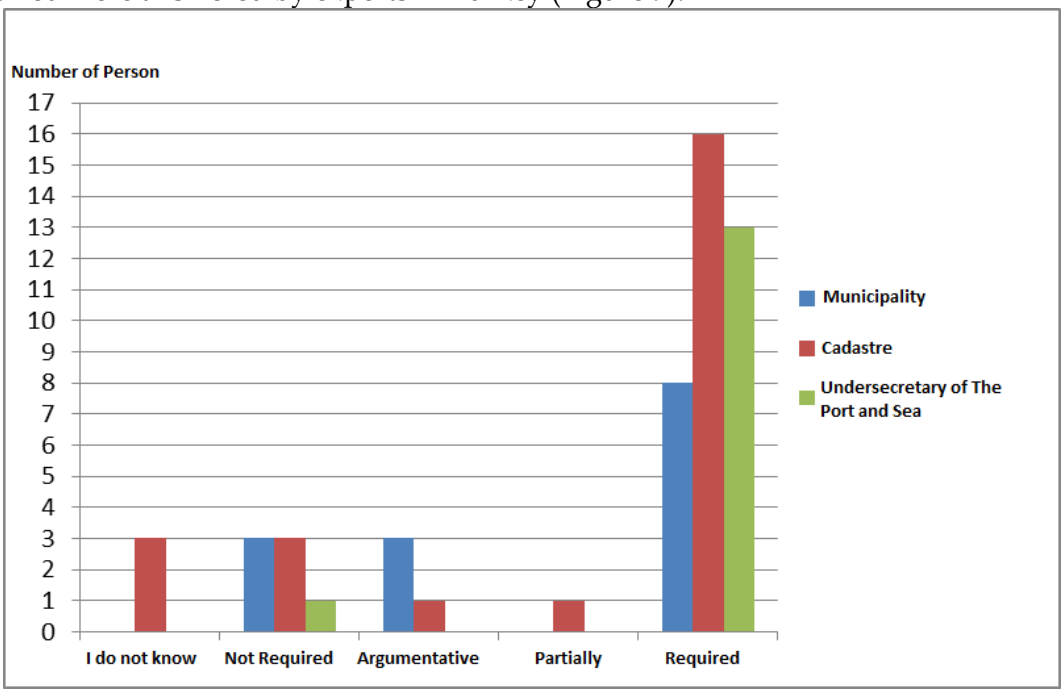

Figure 9. Requirement of Marine Cadastre in Turkey (Erbas, 2013)

4. Cadastral Data Model for the Marine Areas

While creating a model draft of the marine areas, an appropriate modeling was needed for the natural structure of the data in addition to GIS technologies that can be applied to this system. The first study on this subject was conducted by Egenhofer and Frank (2001). Their study used the object-oriented approach method. For the model development process, Unified Modeling Language (UML) class diagrams were used. Firstly, the necessary data was divided into groups (data sets) in model and then the basic relationship between these data sets was defined. However, in the present study, the object-oriented approach method was not used. Instead, simple understandable terms and marks were used. In model, the data was represented with classes that had attributes. Every group represented a different data group. These classes are as follows: Coastal Use, Coastal Construction, Marine Rotas, Use of Marine, Marine Construction, Marine Environment Protection and

Administrative Boundary. These classes can be also called "layers" (Figure 10). All the layers and classes in the model consist of points, lines and polygons in ArcGIS 10.

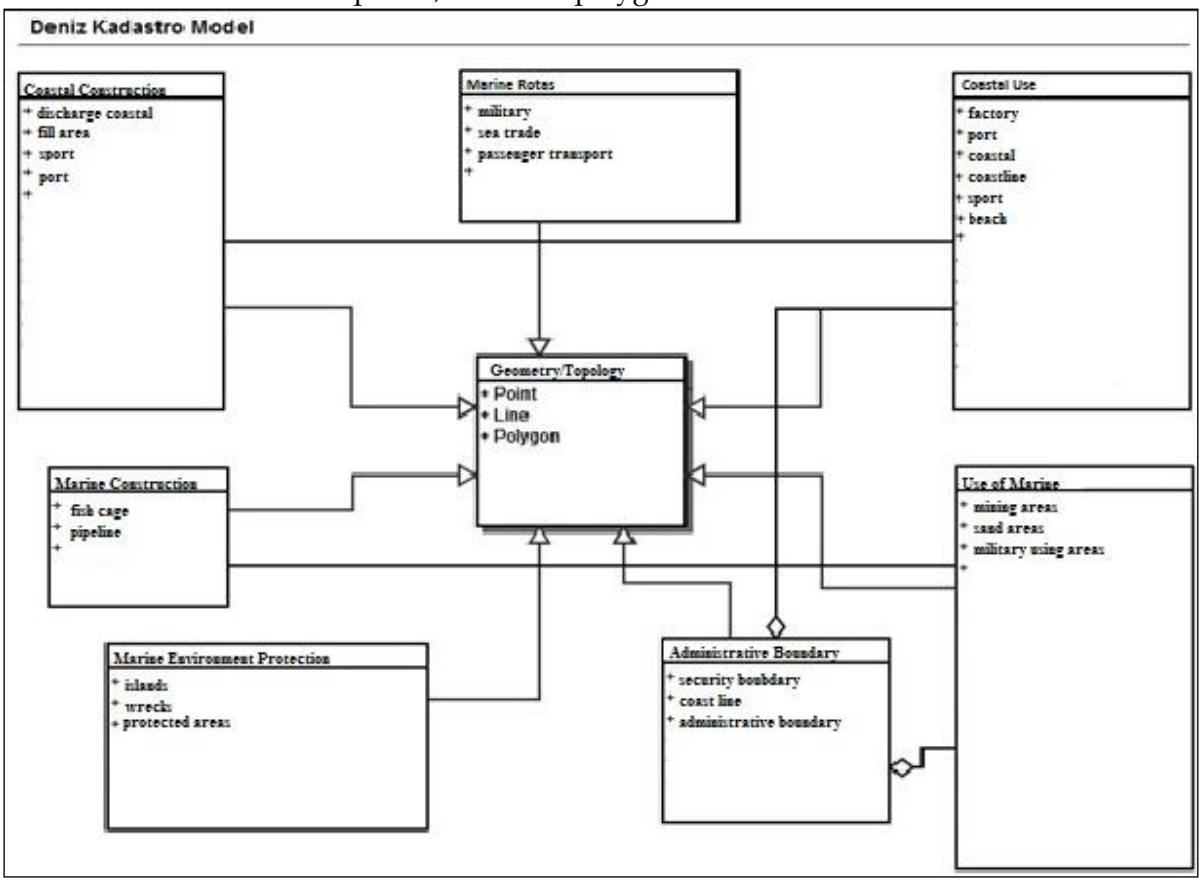

Figure 10. Marine Cadastre Data Model (Erbas, 2013)

Every data compose of topology/geometry and every data sets (seven classes) are associated with each other. Because there is every constructions of using areas on marine areas. For example, there is a port and its covered area is known while its using area isn't known. When marine areas are considered as a parcel, if there is a port, it should be its using area. The port is considered as a house, port's using area should be considered as the house's garden (Figure 11).

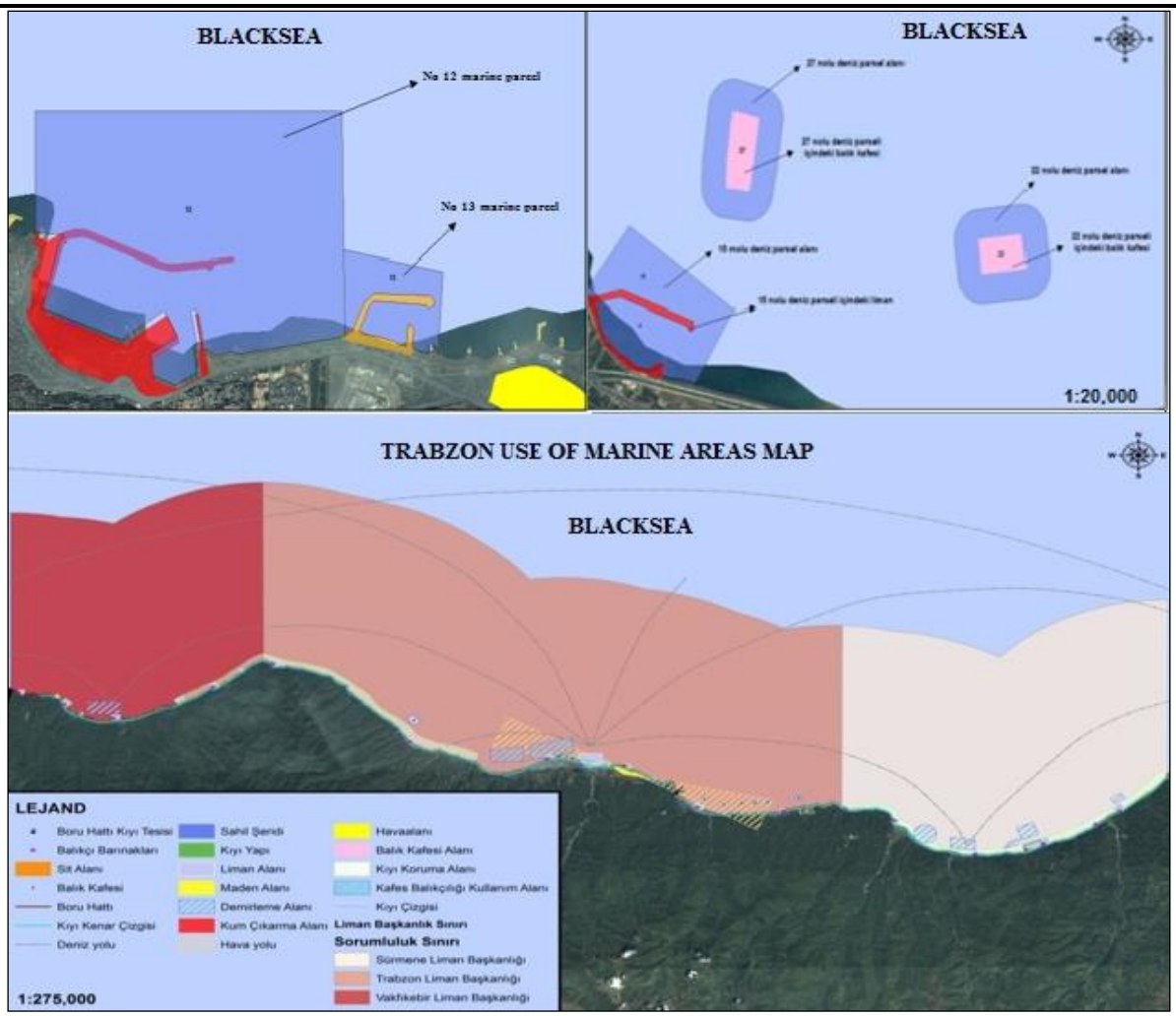

Figure 11. The Marine Area Data Model Experience in Trabzon (Erbas, 2013)

Conclusion

When the applications regarding marine areas are examined in the world, it can be seen that the concept of Marine Cadastre is very common among developed countries. This new concept has just began to emerge and spread in Turkey. In addition, it's emerged that the organizations responsible in marine areas is inadequate about production about spatial information. In this context, studies or arrangements must be conducted with different professional groups. For a sustainable management of marine areas, the management and implementation of activities on the marine area must be controlled. GIS must be used to control such a complex structure, storage and processing. Thus, all data can be stored in digital form for a long period of time. In addition, GIS uses instant decision-making and accurate results and saves cost and money. GIS will provide a great convenience regarding marine cadastre model. In reality, marine cadastre will be a spatial information system for marine areas.

Marine areas are under a serious threat and thus they must be protected, their illegal usage must be prevented, coastal structures must be taken under control and a sustainable marine cadastre must be designed. In addition, making fast and correct administrative decisions regarding marine and coastal areas are needed for accurate spatial and non-spatial data. In the present study, a marine cadastre data model was created using the spatial and non-spatial data within the scope of the district of Trabzon.

References

Binns, A., Rajabifard, A., Collier, P., & Williamson, I., P. 2004. Developing the Concept of a Marine Cadastre: An Australian Case Study. The Trans-Tasman Surveyor, 6, 19–27.

Biyik C., Karatas K., 2002. Yüzyılımızda Kadastroda İçerik ve Kapsam. Selçuk Üniversitesi Jeodezi ve Fotogrametri Mühendisliği Öğretiminde 30. Yıl Sempozyumu. 16-18 Ekim 2002, Konya.

Erbas Y. S., 2013. Denizel Alan Coğrafi Bilgi Sistemleri İçin Deniz Kadastrosu Modellemesi, Karadeniz Technical University. The Graduate School of Natural and Applied Sciences. Geomatics Engineering Graduate Program. Supervisor: Assoc. Prof. Recep Nisanci, 89 Pages, 12 Appendix.

Fowler C., Treml E., 2001. Building a Marine Cadastral Information System for the United Stated – A Case Study. Computers, Environment and Urban Systems. 25, 493507.

Harris T. M., Weiner D., 1998. Empowerment, Marginalization, And "Communityintegrated" GIS. Cartography and Geographic Information Science. 25, 67-76.

Kaufmann J. and Steudler D., 1998. Cadastre 2014 A Vision For A Future Cadastral System. FIG Commission 7.

Lord-Castillo B. K., Mate B. R., Wright D. W., Follet T., 2009. A Customization of the Arc Marine Data Model to Support Whale Tracking via Satellite Telemetry. Transactions in GIS, 13 (S1), 63.

Merrifield M. S., McClintock W., Burt C., Fox E., Serpa P., Steinback C., Gleason M., 2013. Marinemap: A Web-Based Platform For Collaborative Marine Protected Area Planning. Ocean & Coastal Management. 74, 67-76.

Ng'ang'a S, Nichols S, Sutherland M, Cockburn S (2001). Toward a Multidimensional Marine Cadastre in Support of Good Ocean Governance. International Conference on Spatial Information for Sustainable Development. 2-5 October 2001, Nairobi, Kenya.

Nichols S., Monahan D. and Sutherland M., 2000. Good Governance of Canada's Offshore and Coastalzone: Towards an Understanding of The Marine Boundary Issues. Geomatica. 54 (4) 415-424.

Nyerges, T., Jankowski, P., Tuthill, D., Ramsey, K., 2006. Collaborative Water Resource Decision Support: Results Of A Field Experiment. Annals of the Association of American Geographers. 96, 699-725.

Sieber R., 2006. Public Participation Geographic Information Systems: A Literature Review And Framework. Annals of the Association of American Geographers. 96, 491-507.

Sutherland M., 2005. The Marine Cadastre: Legal and Spatial Data Contribution to Economic, Environmental and Social Development. FIG Commission 4 Working Group Activities. April 16-21, Egypt.

URL-1, 2014. Cadastre. Wikipedia. http://en.wikipedia.org/wiki/Cadastre. Last Access date: 1 March.

Widodo M. S., 2003. The Needs for Marine Cadastre and Supports of Spatial Data Infrastructures in Marine Environment – A Case Study. FIG Working Week 2003. April 13-17, Paris, France.

Tok E., Peker F., Kurucu Y., Tok H. H., Saygılı E., 2013. Determining and Mapping the Potential Organic Farming Areas in Istanbul. Journal Environmental Protection and Ecology, 14 (2), 675.