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RESEARCH PAPER

# Spatial Analysis of Effective Coastal Land Use Policies for the Development of Amateur Marine in Turkey

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**Abstract**

Recreational fishing, sailing, activities involving boating are parts of the social life-style which family members practices outdoors as social activities throughout the counties where maritime is common. It is being observed that, these kinds of activities tend to improve in Turkey within the recent years for the reasons like the increase in the national income and acculturation. Consequently, in order for satisfying this demand, new mooring areas with reasonable costs are required. In order to fulfill the berthing and mooring needs of the vessels, cost efficient and environmental solution approaches are need. This article aims to develop a system offering for constitution of sustainable policies with regards to determination of boats berthing and mooring areas that are needed for amateur marine in Turkey. For that reason, geographic information system (GIS) based approaches are taken into consideration for spatial analysis, which is used to specify suggested facilities regarding any component that generates the system. The results showed that the suggested method successfully functions regarding the selection of facility location, and it has been detected that by the suggested system approach, it is possible to achieve new and higher capacities.

*Keywords*: Coastal land use, spatial planning, GIS, spatial analysis, multi-criteria decision analysis.

## Introduction

There have been significant increments regarding the boat market during the recent years in Turkey. The number of the boats which are owned by amateur marines and registered to the Port Authority significantly increased, and reached approximately to 64.000 in the recent years. While 25.876 of them have the opportunity to berth and moor the convenient facilities, the remaining number of boats cannot make use of these services (TUSSIDE, 2015). These numbers show that the country is facing a capacity gap to fulfill the service demand of amateur marine activities. Additionally the cost of using maritime services is considerably high. Therefore, new and economic solution proposals should be produced so that everyone can benefit from maritime services.

When the geographical distribution of amateur marine is taken into consideration, it is seen the demand is clustered in the South Aegean and West Mediterranean coasts. There is also a seasonality of the service demand. These defines the focus of the study. When the travel ranges regarding the travelling boats traffic taken into consideration, because of the collapse in these regions distribution, the problems of failed services in other regions arose.

The economical point of view is not enough for coast resources. The coasts are also natural, cultural even social resources. By legal and administrative regulations and their applicability, the functioning of the mechanisms which would monitor their supervision and implementation, development plant decisions, and the forming of the integrated coast management system in the coasts, will make the constitution of balance inevitable between the cultural, social, natural ecology, and the economy. Within this scope, in addition to the selection of the plant spaces, an integrated operating system is needed. And it is clear that one of the most important factors of this system will be applicable waste management. The building of the sustainable and green facilitates will be possible by the easy and user-friendly planning of the processes with the necessary infrastructure. It is essential for these to be taken into consideration regarding the development of the coast policies.

Various researches are available which oriented on coastal land usage. The central authority formed the integrated coastal area plans for significant regions regarding the coastal areas (Ministry of

Environmental and Urban Planning, 2015). (Sesli, Akyol, & İnan, 2002) A research has been done in order to identify the reaction areas of the coasts. Additionally, there are spatial analyses regarding fishery as well. The selection of the centers regarding using fishing ports for tourism and other purposes with the spatial analysis concerning Turkey has been researched. (Onden, Samasti, Canci, Eldemir, & Aktel, 2017). This research includes the evaluation of sea facilities along with spatial characters in Turkey. (Yucel-Gier, Pazi, & Kucuksezgin, 2013)mentioned the evaluation of Turkey's activities regarding fishery in Aegean Sea coasts with spatial analyses in their research. Research shows GIS usage is an effective tool for coastalutilization analyses.

In addition to land coastal use, nautical tourism and port management have been a research area with wide range disciplinary approaches. (Lukovic, 2013) discussed various aspects of nautical tourism and different book chapters covered various locations' problems, characteristics and also benefits and opportunities. The book covers phenomenon of the nautical tourism, marketing and economic aspects in different geographies, demand and markets suppliers' characteristics, and development opportunities. (Jugović, Kovačić, & Hadžić, 2011) are focused a systematical approach for locations of the nautical ports in Crotia, and applied a mathematic model approach for that analysis.(Kovačić & Luković, 2007) studied on the spatial characteristics of the planning of the nautical tourism ports with multiple dimensions such as social responsibilities, economic aspect and also environmental protection. After discussing various aspects of the tourism ports, they proposed a spatial development model in seven steps. (Alcover, Alemany, & Jacob, 2011) discussed the economic impact of yacht tourism on the Balearic Islands' economy from empirical evidence. They discuss from the number of visiting tourists and their spending' contributions over the local economy in the region. Similarly there are different studies to discuss economic aspect and sustainability of the tourism activities in different regions (Nowak & Sahli, 2007; Rodríguez, Parra-López, & Yanes-Estévez, 2008).

Within the scope of the research, studies have been performed which will provide improvements in amateur marine, and at the same evaluate time sustainable coastal land use policies. With these approaches, both right positioning of the facilities, and minimization of the negative effects which might arose in the long run are aimed. Within the scope of the research regarding the placement of the facilities, meeting with the stakeholders and resorting to their judgment systematically with f-AHP method considering the subject put into practice. Besides, some analytical studies carried out by executing GIS based spatial sustainability analyses. Nevertheless, the study focuses on the argument of the systems which will shape the causal policies, rather than it is being a solely site selection. Within the scope of this research, berthing and mooring locations and quantitative methods are suggested regarding the boat berthing and mooring locations, site selection plans have been made, integration with other functions in coastal usage has been achieved, and strategies and policies have been evaluated according to future tendencies.

In the article, five policy suggestions are being implemented regarding the coasts of Turkey. Due to the paper focuses on system suggestions, technical backgrounds of the analyses are not given in detail. In the paper firstly, the policy suggestions have been argued regarding Turkey. In the following chapter, the enhanced evaluation methods are being introduced regarding these policies. Subsequently, there is the application section which these methods are being implemented. With the new costal usages which will be executed in the application section, the identification of the facilities is done. After this point, the findings which were actualized were given in the final section.

**Effective Coastal Land Use Suggestions in Turkey**

There are two core principles come into prominence regarding the effective usage off the coasts. The first of them is the determination priorities such as the naturel structures, ecological specifications, the qualifications and the usage potential of the coastal structures which are identified as a priority. Another critical factor regarding the effective usage of coastal areas is carrying capacity. The carrying capacity notion is the capacity which determined as increasing the satisfaction quality of the coastal users by preventing the physiological, ecological, economic and socio-cultural structure of the coast from icing, and the capacity where the locations numbers and types of the coastal structures are calculated (A.C. & Ergin, 2007; Kaboğlu *et al*., 2012). Based on this principle, it is an indicative showing the natural and cultural coastal resources, locations of the coastal areas, transportation connections, types and magnitudes, and the consideration of high use of the land resources and strategies which defined regarding nautical and terrestrial areas in sub-regional context.

Due to the seasonal weather conditions, changes in the demand to the facilities, being able to mobile turn to a priority to the discussed suggestions. Via that specialty, it will be possible to decrease the capacity or totally uninstall the facilities or move to another region from the located area. Similarly, it will be possible to increase the capacity in a need. Since these facilities provide flexible solutions to initial investment and operating costs, their cost will be significantly less when compared to constant facilities. Another characteristic of these facilities is that, they provide an environmental friendly structure which makes them the sustainable alternatives (Figure 1).

Within the context of the study, suggestions of

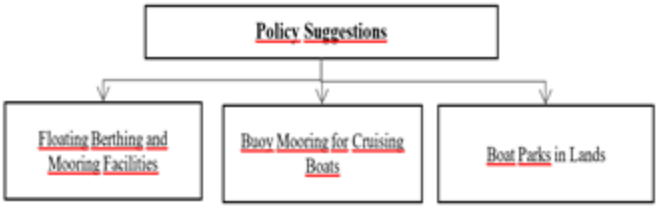



**Figure 1.** Evaluation of the policies within the scope of the study.

the conceptual facility design types for coastal land use are introduced which provide new capacities and ensure environmental-friendly approaches, regarding the policies of effective usage of the costs. System suggestions are consisting of three fundamental components. These are; Floating Berthing and Mooring Facilities, Buoy Mooring for Cruising Boats, and Boat Parks in Lands.

Floating Berthing and Mooring Facilities are the facilities consisted of Floating Breakwater and Floating Pontoon Landing Stages, which are suitable for seasonal usage, and principally protecting the natural structure of the sea. The main feature of the floating facilities are, they are portable as they complete their purpose, or by the end of the season (TUSSIDE, 2015). Floating facilities rise to prominence which provides the protection of the natural structure by preventing structuring such as docks, fill areas etc. in the coastal stretch, because landing stage and seawall pontoon blocks are in a floating state, the water circulation inside the see and ecological effect in sea bottom remain at a limited level.

Another type of floating berthing and mooring facility in the areas where demand is relatively low might be, Pontoon. These facilities are suggested for short term berthing and mooring needs. The selection of appropriate areas for floating berthing and mooring facilities, a set of decision criteria has to be taken into consideration similar to marina area selection which evaluated within various technical reports. Wind, wave length, tides, storm raises, water quality, sedimentation movements, seabed and environmental nature were stated as important in US International Development Agency's guideline for Jamaica (US Agency for Interational Developement, 1996). For Mexico, sensitive fields for conservation, water pass, environment, demand, marina infrastructure and services of the municipality are stated for berthing and mooring facility parameters (Ross, 2003). For Virginia, habitat, water quality, design are stated as decision criteria of marina suitability (Berman, Havens, Rudnicky, & Bernard, 2002). For California lake berthing and mooring facilities, proximities to the roads, availability of the infrastructure investments, exposure to the wind situation, availability of the present area and design are stated as parameters (*New Melones Lake Marina Siting Plan*, 2011).

In order for berthing and mooring facilities to serve in the working area successfully, they have the obligation to qualify the service demand. It is possible to use modular floating systems which do not cut the connection of sea and coast, they also suggests lower investment costs, and also decrease the negative environmental effects.. Additionally, since these systems can be built with lower costs compared to the classical marinas, they can be used for amateur marine as well. Because structuring costs are too high in the coastal area regarding the working area, the probability of these facilities to be successful is increasing considering they provide limited structuring. The aspect which requires the systems to be successful, that they have to block up to 1.5 meters waves (TUSSIDE, 2015). In order for these systems to operate successfully, the wave size has to be below that value. For this reason, these facilities have to be built where the wave length is limited, and in the areas where they will be protected from the destructive effects of the open sea.

Buoy Mooring for Cruising Boats: Floating facilities usually satisfies the needs of the boats, which are accommodating. Another need of the users are visiting the natural beauties and staying for a short-term in these areas. Buoy mooring systems suggested in the study are locating buoys, and that prevents random buoys in these sensitive areas.

Boat Parks in Lands: Boat parks in lands are alternatives for avoiding high berthing and mooring inside the sea costs of the boats which lie at anchor during the season, and wintering areas in the off-season.

## Methodology

Within the scope of the study, solution suggestions are introduced regarding the problem, benefiting from the GIS/spatial analysis techniques. Therein before, three policy recommendations were executed regarding the effective usage of coasts. Analytical studies were actualized regarding the first three of those policy offerings. The techniques which are partaking in the methodology were introduced within the scope of this chapter. Subsequently, the descriptions of methodologies used are given, and their details are included as well.

### Analysis Techniques/Approaches

### Field Studies

Workshops have been organized in order for

gathering the ideas of the experts regarding the study. Two expectations were aimed to be met within this study and meetings have been executed in 4 regions gradually. Before the meetings, limited numbers of specialists were invited to discuss about the existing decision environment and the existing problems, and the determination of the situation has been carried out. Additionally, it has been asked the specialists to identify the problems as open-endedly, and name the criteria which affect the location analyses of berthing and mooring facilities. On the following-up meetings, evaluations have been actualized regarding the discussed policies. In this context, surveys have been prepared regarding the significance level of the parameters which effects the site selection by the f-AHP based survey forms that prepared by the study group. By using fuzzy Analytic Hierarchy Process (f-AHP) through the survey, the options of the specialists determined the priorities of the decisions criteria.

AHP is a popular decision making and evaluation technique proposed by Saaty (Saaty, 1980). The technique brings a systematic approach for criteria evaluation and it compares the criteria with each other, instead of asking the criteria weights directly. Fuzzy Analytic Hierarchy Process (f-AHP), on the other hand, uses fuzzy logic capabilities to represent the differences of the experts' approaches over a decision criterion. To that aim, f-AHP defines an interval with a membership degree and defines an expert's judgement as a fuzzy interval instead of a crisp value. That leads the technique to show a range of judgement. Consequently, it provides to reflect the different typed human characters better by the intervals which it identified. Due to the expressed superiority of the technique, it has used to analyze the decision criteria weights.

There are different approaches for f-AHP analysis. In the study Buckley's (1985) f-AHP approach is preferred over the other approaches due the discussion in the literature (Onden, Acar, & Eldemir, 2016). The technique has 3 analyses stages regarding the determination of criteria weight. The analysis starts with taking the judgments by linguistic scale from experts. The comparisons which are pair-wise comparisons are gathered by the invited experts to the workshops. The gathered information is formed the comparison matrix that represents the whole comparisons. The comparison matrix constituted with fuzzy triangle values and that matrix is built for all decision criteria including sub-criteria.

In the second stage, fuzzy triangle values and their geometric means are calculated. That is a fuzzy math operation shows the weights of the each decision criteria. With the second stage, we found the necessary decision weights for GIS analysis in fuzzy triangular values. Since this paper did not aim to contribute fuzzy decision analysis, the details of these math steps are not given. For further information of the calculation please see: (Buckley, 1985; Onden *et al*., 2016). The third stage, the fuzzy values turned into crisp values. This process is carried out with total integration value method (Liou & Wang, 1992). For the details of the analyses see: (Buckley, 1985; Onden & Eldemir, n.d.).

**Geographical Analysis Methods**

Geographic Information Systems (GIS), provide layer-based reflection of the real world by the spatial data. It provides with it abilities to keep, represent and analyze the input data. By its' mentioned ability, it is possible to produce geo-information from geographical data. This capability is important for decision analyst when they need to conclude a decision related to spatial information. Due to mentioned analysis capabilities, ArcGIS 10.5 software is used in the analysis.

When we look at the literature, there are some consolidation works regarding this manner in the literature (Jankowski & Richard, 1994; Malczewski, 1999; Onden & Eldemir, n.d.). Also, it is possible to say that GIS and spatial information has been studied by researches in the scope of the sea (Onden *et al*., 2017; Yucel-Gier *et al*., 2013). These researches show the convenience of the GIS analyses in this field.

There are a wide range analysis approaches in the GIS, and tools of spatial analysis are used in the research. Spatial relationship and necessary information is processed by these analyses. The first one of the used spatial analysis tool is the Euclidean Distance Analysis. Even though this analysis approach is one of the most commonly used, it is simple and powerful to measure the impact of any affecting criterion's impact area. This analysis can be used for both point and line vector data which can be a specific location or a considered border. A brief illustration how the technique is working is given in Figure 2.

Euclidean distance analysis is capable of measuring distances. However, in case there are a various set of distance map, and the focus is comparing alternatives instead of evaluation of the proximities, it is needed to simplify these numbers. For that manner, reclassification is capable of simplifying these numbers in understandable clusters. There are different ways to determine new distance classifications, in the study Jenks' natural break point (Jenks, 1967) is used to determine new distance clusters spatially.

The second analysis used in the location analysis is Density Analysis. Density analysis takes the considered entities and their weights, which is a vector dataset as the input, and gives the density map which is a raster map. Density map does not just show the counts or volume of the considered data, it also takes the neighborhoods into consideration and results the map. This analysis approach is used to analyze a voluminous data set to a better representation than a distance analysis which is not capable to represent the

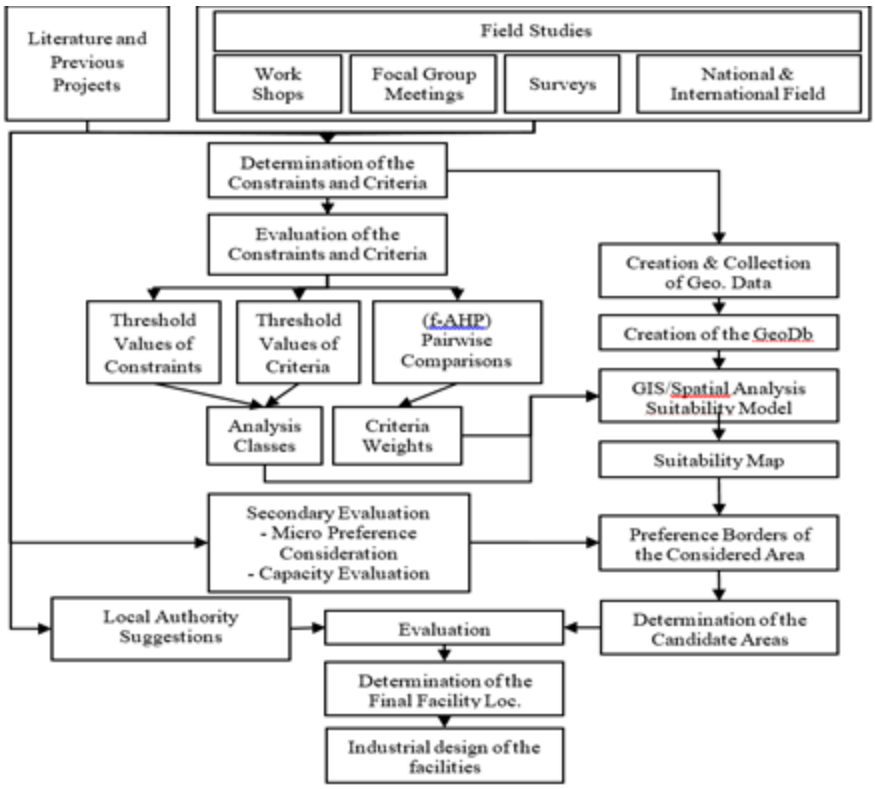



**Figure 2.** Methodology of the Floating Berthing and Mooring Facilities.

densities when the data is sprawled all over the analysis area. For the technical details, please see: (ESRI, 2014). Reclassification of these analyses is also necessary to be able to use in suitability mapping.

Overlaying & Suitability Analysis: Overlaying means the summation of the input maps which can be distance or density maps and their weights. The result of the overlaying analysis is the suitability values of the considered geography and potential convenient locations. In this step the weights are coming from f-AHP analysis and the input maps should be calculated before the overlaying analysis. Suitability levels of the candidate areas represent the preference levels of the locations for a facility which will serve as a berthing or mooring facility. Expert discussions over candidate areas, which is found in the most preferable level, is necessary for a applicable facility decision.

The final consideration of the GIS/Spatial Analysis is the natural constrained areas. GIS can eliminate the sensitive regions from decision environment. Thus, in the study the area which is needed to be preserves as is are identified with a constraint map. The areas are kept out of consideration for any action.

## Location Methodology of the Floating Berthing and Mooring Facilities

The facility location methodologies discussed in the paper has several analysis steps. The methodology has an iterative structure and the briefly explained techniques are used in this decision making stage. The first analysis methodology reaches the locations for floating berthing and mooring facilities. To be able to point the convenient locations, the methodology illustrated by analysis steps is given in the Figure 3.

Primarily, the analysis starts with the field research. In that stage, determination of the experts who have experience and knowledge in the field are selecting and gathering for workshops to discuss the problem and solution approaches. Additionally literature surveys and existing experiences are collecting and evaluated in this stage. This step gives a sight for the researchers who will follow the new steps in the study. And, it shows also; presentation of the decision environment, identification of the effective parameters, suitability level specifications. In the green aspect, this stage also represents what and which locations are sensitive and how to protect these regions. As the output of this step, the decision criteria affecting the judgment and the constraint criteria which will form the constraint maps will be determined.

At the end of the first stage of the study, the evaluation of expert judgments will be determined. As the result of the literature study, candidate and used decision criteria in previous works and the use of these criteria in previous works will be learned by researchers. After discussion by focal researcher and consultant group, the decision criteria will be used in

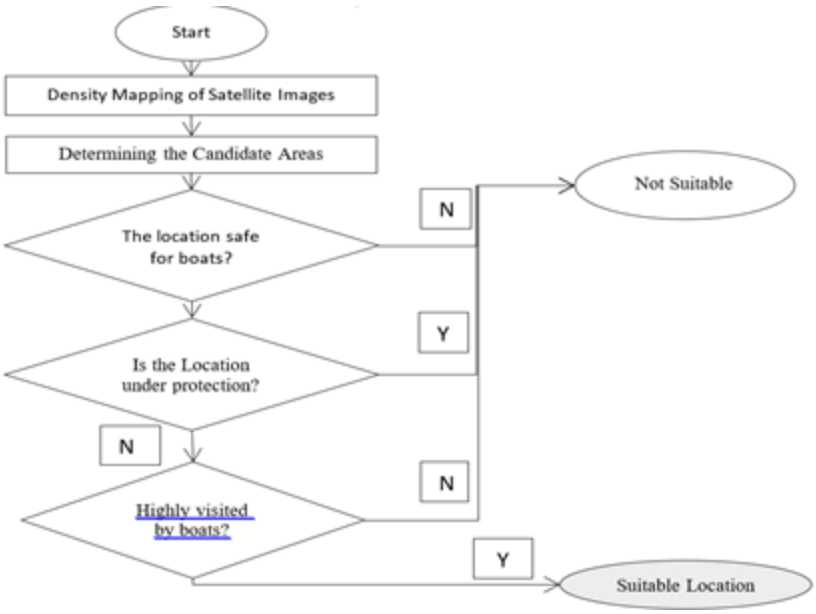



**Figure 3.** Methodology of the Buoy Mooring for Cruising Boats.

the suitability analysis will be determined.

After that analysis step how the decision criteria will be analyzed and which data will be collected and created stages will be carried out in the same time. In decision criteria evaluation, determination of the impact thresholds of constraints and criteria and decision criteria comparisons will be done. The results of these considerations will be the analysis classes and decision criteria priorities. These outputs will be the inputs of the GIS/Spatial Analysis suitability model's inputs. To be able to conclude the geographic analysis, it will be necessary to create a geographic database, a spatial evaluation model. The result of the geographic suitability model will illustrate the suitability preference borders, and convenient locations will be determined from the most suitable regions.

Even though the model is capable of drawing most convenient areas, for applicability a final evaluation will be done by regional administration and researches who conduct the research. After that stage, the final locations will be determined and industrial designs will be the subject to discuss the capacities of the facilities.

**Location Methodology of the Buoy Mooring Locations for the Cruising Boats**

Similarly to the floating berthing and mooring facilities, location methodology of the buoy mooring location selection for the cruising boats follow an iterative methodology. However there are dissimilarities in analysis to point the convenient locations for buoy mooring facilities than floating berthing and mooring facilities.

In the analysis three main considerations are shaping the analysis structure. The primary consideration is the safety from sea's destructive effects. The second consideration is the location's desirability from boat owners. The third consideration is the environmental protection. In other words, the determined location should be in a safe area, densely visited area and should not harm to the environment. The methodology illustrated in Figure 4 shows how to locate such a location.

The first stage of the method is determination of the spots which are used frequently from satellite images, and confirmation of the density maps showing these densities through GIS. After determination of candidate locations, the mooring located based on these dense locations. Then, the selection of the proper area can be made regarding the wave etc. parameters consisting the candidate locations. Yet another analysis is, testing whether these facilities are environmentally under protection. There is another analysis which controls whether the determined locations are in the dense traveling course of boats of not. After these stages, the final decision for the buoy mooring locations can be settled. The related methodology flow is introduced in Figure 4.

**Application**

This section explains how the research has been conducted. Before location analysis, necessary field analysis results, criteria evaluations and weighting, and GIS/Spatial Analysis results are given. Then how the location decisions have been reached is given.

**Field Analyses**

Turkeyhas shores to four seas which have

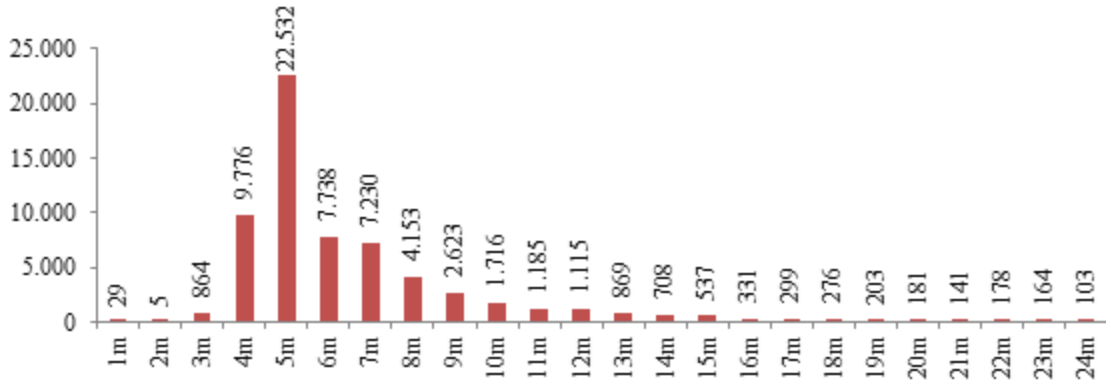



**Figure 2.** Distribution of the boat numbers by the lengths.

different characteristics. To be able to understand characteristics of these seas, 4 broadly participated workshops, 2 focus group discussions and 30 expert research staff meetings have been held. The expert research staff consisted by 6 experts; 1 urban planner, 1 sea expert, 1 site selection expert, 1 transportation and logistics expert and 2 engineer support members. 2 focus group meetings were done, in the beginning and in the end of the study. These numerous meetings were held with following reasons; coastal planning, marine and site selection. The first focus group meeting was held before all the analyses and data collection phase, and the scope of the problem policy suggestions and frame were decided. The second and the final focus study were organized in the end of all the analyses, and final policy suggestions were discussed.

Workshops were done after the first focus group study. There were 4 workshops in the regions as follows; North Aegean, South Aegean, Mediterranean and Black Sea, and studies as such carried out: problem identification with more than 200 participants, survey study, the determination of decision criteria. In the workshop, there were participants from all related areas. People from the public, central management, private sector and scholars were present, and they participated with their ideas and experiences. The outputs of the workshops provided inputs to analytical researches. As surveys executed in the workshops, f-AHP surveys were given to the participants, and comparisons were obtained regarding the criteria which its' effect to the residential areas determined.

**Data Production**

Within the context of the study, the amateur marine inventory in Turkey was identified. In this context, the gathering and analysis of three types of data which will be the base to the analyses. The first one among these is, the analysis of the boat movements within Turkey's coasts. These activities were analyzed with three types of data. The first of them is Automatic Information System (AIS) data. These data provide all the movements. But, there are not only ships with AIS devices on this data set. Thus, the boats which do not have an AIS antenna and in the scope of the study might have been failed to notice. To represent the movements of these data, Transit Log records which are held by Turkey Coastal Management is used. These records are important for the reason that they include all the boats and record all the movements of the ships. Either for the identification of the boat inventory, or their movement, these data were taken as a base. As a result of the analysis, the length distribution of the boat lengths was given in Figure 4.

By exploring these data, the boat number in each district considering the local classification, mooring capacity, and capacity gap were determined. Additionally, the number and the course of the international visiting boats were determined as well. Furthermore, the boats which are mooring in the sea regarding the study were determined by monitoring the satellite images. Figure 5 (a) shows the areas of the boats which are mooring in the off shore. Figure 5 (b) shows the density of the existing boats with respect to the AIS data.

Marines, fishing ports, mooring locations within the creek were determined as sea inventory. In addition to the sea inventory, geographical data which will be used within the analyses were produced as well. The first data set is the frontier port authority. The gathered data is converted to vector data for geographic analysis. Additionally, residential area data such as the land usage and city centers created. The data regarding the transportation infrastructure gathered to be used in analyses. Additionally, the slope data, which is created based on ASTER GDEM data, was taken into consideration. Besides, the

natural protected areas were defined and constraint map is used.

Another one of the analyses is about the distribution of the berthing and mooring facilities within a year. Within this context, the monthly quantity of the boat harboring requests with regard to inventory in the existing harboring facilities was identified. The distribution of the existing harboring places by months shows an increase starting from March, and continues to rise during April, May and June. Figure 6 shows the monthly distributions of the boat requests within the existing harboring places.

According to this, the harboring request hit peak during in the months of July and August, and by September they tend to go down gradually. According to the structure of the demand, it is low between the months of October and March. Within these months, the berthing and mooring capacity is sufficient regarding the existing facilities. These obtained data show additional berthing and mooring need appears between the months March-September.

**Decision Criteria for the Location of the Floating Berthing and Mooring Facilities**

The decision criteria are identified for the evaluation of the decision whether floating facilities should be connected to the piers in the coasts, or should they locate some place on the open sea which is near to the coast. As a result of the meeting with the experts, two necessity provinces are determined as the criteria. The first one among them is inside the city, in an area which it can compose new berthing and mooring capacity on a limited scale in the related region by letting the coastline to the service of the people, and by preventing new structuring. The second area type is outside the city, the areas with a boat attracting potential (Figure 7).

The analyses which were executed have three main evaluations. These are; the facilities being in protected area, sheltered from the destructive effects of the sea, the facilities being in the zones where the boats frequently visit, and the facilities being in the appropriate zones which were determined. After the field studies, all the protected areas are identified as candidate areas. These areas stand for the areas where the sea waves cannot reach. After the identification of these zones, a checkup has been made whether to control that zones were visited by the boats or not. The candidate facility zones in the areas where no visits noticed were canceled. After, the evaluation regarding the suitability analyses, which were given on Figure 8, is executed. This evaluation shows whether the facilities are in the suitable areas as

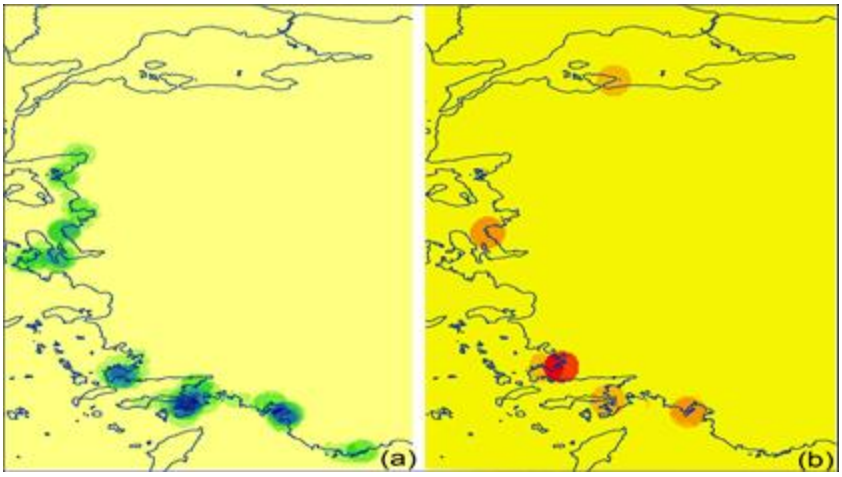



**Figure 3.** Boat densities in the study area.

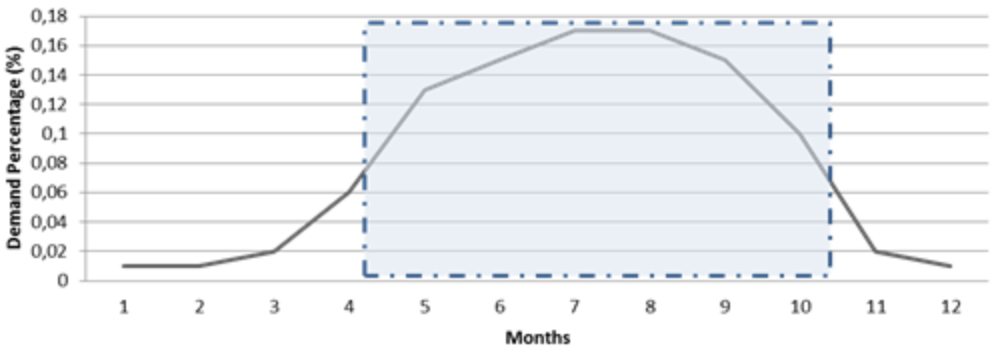



**Figure 4.** Seasonality of the mooring demand in Turkey.

**Figure 5.** An example of the Floating Berthing and Mooring Facilities.

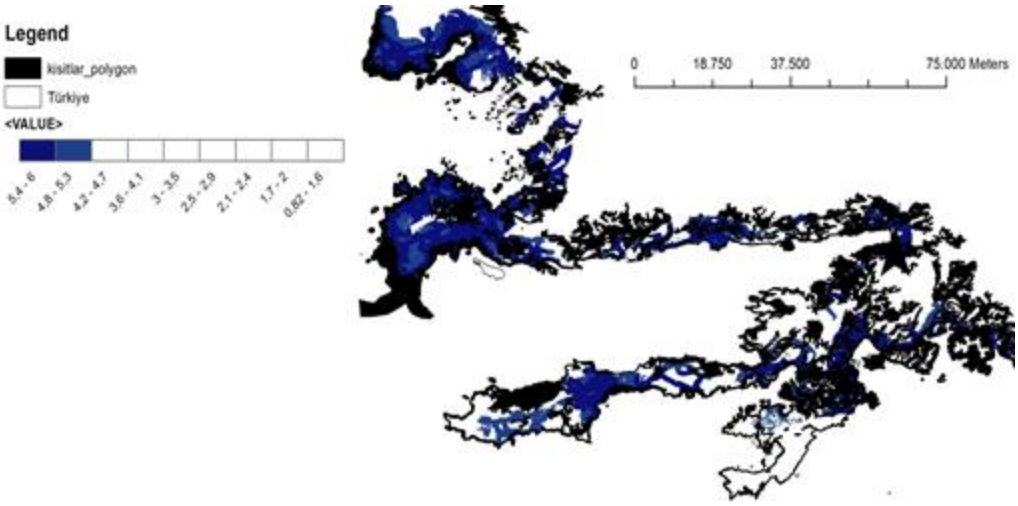



**Figure 8.** Result map of the suitability analysis.

spatial regarding the criteria weights, and the criteria which were obtained from the opinions of the experts. Thus, the areas which don't fall within the suitable areas that were determined within the scope of this analysis, or facility areas which fall within the constraint areas, removed from being candidate areas, and the remaining areas determined as the candidate areas. These areas were shared with the local authorities and the ones which were assigned as suitable were offered in this region, which considered assured by taking their opinions as well. The capacity analyses and indusial design were actualized regarding these regions, and the number of the facilities which can harbor in the region is determined. 36 floating system facility areas were identified, and 6910 boat mooring capacity is recommended in the new regions. Additionally, the cost of the construction is identified as well. The spatial distribution of these regions is given in Figure 9.

The critical factor of the floating facility areas to be sustainable is, its' possibility to constitute a system regarding waste management. There are three main components in the floating facilities regarding waste management. These are, floating mooring areas, to make a connection between the facilities and the coast, and building discharging, storing and decomposing units.

It is a knows fact that, at the present time the supply of electricity and water services are standardized in the mooring platforms. However, it is mandatory for a service boat to transfer the gray wastes to a storage space in the coast regularly. Considering black wastes (bilge wastes), because these wastes are not dense as domestic wastes and need to be discharged less frequently, their safe discharging and pumping in the facility which is located in the coast with a discharging unit are supplied as the boats edge in with the pier that is located in the coast when needed. There is a need for a plan for the gathering of domestic wastes regarding the facility in the coast, the transfer of the liquid

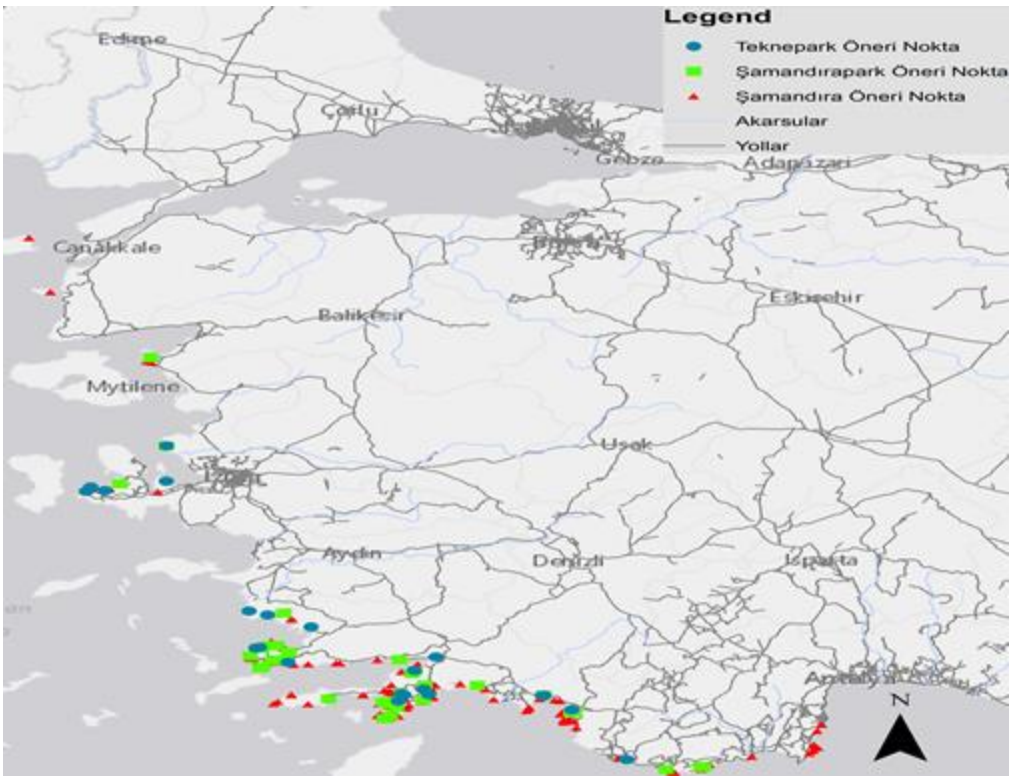



**Figure 9.** Locations of the Suggested Facilities.

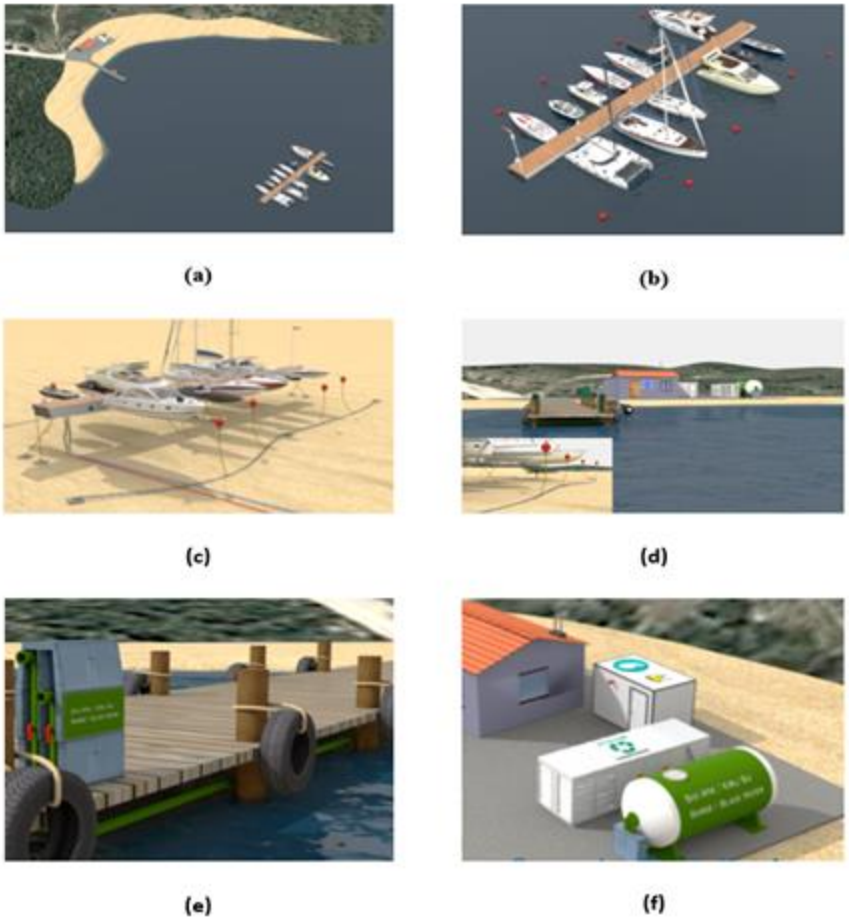



**Figure 10.** Industrial design of the Floating Boat Shelter and Mooring Facilities.

wastes (grey wastes) to the sewer of the municipality, and the transfer of the black wastes to the disposing facility with special vehicles (ADR appropriate) (Figure 10).

**Floating Facilities Location Suggestions**

Marinas are the fundamental component of the service supply regarding yacht tourism. Due to the high investment costs and service costs, the floating facilities in the areas are considered as alternatives for these facilities., They also shelter boats from the waves. In analysis, firstly the wavelengths were focused. For that purpose, The European Centre for Medium-Range Weather Forecasts (ECMWF)'s last 100 year data are considered. below 1.5 meters wave areas are determined. due to the system can protect up to this wave length. In addition to this wave length consideration, spatial suitability criteria are also focused for location decision. However, in the literature there is no comprehensive filed study has been carried out, and other sea structures have to be taken into consideration. As stated in the section before, the decision criteria, which effect the decision as a result of these studies, come under 4 main criteria. Table 1 shows these criteria.

After the determination of decision criteria, the geographical data collection, production, gathering and evaluation phases have to be carried out. These data used with criteria weights within spatial analyses. The criteria weights values are calculated as the result of field studies with f-AHP analysis. The results of the f-AHP are also given the priorities of the criteria. For instance, the most important criteria for the location analysis is found proximity to residential area.

Criteria values and threshold value provides input to GIS/Spatial analysis. These inputs are combined with the maps. And the result map illustrated the spatial suitability values. Within this context the distance provided input maps to the suitability analysis by using density analyses. The suitability map is obtained through gathering criteria maps and criteria weights which gathered from f-AHP and the constraints.. The first two classes of the suitability values are considered as candidate areas from 9 suitability classes.

In addition to the suitability value, the constraint maps were taken out of the study due to environmental reasons;Expression of the suitability map and constraint map illustrated in Figure 7.

The evaluation of these facility spots was evaluated with the local authority and 22 areas were identified as suggestion areas; the locations of the facilities are given in Figure 9. With these new facilities 6091 new boat mooring capacity suggestion is actualized.

**Suggested Areas for Buoy Mooring Regarding the Cruising Boats**

Nowadays, the buoying locations are used in dense visiting areas for amateur marine. However, due to vaults which have been thrown randomly, the environmental protection cannot be held. Besides, because these spots were not systematically identified, the system approach cannot be implemented, only local solutions are actualized. For this reason, the areas which were determined regarding the study are identified as taking protection areas into consideration, and determination of the areas which are in the inflow frame that were given in the methodology section.

Boat mooring takes place in the open sea in the study are identified through satellite images for Turkey's coasts. The density analysis of these areas was performed via the ArcGIS 10.5. As a result of the analysis, the mooring zone densities are determined. The analysis and its' result which were illustrated in Figure 6. The candidate points were located for the dense zones which were obtained in the density analysis. The first evaluation regarding the determined spots are, the control of these sports whether they are protected areas for the boats or not.

**Table 1.** Decision Criteria and Weights of Safe Sheltering Areas

| Decision Criteria | Main Criteria Weight | Sub-Criteria Weight |
|---|---|---|
| Boat Criteria | 0.434 | |
| Boat Activities/Trips | | 0.09 |
| Number of Boats | | 0.26 |
| Potential of the increment of the number of Boats | | 0.09 |
| Environmental Criteria | 0.096 | |
| Characteristics of the bottom of sea | | 0.02 |
| Oceanography | | 0.02 |
| Wind Characteristics | | 0.02 |
| Land Surface | | 0.02 |
| Air/Water Pollution | | 0.03 |
| Service Criteria | 0.052 | |
| Logistics | | 0.02 |
| Accessibility | | 0.02 |
| Proximities to Existing Mooring Facilities | | 0.01 |
| Proximity to the Population | 0.418 | |

The evaluation within this context is if there is a probability of damage regarding the boats considering the wavelength and waves. The convenient alternatives as a result of this evaluation are utilized whether the areas are under protection or not as environmentally. Within this scope, the candidate spots which are within the sensitive zones were also eliminated. Finally, if the areas are visited often or not, and based on the frequency if there is a surplus in the region which the candidate spots were located were evaluated. The candidate spots which were left behind these four steps were determined as mooring zones, and the locations were identified.

The exemplary designs which were drown for traveling boat buoy mooring areas, are given in Figure 11. Figure 11 (a) shows the system which is at the bottom of the sea, and Figure 11 (b) show the boats which are parking to the buoys that are on the sea.

The suggested spots regarding the buoy mooring zones with floating systems are given in Figure 9.

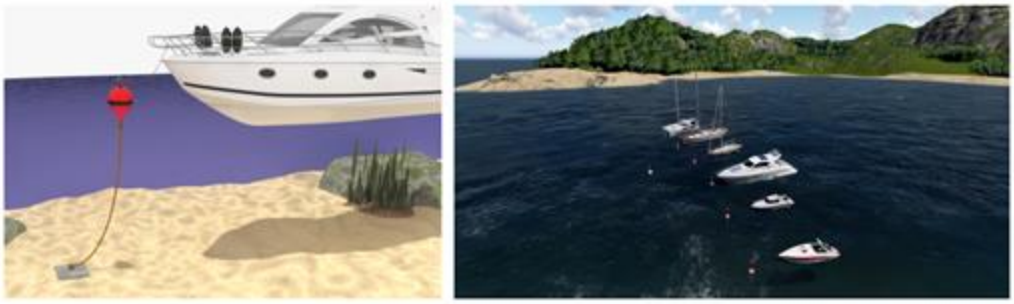
**Boat Parks on the Land**

Aside from previous two system suggestions, the third is the boat park on the water ground. Since the demand is seasonal, the land connection via ramps are suggested and figure 12 is given this connection visually.

Boat parking areas with high boat capacity needed which the boat owners can preserve their boat in off-season periods. These areas shall not only to preserve, but also they have to be the areas where the boat preparation for the sea occurs, and equipped with services areas. The locations of the boat parks in the land have to be locations between the place where the boat park is located, and the sea where they can easily reach on demand. The most significant feature for a facility as such is, the operating cost being competitive with the marina in the sea, or harboring facilities. For this reason, the facility's cost-efficient feature regarding value of property comes to the forefront. Yet another important feature is to have adequate ramp areas in the land, where the boats can be taken out to the sea from the land or land from the sea; this is one of the key factors regarding the solution.

## Conclusion and Evaluation

Within the scope of the study, spatial analyses have been applied regarding the solution proposals for the usage of Turkey's coasts in a sustainable and efficient way. This paper carries importance in decision science literature. It is discussing to combine various criteria to reach one suitability decision with understandable spatial analysis. Integrating the



(a) (b)

**Figure 11.** Illustration of the Buoy Mooring for Cruising Boats.

**Figure 6.** Illustration of the Boat Park Concept.

various decision criteria to recommend facility location ensures that certain components are not missed. Thus, experts can use this approach when they face sophisticated maritime location problems. Additionally the approach bring coast benefits after enhancing location advantages.

This paper has to two main suggestions, one system approach for developing policies regarding the sustainable efficient usage of the coasts with respect to traveling boat mooring areas, and floating berthing and mooring facilities. Therefore, this approach can be used in different location selection areas. With the approach, not only the location but also the low cost 13000 boats with new capacity are proposed.

As the result of the analyses, 22 locations were determined for the floating berthing and mooring facilitates which will be built on the coast, and 36 locations determined for pantheon like facilities on the sea. Additionally, 115 spots were determined as buoy mooring areas for boats which are traveling. Another consideration should be done for the piers. It is also needed for building the connection with the waste facility in the coast for domestic wastes of the boats.

The systems, which were offered, provide environmental and cost-efficient alternatives. Consequently, they express alternative systems to existing marina investments. Additionally, because they don't disconnect the link between the coast and the sea, their environmental side is strong. They are convenient for sustainable coat usage as well. Also, new systems were produced with new generated mooring capacities, which the boats with the need of mooring places can use.

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