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## Abstract

Functional zoning of Akcakoca District located along the Western Black Sea Coast of Turkey is achieved by implementing the 'Methodology for Spatial Planning for the Coastal Zone' developed by European Union for coastal areas. The aim of applying the methodology was to realize functional zoning of the district that will eventually lead to spatial planning. In this technique, a typical base map at an appropriate scale and thematic layers are prepared for each of the environmental components for further analyses. The possibility to overlap different layers according to a specified procedure and to realize new theme mapping is a considerable factor while using GIS for the functional zoning. Identical grading system has been applied to each layer formed in order to achieve the overall importance and vulnerability maps of especially the natural components of the district. Functional zoning map is further developed through comparing different layers and current land-use information obtained from satellite imagery coupled with the findings of both the importance and vulnerability analyses. This attempt of applying such a methodology was a significant study as it addressed the decision makers on the multi criteria analyses through the visualized maps of different layers.

**Keywords**: Geographical Information Systems (GIS), functional zoning, importance, vulnerability.

## Introduction

Functional zoning and land-use planning is based on an integrated assessment of the conditions and the potential of natural components, natural factors and anthropogenic impact on the environment as well as on the alternatives of nature management and socioeconomic conditions (Taussik, 2007). Its goal is selection and introduction of such types of nature management which meet the population's requirements for socioeconomic sustainability together with the international requirements for resources conservation to fulfil the demand of future generations. Implementation of functional zoning, which in turn, lead to spatial planning may be realized at three main levels: national, regional and local. Different kinds of decisions may be taken at each level, wherein the methods of planning and kinds of plan differ (Mc Kenna et al., 2008). For example, the coordinated planning and management of marine and terrestrial sides of a coastal zone are of priority issues. It should develop a global vision of the coast, land and river management. This study can be evaluated as a precursor of this objective.

In spite of many international and national efforts to ensure sustainable management of coastal areas especially after 2000s throughout various seas, the coastal countries still face severe pressures and problems which threaten coastal resources (Vivero and Mateos, 2005; Brennan, 2007; Shipman and Stojanovic, 2007; Burak et al., 2004, Xu et al., 2009; Stuart, 2010; Musaoğlu et al., 2015). The importance of such areas is widely recognized, since anthropogenic pressures are becoming more and more intense like tendency to settle on the shores, changing agricultural production systems, industrial development, expanding transport infrastructure, and rising tourism. It is a remarkable observation that beneficiary countries have already started to act together on the conservation of their coasts since the past two decades. An example of the joint efforts is the Protocol signed in early 2008 by most of the countries sharing the Mediterranean Sea on integrated coastal zone management acting under the umbrella of the Coastal Management Centre at Madrid in the region. This is the 7th Protocol in the framework of the Barcelona Convention. However, still many of the EU's coastal zones face a variety of environmental threats; EU has been slow in adopting specific legislation developed to tackle with this important problem (Mc Kenna et al. 2008). EU communications on coastal zone management between years 2000-2007 advanced a more prominent role regarding environmental protection and sustainable development. Deboudt et al. (2008) reviews such coastal zone management efforts realized between years 1973-2007 in France. Jones et al. (2008) mention the development of a model with a series of measurable indicators to practically monitor the effectiveness of their coastal zone management plan. Sano et al. (2010) refers to a Spanish coastal zone management initiative considering the Mediterranean protocol of the Barcelona Convention.

Books by Krishnamurthy et al. (2008), Moksness et al. (2009) and (Green, 2010) also emphasize the global challenge of coastal zone management. All these books give state-of-the-art examples from different countries. The Indian Ocean Commission (IOC) runs a program named as Regional Coastal Management Programme (ReCoMaP) among the beneficiary countries (RECOMAP, 2009). A paper by Islam et al. (2009) on the other hand refers to implementing a management program model used in a developing country to another country as a benefit transfer.

Moreover, the presence of similar social, economic, and ecological problems required the necessity of close cooperation of all the Black Sea countries in creating and improving their national coastal zone management systems and in finding regional solutions. The process of utilization-protection balance is recognized as almost impossible without development of an efficient system in every beneficiary country at the regional level. Corresponding activities in the Black Sea region date back to the signing of the Convention on the Protection of the Black Sea against Pollution (Bucharest Convention) in 1992. The first steps and achievements in coastal zone management within the Black Sea region are presented and further steps are outlined in Antonidze (2009). Since then, quite a lot of national and international projects are conducted at the region among which PEGASO and SCENE are directly related to coastal zone management.

Evolving practices in developed countries for coastal management indicate that the application of tools like spatial planning based on functional zoning is the most rational way of implementing the principles of sustainable development in a coastal zone (Sabatini et al., 2007). Functional zoning concept has been currently in use regarding different aspects of geographical functions. Pei'er (2007) refers to a resource-oriented environmental economics in marine functional zoning whereas Chang et al. (2006) mentions ecological functions of forests by means of forest landscape. Fan and Li (2009) and Fan et al. (2012) give examples of function-oriented zoning in China.

The EuropeAid-TACIS project developed the "Methodology for Spatial Planning within Integrated Coastal Zone Management" for fulfilling functional zoning efforts. Demonstration Projects among the Black Sea countries on implementation of this developed methodology has been initially tested by Russian Federation in Gelendzhik Resort. The outcome of this project was the elaboration of a spatial plan based on preliminary functional zoning. For the development of this territorial plan, original techniques including vulnerability and importance analysis for assessment the effects on the environment were used (Gazioğlu et al., 1997, Doğan et al., 1998, Black Sea Commission, 2005; Antonidze, 2009; Sievert et al., 2016). The methodology is further applied in Akcakoca district of Turkey in 2007-2008 with a specific objective to develop functional zoning for the district using multi-criteria analysis. Within the framework of this article, emphasis will be given to importance and vulnerability analyses of the district's natural land components to highlight the utility of such multi criteria analyses in functional zoning studies using GIS as a tool. This technological tool has recently been utilized sometimes together with remote sensing (RS) in several other national studies (Yüce and Gazioğlu, 2006, Sertel et al., 2008; Kaya et al., 2008; Demirel et al., 2008; Güven et al., 2010, Ertürk et al., 2010; Şeker et al., 2013, Kaya et al., 2014; Musaoğlu et al., 2015; Nandy et al., 2015; Song et al., 2015).

## Materials and methods

### Study Area

The study area is located along the Western Black Sea Coast of Turkey within the boundaries of Düzce Province. The surface area of the Akcakoca district is 351 km2 with a coastline of approximately 30 km. Its geographical location is shown in Figure 1. The district is located at almost in the midway of Ankara-Istanbul line. One of the first coastal tourism activities in Turkey has started at Akçakoca due to its proximity to these two important cities as seen in Figure 1. The central town is located on rocky soil formation except some structures established along the river beds and the coastline with an elevation of 80-90 m. The soil surrounding the centre is composed of sand, stone and partly limy and clayey soil. The bottom of the creek valleys are highly formed of alluvium, the slope of the hills is of silica formation and the top of the hills is composed of sandy and gravely layers. The dominating climate of the town is moderate sea climate. Even though the region is at a transient condition between Marmara and Black Sea Regions, the Western Black Sea climate characteristics are dominating in the region (Algan et al., 2000, Özturk et al., 2007).

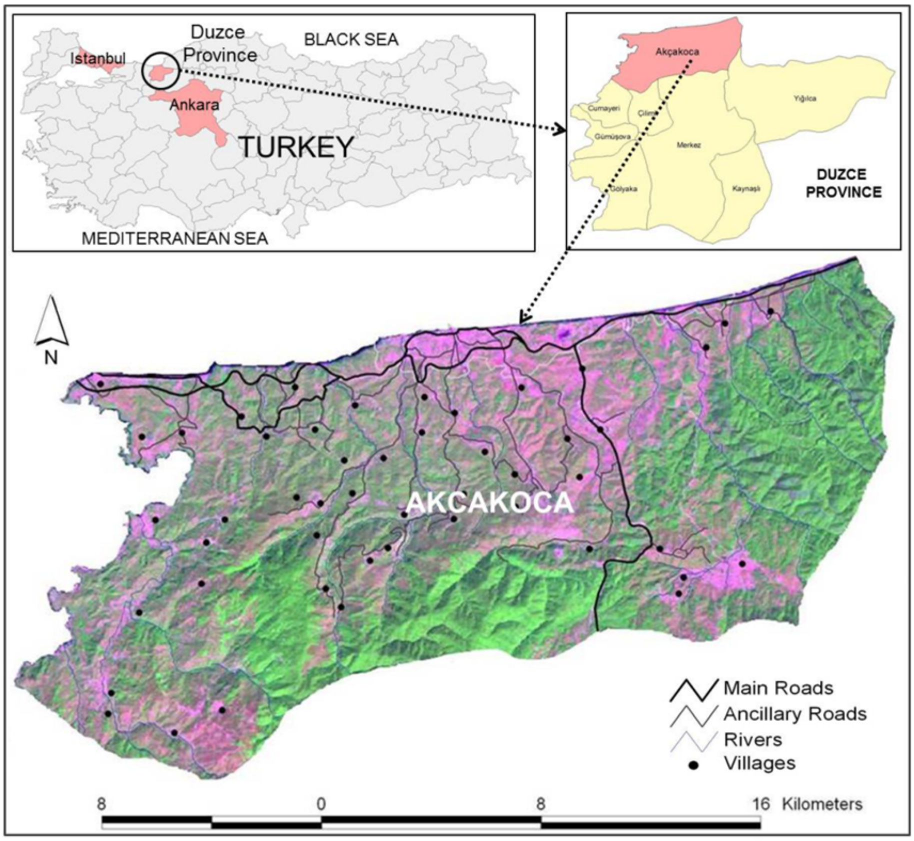


Figure 1. Geographical location of Akcakoca district.

1999–2000, rapid population increase is observed. The reason of this increase is migration from Düzce Centre to Akcakoca after the August 1999 Earthquake. In 1985–1997, rate of population increase in Akcakoca centre was comparatively higher than the Düzce Centre. Besides, Akcakoca among the other Düzce districts is the second district in terms of migration from villages to the town. In 2007 and 2008 the urban population of the district remained almost the same; 22 416 and 22 522, respectively. In 2009, the urban population was registered as 23 378 and rural population as 14 976 with an overall figure of 38 354 in Akcakoca. From 2010 to 2015 the population almost remained constant with the similar distribution among rural and urban population. In 2015 the total population was recorded as 37 570.

Almost 13 % of the town's land is covered with Soil Capability Class I, II and III, known as agricultural soil. The rest 87% belong to soil classes of IV, VI and VII. Soils of Classes I and II surround the valley beds. Land up to classes VII are used for hazelnut growing which is the dominant agricultural activity in the region. There is lush vegetation cover in the town because of the abundant rainy climate. The coastline of the district is mostly covered with hazelnut fields and pristine forests. The most important means of livelihood are hazelnut cultivation and fishery where almost 90% of the economical structure is based on hazelnut cultivation. As income from hazelnut cultivation was satisfactory enough years ago, tourism did not develop well as expected. However, as families started to disintegrate, income gained from hazelnut groves became insufficient. Decreasing of income from hazelnut cultivation caused people to find other new economic sources. The other important economic sources turned out to be tourism and poultry husbandry.

It is important to note that the inhabitants wish to reduce unemployment rate in their town which seems to be possible by increasing the tourism investments without destroying and damaging the natural environment, and to establish hazelnut processing plants as soon as possible. There are 8 industries established in Akcakoca. These are hazelnut and bait processing industries together with pipe and steel manufacturing plant. Especially, the pipes manufactured in the district are exported that supplies an important economic income to the district.

The land-use classification and land-use change are derived from the Landsat satellite images belonging to years 1987 and 2006, and Table 1 indicates the land-use distribution for these two years. As is seen, areas devoted to forests present a slight increase, and an even more pronounced increase in agricultural areas; however, meadows and pasture decreased considerably and an even more pronounced change is observed in the areas allocated for settlements. One of the important factors of this increase in the residential areas is due to the past earthquake that had occurred in 1999 at the region. As is known, the central district of Düzce has been highly affected from the two consecutive earthquakes and most of the inhabitants preferred to move to the less affected coastal region of the province. Land-use change determination was conducted in order to follow the urbanization trend in the region during functional zoning whose details are given in Tanık et al. (2008).

Table 1. Land-use distribution of the district in 1987 and 2006.

| Land-use | Area (ha) in 1987 | Area (ha) in 2006 | Change (%) |
|---|---|---|---|
| Forestry | 20718.3 | **21222.7** | +2 |
| Agriculture | 3946.3 | **5715.6** | +45 |
| **Meadows & Pasture** | **10336.7** | 7480.6 | -28 |
| **Settlement** | **72.9** | 655.5 | +800 |
| **Total** | **35074.2** | 35074.2 | |

**Methodology used for functional zoning**

The methodology set by EuropeAid-TACIS projects (1998-2003) consists of the following steps;

- Development of a GIS data base,
- Displaying environmental, land-use, and socioeconomic data on maps using GIS thematic layers,
- Identifying conflicting uses and presentation of these uses via GIS layers,
- Development of prioritizing uses, based on analysis of natural and economic resources and land-use features,
- Development of spatial plans (functional land-use zones), using primary information and evaluation of conflicting land-uses, and display via GIS layers, and
- Incorporating opinion of stakeholders in iterative series of refinements to land-use plans.

GIS based data analysis and integration is preferred as useful tools to identify spatial connections between different information layers (Rodriguez et al. 2009). Similar approach has been developed, tested and put into operation to support management decisions related to land-use planning, functional zoning and utilization of natural resources in a sustainable manner during the application of the methodology to Akcakoca district in Turkey. The database provides support for better and sustainable management of the district. During the development of the database, spatial data and attributes collected were initially entered to the system. Data used has been supplied from various sources. Soil map scaled 1:25.000 and Standard Topographic Maps (STM) scaled 1:25.000 were obtained in digital form from General Directorate of Rural Affairs and General Command of Mapping respectively. All different map data were transferred to the same coordinate system. The GIS database contains several layers such as administrative boundaries, sub-watershed boundaries, topography, soil characteristics, land-use/cover, transportation network, water resources and streams, soil map, dump site, wastewater treatment plants, etc. Moreover, a Digital Elevation Model (DEM) of the study area was produced from STM for better expressing the land surface.

Overlay analysis by which multiple theme maps are used to spatially analyze environmental components, to derive new parameters, or to select least impact alternatives is especially useful in resource conservation and management programs. In this technique, a typical base map is prepared at an appropriate scale and overlay maps are prepared for each of the environmental components or attributes to be further analyzed. The possibility to overlap different layers according to a specified procedure and to realize new theme mapping is a considerable factor during functional zoning.

Figure 2 illustrates the flowchart of the overall methodology used for functional zoning. According to this methodology, the database comprises of three main groups of layers; natural components, social and demographic components, and geographical components. The flowchart also covers the ecological components; however, as there were almost no data on the spatial and temporal distribution of the ecological values of the district, this component is excluded in the applied methodology. For each of the layers, importance and vulnerability assessments are conducted and by the help of the grading system used during this analysis, the necessary information and related maps are produced. In this study, emphasis will be given to the importance and vulnerability analyses of the natural components that form part of the overall methodology.

Prior to importance and vulnerability analyses, data collection, generation of GIS-based digital maps, processing of environmental, socioeconomic and land-use information, determination of sectoral conflicts and displaying the current land-use distribution in the form of maps were realized. Details of conflict analyses are explained in Tanık et al. (2008). All these efforts aimed to put forth priority uses of land resources of the district. The outputs of these studies basically aimed to submit the findings to the decision makers for future planning approaches. During the implementation of the methodology for spatial planning of Akcakoca District, 3 field trips to the area had been organized with the aim of gathering available data and information, realizing visits to different parts of the district, and arranging meetings with the inhabitants and other stakeholders for discussion on the findings of the study. The public participation was high and their comments contributed significantly to the vulnerability and importance analyses. Each site visit lasted 4 days and the last day of the visits had been devoted to stakeholders meetings. In these meetings, information is provided on the methodology applied to all stakeholders comprising of different local authorities, journalists, fishermen, farmers, NGO's and public. Public vision along the overall study was high and consultation to public had a positive pressure on the local authorities.

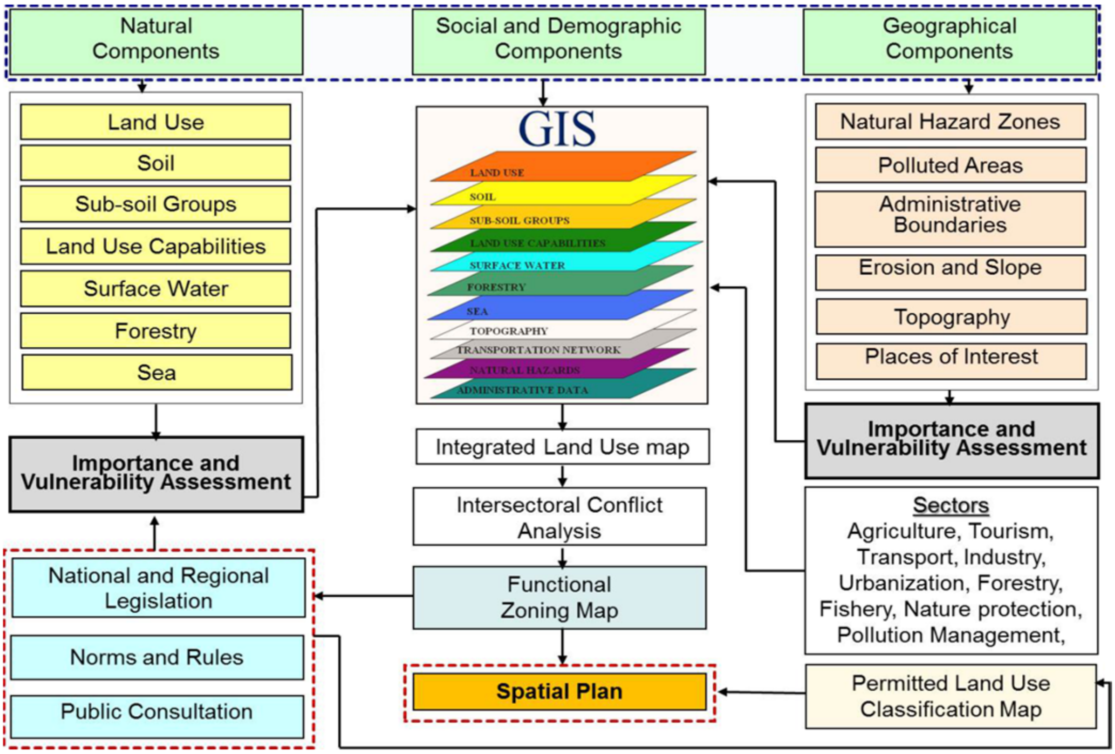


Figure 2. Flowchart of the overall methodology used for functional zoning.

## Results and Discussion

### Vulnerability and importance analyses

Importance is considered as the contribution level of the natural resource or structure within the context of sustainability of human activities and/or it's availability for human activities. Vulnerability, on the other hand, is considered as the tolerance level of the natural resource or structure to the human activities. The intensified use of coasts and coastal waters has increased their vulnerability to all kinds of impacts. These losses make the coast more vulnerable to all kinds of natural and human induced impacts. Specific importance and vulnerability levels together with the significance of each natural component are defined depending on the target function of the natural component of concern. The importance and vulnerability are generally assessed for the natural components of soil, water resources, flora and fauna, sea and wetlands (BSEP ICZM RAC, 2004). Thus, the natural component target function forms the main function of the overall system. Properties of the natural component defining its importance basically on preservation the qualities and features aimed need to be in accordance with its target function. Criteria related to importance and vulnerability allows various scoring alternatives using the same scale and similar quantifiable values like 3, 5 or even 10.

Table 2. Importance and vulnerability values for different GIS layers.

| Layer | Criteria | Area ($km^2$) | % | Importance | Vulnerability |
|---|---|---|---|---|---|
| Slope | 0-2 % | 169,74 | 48,39 | 3 | 1 |
| | 3-6 % | 24,21 | 6,90 | 3 | 1 |
| | 7-12 % | 42,18 | 12,03 | 3 | 2 |
| | 13-20 % | 68,20 | 19,44 | 2 | 2 |
| | 21-30 % | 40,82 | 11,64 | 1 | 3 |
| | above 30 % | 5,59 | 1,59 | 1 | 3 |
| Current Land-Use | No data | 6,32 | 1,80 | | |
| | Horticulture (dry) | 3,69 | 1,05 | 2 | 2 |
| | Horticulture (wet) | 2,63 | 0,75 | 3 | 3 |
| | Dry agriculture | 11,44 | 3,26 | 2 | 2 |
| | Meadows and pasture | 0,45 | 0,13 | 3 | 2 |
| | Dry agriculture (without | 0,30 | 0,09 | 2 | 2 |
| | Wet agriculture | 1,41 | 0,40 | 3 | 3 |
| | Hazelnut cultivation | 160,12 | 45,65 | 1 | 1 |
| Land-Use Capability Classification | No data | 4,74 | 1,35 | | |
| | I | 6,73 | 1,92 | 3 | 2 |
| | II | 1,38 | 0,39 | 3 | 1 |
| | III | 5,13 | 1,46 | 3 | 1 |
| | IV | 50,34 | 14,35 | 2 | 2 |
| | V | 0 | 0 | 2 | 2 |
| | VI | 117,14 | 33,40 | 1 | 3 |
| | VII | 165,26 | 47,12 | 1 | 3 |
| | VIII | 0,03 | 0,01 | 3 | 3 |
| Degree of Erosion | No data | 4,87 | 1,39 | | |
| | None or slight | 222,45 | 63,46 | 3 | 1 |
| | Medium | 115,51 | 32,95 | 2 | 2 |
| | High | 7,72 | 2,20 | 1 | 3 |
| Land-Use Capability Sub-Classification | No data | 15,54 | 4,43 | | |
| | Slope and erosion | 65,01 | 18,54 | 1 | 3 |
| | Erosion and soil | 269,10 | 76,72 | 1 | 3 |
| | Soil insufficiency | 0,47 | 0,13 | 1 | 2 |
| | Soil insufficiency and | 0,63 | 0,18 | 1 | 3 |
| Surface Waters | Wet streams | | | 3 | 3 |
| | Dry streams | | | 2 | 2 |
| Forests | No data | 0,34 | 0,21 | | |
| | Preserved forests | 47,57 | 28,94 | 3 | 3 |
| | Production forests | 60,99 | 37,10 | 3 | 2 |
| | Private forests | 0,11 | 0,07 | 2 | 2 |
| | Hazelnut cultivation- | 55,37 | 33,69 | 1 | 1 |

Table 3. Scoring of vulnerability and importance of current land-use layer.

| Layer | Categories | Importance | Explanation of Scoring | Vulnerability | Explanation of scoring |
|---|---|---|---|---|---|
| CURRENT LAND-USE | Horticulture (without irrigation) | 3 | These lands have an importance because of their economical values although they are limited in abundance. | 2 | They form a semi-vulnerable structure since monotype usage of pesticides and fertilizers depending on the crop type may affect the soil fertility. |
| | Horticulture (with irrigation) | 3 | These lands are highly important regarding the soil properties and water accessibility. | 3 | The effect of human activities and meteorological-based disasters rapidly observed. Moreover, irrigation poses the risk of pollution transportation and thus, it may lead to negative impacts on the other natural ecosystems. |
| | Non-irrigated agriculture (not fallowed) | 2 | Both lands (non-irrigated with or without fallow) include similar compliances. They may have different important aspects in different years in terms of human activities depending on meteorological conditions. | 2 | Vulnerability value in these lands can be more sensitive according to no alternation in crop type, application of monotype system of pesticides and fertilizers and amount of precipitation. |
| | Pasture | 3 | Pastures are not only lands used as agricultural lands, but also they are important environments for robustness of the biogeochemical cycles and ecosystems. They are critical places for biological diversity as well. These lands usually situated among the medium- sloped areas forming a buffer zone between agricultural land and forests. The land cover in such areas is highly important for preventing | 2 | Pastures may have vulnerable characteristics in case of inappropriate pasture management (determination of seasonal breeding stocks) and / or misusage of pastures (e.g. housing in pastures). |

| | | | | | |
|---|---|---|---|---|---|
| | | | erosion. | | |
| | Irrigated agriculture | 3 | Lands of irrigated agriculture usually are high productive fields in absolute agricultural zones with high soil capability and no irrigation problems. | 3 | A change in the water regulation in irrigated agricultural lands affects the whole system including many habitats, wildlife and other life forms. Moreover, a change in these lands could have negative impacts on agricultural productivity. Inappropriate soil tillage or misuse of pesticides or fertilizers can cause erosion, water pollution and eutrophication. |
| | Hazelnut cultivation | 3 | This crop is very important in terms of human activities in a settlement like Akcakoca which its main economical building block is mostly dependent on only one type of product. | 1 | Hazelnut is very enduring crop which is not easily affected by many factors such as soil type, land class, slope status, elevation, etc. However, it is vulnerable to meteorological based natural disasters. |

In this study, the scoring range is selected as 3. In other words, the criteria regarding vulnerability and importance scores varied from 1 to 3 for each of the natural components (Score 1 – low, 2 – average, 3 – high). It is important that one must be sure about the reliability of the data gathered, measured and/or agreed by all in order to reach satisfactory conclusions by the criteria selected. Thus, a narrower range was selected for this study to compare the findings more roughly rather than more sensitively. The below principles are taken into account;

- Each vulnerability item is scored independently since vulnerability scoring should not take into account any interaction with other vulnerabilities.
- Only the direct impact to the target host is considered during scoring vulnerability.

The importance and vulnerability scores given for each natural component based on various layers is shown in Table 2. In this table, areal values are shown for each sub-layer. Descending scores represent comparatively decreasing importance and vulnerability. In order to demonstrate an example on how the scores given are explained, the land-use layer is selected and shown in Table 3.

Criteria for each of the natural layers of the district were determined and consequently vulnerability and importance maps were generated for each of the layers. Maps shown in Figure 3 (a, b, c, d, e, f) are generated by taking into account the scores given for each of the layers.

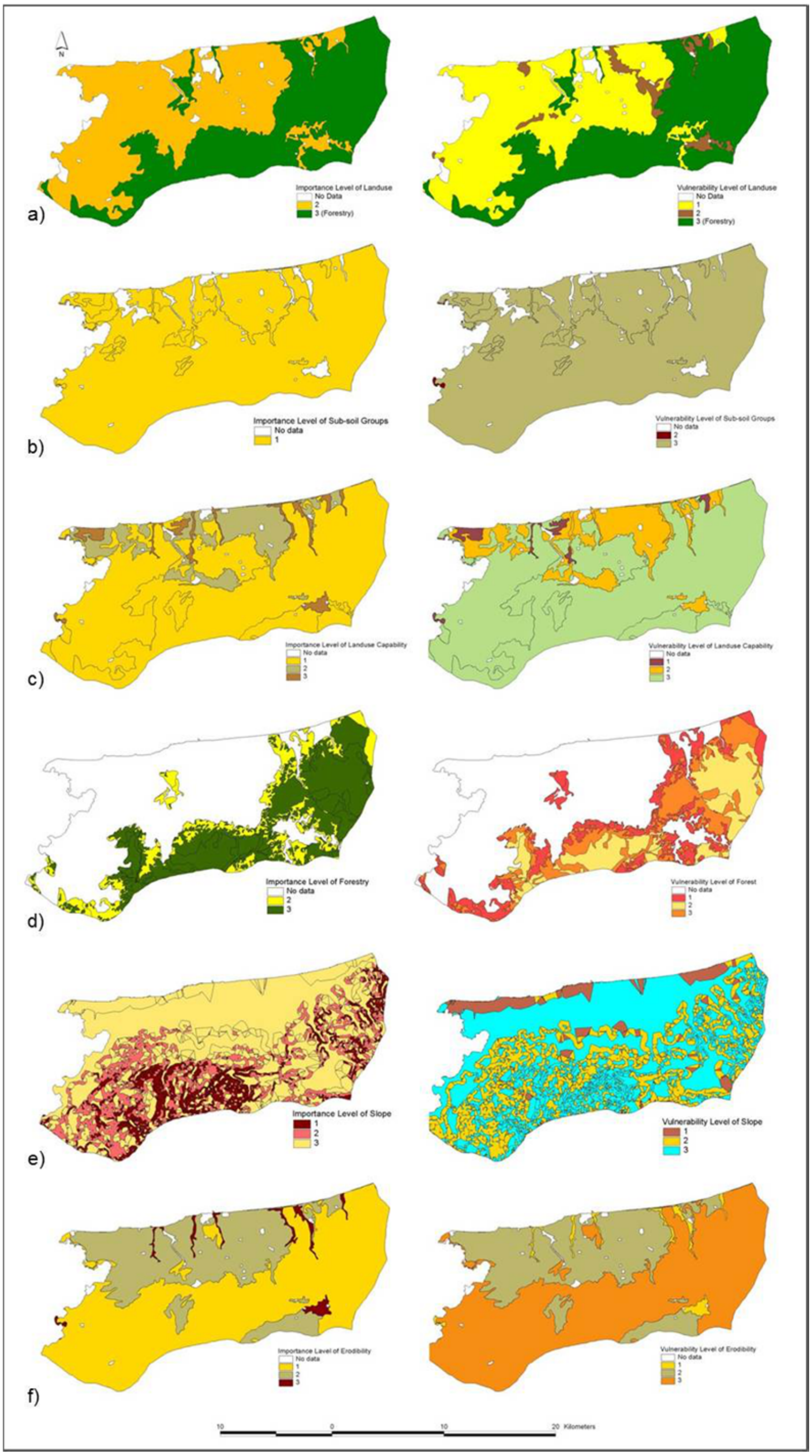


Figure 3. Importance and vulnerability analyses on (a) current land-use layer, (b) sub-soil group's layer, (c) land-use capability layer, (d) forests layer, (e) slope layer, (f) erosion layer

According to the evaluation of the importance and vulnerability analyses and functional zoning Figure 4 has been consequently produced by overlaying the individually scored GIS layers of concern. The maps in this figure present the finalized forms of both importance (a) and vulnerability (b) analysis results.

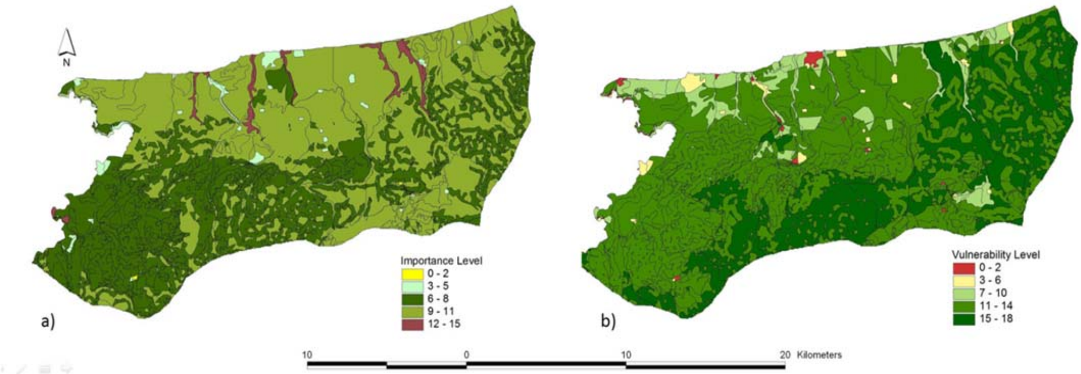


Figure 4. Importance and vulnerability maps of the study area.

The significant findings of the overall importance map are summarized below;

- Areas with the lowest scores of 0-3 are generally river mouths and alluvial areas that can be characterized as vulnerable ecosystems. However, they are not considered as suitable for human activities. The other regions with lowest scores apart from the river mouths are determined as residential sites which do not have sufficient available data to be better evaluated in terms of natural resources and features.
- Areas represented by scores 4-6 are generally highly sloped, not suitable for human activities in terms of land-use capability, and bear problems like erodibility and soil insufficiency.
- Lack of data seems to be the main reason of why the regions with scores 7-9 cover the majority of the district. Missing data on forestry and natural vegetation cover grouped as medium importance level do not allow further evaluation concerning human activities.
- Regions with scores 10-12 generally represent suitable areas for human activities pertaining to slope, land-use capability and erodibility. Agricultural activities prevail on such areas.
- Land with highest scores of 13-15 is extremely limited, and they do not propound assessable features because of the scale used.

The vulnerability of the natural environment of Akcakoca district against human activities is summarized below;

- Land with lowest scores of 0-2 represents areas with no vulnerability. These areas are rather residential sites in the district.
- Land with scores of 3-7 is highly rural areas with lack of sufficient data.
- Areas with scores of 8-12 characterize medium vulnerability level. Such an evaluation is derived as such areas with lower elevations and slope groups belong to lower sub-groups in terms of land-use capability.
- Regions with higher scores of 13-18 generally bear high and extremely high slopes, lower land-use capabilities and face various erosion and soil insufficiency problems.

Table 4 on the other hand summarizes the areal and percent distribution of the overall importance and vulnerability analyses. The layer of surface waters is considered in Table 2, but since their surface area is negligible comparing to others, no information exists in Table 4.

Table 4. Areal distribution of GIS layers for overall importance and vulnerability analysis.

| | Level | Area ($km^2$) | % |
|---|---|---|---|
| **Importance** | 0-2 | 0,43 | 0,12 |
| | 3-5 | 12,38 | 3,53 |
| | 6-8 | 148,68 | 42,39 |
| | 9-11 | 183,69 | 52,37 |
| | 12-15 | 5,56 | 1,59 |
| **Vulnerability** | 0-2 | 1,76 | 0,50 |
| | 3-6 | 4,70 | 1,34 |
| | 7-10 | 33,96 | 9,68 |
| | 11-14 | 217,28 | 61,95 |
| | 15-18 | 93,04 | 26,53 |

Functional zoning of the district is further achieved as presented in Figure 5. This map is developed as a consequence of comparing different layers and current land-use information obtained from current Landsat satellite imagery, coupled with the findings of both the importance and vulnerability analyses.

The 'Functional Zoning of Akcakoca District' is introduced in the light of the general evaluations attained and by utilizing the available and useful data. The zones are symbolized by different letters and their share in total district area is given in parentheses.

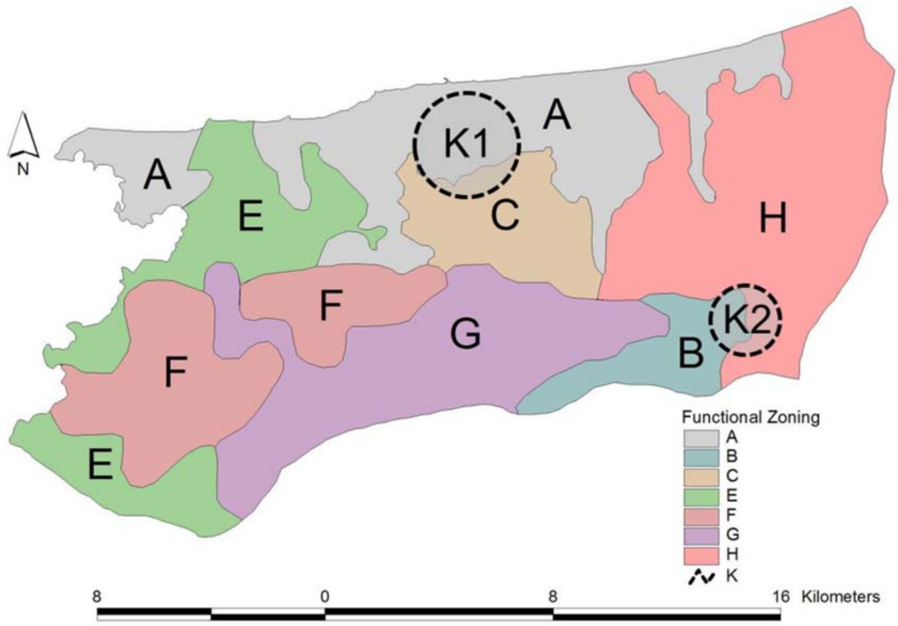


Figure 5. Functional zoning map of Akcakoca district.

The below referred comments are made on the functional zoning map;

K; This group identifies the urban development areas including the centre of Akcakoca and its vicinity. It identifies the intersectional zone of sectorial functions like urban planning, transportation, logistics, and forestry. There is a continuous interest among two residential sites (K1 and K2) reflected by the transportation network. K1 and K2 covers 10.34 and 3.73 km2 respectively. K group should not be considered as a separate zone since it overlaps with various other zones. It may be used by decision makers during future land-use planning.

A; Dominating functions at the coastal area around the centre of the district are agriculture, forestry, recreation and tourism (21%).

B; This group covers the residential areas around which agriculture and forestry functions prevail (5%).

C; This group located at the south of Akcakoca centre that cover highly dense rural settlements, plantation and livestock breeding include functions of agriculture and nature tourism (7%).

D; Coastal area extending from the Centre of the district till the mouth of Melen River includes the major functions of coastal tourism and recreation together with agriculture, forestry and transportation.

E; This group includes agriculture and forestry functions and also describes the region where agricultural activities constrict forestry function (13%).

F; This group that is not suitable for the development of human activities defines areas where the functions of environmental protection and forestry have to be intensified (14%).

G; This group presenting both the highest elevations and the most highly sloped areas of the district basically includes forestry function (17%).

H; This group lying on the east of the district is recommended to be dominating with the forestry function as there is a necessity to improve the land's quality by environmental protection studies against the negative human effects encountered by agricultural activities, transportation, etc. (23%).

This specific effort on developing the functional zoning map of a coastal region is an essential step towards the generation of an efficient spatial plan of the area of concern. When the functional zoning map is coupled with national and regional legislation, and further enriched with the public hearings, spatial plan will be successfully put forth. Spatial plans are tools of land-use activities. Planning of land-use activities has become the most important issue in watershed management that covers the coastal zones as well. All sorts of environmental degradation and deterioration of water quality are due to wrong and illegal use of land resources. As such, functional zoning of land and spatial planning have become outstanding topics in sustainable management of natural resources that basically cover land and water resources. That is the main reason of why so many studies are being conducted in different parts of the world on coastal zone management as described in detail in the introduction part of this study.

The methodology followed in this study covered three basic components; namely natural, socio-demographic and geographical components. However, the original methodology had four components, the last being the ecology component. Missing of this last component indicates the reality that insufficient ecological information existed on this component which led to ignoring it in the application of the methodology in Turkey. This fact once underlined the reality that ecological studies covering the in- depth surveys and analyses on both flora and fauna in different regions of the country are still lacking which would provide invaluable data to the ecology component of the methodology.

Vulnerability and importance analyses and their outcomes presented via mappings and illustrations are good examples that form integrity between the various components under inspection. The range of scoring selected in the study is within 1-3 for each of the vulnerability and importance analysis. The cardinal basis for the assignment of scores highly depends on the details and completeness of the input data used. Broader ranges mean that detailed and deepened information exist. In this study, the formed scale is considered to be satisfactory regarding the precision of the input data used and the target of the study which mainly attempts to make a descriptive presentation of various components that will form an initial database for a comprehensive assessment study.

It is important to note here that such studies covering multi criteria analyses coupled with scoring and illustrations must always be presented to the inhabitants of the region of concern to get feedback on what has been determined and put forth. Consultation with public is one of the most important steps in developing and improving sustainable management strategies. Otherwise, the analyses conducted and the assessments done would be meaningless and of no use.

**Concluding Remarks**

Functional zoning leading to spatial planning have become more popular in Turkey especially in the rapidly urbanizing coastal areas where tourism and fishery attracts both the domestic and foreign visitors. The lack of a national strategy and plan for coastal areas and the lack of a regional authority have hindered the realization of a sound management in Turkey representing a developing country. These facts have been the main limitations during the implementation of the methodology. The use, planning and management of coastal areas are mainly determined by local construction plans and this leads to fragmented planning applications. For an effective management system, the establishment of national and regional institutions as well as development of national and regional strategies and policies is advised. Another significant limitation experienced during the implementation of the methodology has been lack of available data utilizable by GIS. Ecological data covering flora and fauna distribution at both the land and marine sides of the district was accepted as the main weakness during the implementation of the methodology. Moreover, available data could be hardly gathered as they are scattered around at different institutes and state offices and have not been yet documented in a systematic database. In particular, insufficient data is of crucial importance, since it is one of the main components of coastal area management. In practice, no accepted definition exists of the “coastal area” in Turkey. Land-use planning deals with almost terrestrial area. Resources like soil, forests and alike, need to be presented at the country level, and then they have to be discussed at coastal regions and at provincial levels. Similar approach has to be followed for discussing coastal developments like tourism and urbanization.

Besides the limitations addressed, the practice of this methodology provided many benefits especially in increasing the awareness of the stakeholders including the inhabitants. Throughout the study, close contact with the Mayor of the district and his staff provided better explanation of the methodology to the inhabitants and other stakeholders of the district. Mutual discussions increased the interest to developing spatial plans under the light of functional zoning map by the decision makers. By this trial, the administrative staff of the district and the public became familiar with the advances of modern technology of GIS and RS used as tools to better visualize and present the outcomes of the methodology used, and to illustrate the results of multi criteria analyses covering importance and vulnerability grading and mapping. A classification needs to be established for the different types of coastlines in the regional seas according to their degree of vulnerability. Social, ecological, economic and cultural criteria need to be equally applied in order to assess interactions, enable a discussion of priorities among stakeholders and support the design of integrated implementation strategies for a more sustainable coastal development. The emphasis given to working with natural processes in the development and review of Shoreline Management Plans shows that this approach has become an accepted practice.

In conclusion, it is important to note that implementation of the outcomes of the study will be continuing in future as such efforts also need financial support from the administrative and other operational stakeholders. However, public participation during the implementation stage of the outcomes was remarkable.

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