DEVELOPING A GIS BASED METHODOLOGY FOR DECISION MAKING FOR MULTIOBJECTIVE RECREATIONAL AREAS, CASE STUDY : EASTERN BLACK SEA REGION

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
GEODETIC AND GEOGRAPHIC INFORMATION TECHNOLOGIES

MAY 2006

Approval of the Graduate School of Natural and Applied Sciences.

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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ABSTRACT

DEVELOPING A GIS BASED METHODOLOGY FOR DECISION MAKING FOR MULTIOBJECTIVE RECREATIONAL AREAS, CASE STUDY : EASTERN BLACK SEA REGION

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May 2006, 100 pages

In this study, a method is proposed for decision making for multiobjective recreational areas, by using multi attribute decision making rules within GIS. The method provides integration of ecological, sociocultural and economic considerations of an ecologically valuable area in a systematic way. The first stage of the methodology includes determination of suitable areas for three usages of forest area; outdoor recreation, timber production and protection needed areas. The second stage comprises decision making analyses. In this stage, two of multi attribute decision rule methods; simple additive weighting method and ideal point method, are used. As a result of these analyses alternative proposal maps for study area and ideal areas for recreation and timber production are acquired. Finally, in the third stage these alternative proposal maps and ideal area are compared with each other and with defined protection zone in the study area. Ideal areas for recreation and timber production are defined by also considering the protection needed areas. The methodology is applied on Eastern Black Sea Region.

As a result of the study, ideal areas both for recreational usage and timber production are defined. According to these ideal areas, best fitting alternative map is

selected. Finally recreation and timber production proposals are compared with protection needed areas. Results of this study provide a general decision for multi purposed areas in regional scale. The suggested protection zones and suitable areas for recreation and timber production should provide a primary information for forest management studies which must be done in more detailed scales.

Keywords: Recreation, Timber production, GIS, Simple additive weighting, Ideal point

ÖZ

ÇOK AMAÇLI REKREASYONEL BÖLGELERDE KARAR VERME SÜREÇLERİ İÇİN CBS TABANLI BİR YÖNTEMİN GELİŞTİRİLMESİ, ÖRNEK ALAN:DOĞU KARADENİZ BÖLGESİ

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Tez Danışmanı: Yrd. Doç. Dr. Zuhal Akyürek

Mayıs 2006, 100 sayfa

Bu çalışmada, ekolojik olarak hassas bölgelerde karar verme süreçleri için, çok nitelikli karar verme kurallarının CBS ile kullanıldığı bir yöntem önerilmektedir. Bu çalışmadaki yöntem ekolojik açıdan değerli bir alanın ekolojik, sosyo-kültürel ve ekonomik koşullarının sistematik bir şekilde birleştirilmesini sağlar. Yöntem üç aşamadan oluşmaktadır. Birinci aşama, açık hava rekreasyonu ve kereste üretimi için uygunluk analizleri ile korunması gerekli alanların belirlenmesi analizlerini içermektedir. İkinci aşama karar verme analizlerinden oluşur. Bu aşamada, çok nitelikli karar verme kurallarından ikisi olan; basit eklemeli ağırlıklandırma yöntemi ile ideal nokta yöntemleri kullanılmıştır. Bu analizlerin sonucunda çalışma alanı için alternatif öneri haritaları ile rekreasyon ve kereste üretimi için ideal alanlar elde edilmiştir. Son olarak, üçüncü aşamada bu alternatif öneri haritaları ile ideal alanlar hem birbirleriyle, hem de daha önceden belirlenmiş olan korunması gerekli alanlarla karşılaştırılmıştır. Rekreasyon ve kereste üretimi için ideal alanlar, korunması gerekli alanları da göz önüne alarak tanımlanmıştır. Yöntem Doğu Karadeniz Bölgesi'nde uygulanmıştır.

Sonuç olarak, hem rekreasyonel kullanım, hem de kereste üretimi için ideal alanlar tanımlanmıştır. Bu ideal alanlara göre, en iyi uyum sağlayan alternatif harita seçilmiştir. Son olarak, rekreasyon ve kereste üretimi için önerilen alanlar, koruma gereken alanlarla karşılaştırılmıştır. Bu çalışmanın sonuçları bölgesel ölçekte, çok amaçlı alanlar için genel kararların verilmesini sağlar. Koruma ile rekreasyon ve kereste üretimi için önerilen alanlar, daha detaylı orman yönetimi çalışmaları için veri olabilecek niteliktedir.

Anahtar Kelimeler: Rekreasyon, Kereste üretimi, CBS, Basit eklemeli ağırlıklandırma , İdeal nokta

ACKNOWLEDGEMENTS

I would like to express my grateful thanks to my supervisor Assist. Prof. Dr. Zuhal Akyürek not only for her guidance and understanding during the long process of the thesis, but also her great support for encouraging me.

I would also like to give my best appreciations to research assistants and my friends Serkan Kemeç, Kıvanç Ertugay and Ali Özgün Ok for their help especially for technical problems during my laboratory studies and for their friendship.

I would like to thank sincerely to my dear friends Alper Fulat and Başak Şener for their strong motivation, friendship and help throughout the study

I would like to express my deepest thanks to Göktuğ Evin and Sibel Sivrikaya for their honest support during this study. Also thanks are extended to Esra Atlı, Özge Özdemir, Arzu Gürbüz, Burak Gürhan, Filiz Toprak and Buket Mesta, for their motivation in every part of the study.

My major thanks go to Özlem Şevik, Müge Baykan and Didem Gürpınar, not only for their sincere support during the study, but also for their help in every part of my life.

And my pleasing thanks go to, Ebru Coşkun, and Çiğdem Öztürk, who are always near me with their endless support and inexhaustible friendship.

I would like to declare my appreciation to my beloved family; my parents Erdal and Ruhsen Kaya, my brother Özge for their support and confidence in me throughout my life, but more importantly for only giving their love to me.

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CHAPTER 1

INTRODUCTION

Recreation is a fundamental component of life. From ancient civilisations to nowadays, people have always been in different activities with the goal of entertainment, sports and being in a social community. As the life styles have changed from ages to ages, the way of having fun for people in their leisure times have changed. In ancient ages people were getting together, dancing, signing and painting by means of religious reasons. There were not many differences between work and leisure. As this difference became more distinguishable, the leisure time became more worthy and people began to make many activities especially at outdoor area.

Development in industry and technology, have sharpened the differences between work and leisure. This development have brought e new life style and have speeded up the time for living, working and playing. Some of life's pleasures remained simple indeed. Speed of daily life and crowd of cities, pushed people to outdoor areas, mainly to forests, in their leisure times. This brought the fact that forests have a new usage besides being a source for timber production and being a shelter for many flora and fauna species. Therefore, the necessity of comprehensive plans for forest management came up.

1.1. Expectations from Forest Areas

Forest areas are multi objective areas. There are three different expectations from forests; recreational usage, timber production and sustainability by means of ecologic considerations.

In February 2005, General Directorate of Forestry published a report for a general outlook to forestry in Turkey towards the 100th anniversary of the Republic of Turkey. In this report, it is explained that, in traditional forest management plans, forests were taken into consideration only with their wood production. However, recent approaches to forest management, consider ecological sensitivity and social services that could be provided from forests. Furthermore, it is mentioned that Geographical Information Systems (GIS) technology will be efficiently used in further studies.

Recent forest management studies in Turkey, includes functional management strategies. The plans which are made by using these strategies contain formulations for ecologic and social functions of forests and their harmonization with economic functions.

1.1.1. Recreation

It is possible to define the term recreation in many different ways. Below, some definitions are presented from variant sources.

“Recreation derives from the Latin *create,* to create. In the fourteenth century it appears to have meant ‘refreshment by pleasant occupation’, and by the fifteenth ‘restore to a good or wholesome condition’.

The word ’leisure’ appears first in the fourteenth century, and refers to freedom from occupation and hence free time.” (Broadhurst, 2001).

Recreation is the “Use of leisure time for personal satisfaction and enjoyment and for physical and mental health. Recreation may be a basic human need. It may be undertaken individually or with others. It may be planned or spontaneous. It may be passive or active, may or may not require skills and training, and may or may not require a designated area. It includes such activities as swimming, picnicking, boating, hunting, and fishing. It is not a resource but a complex activity composed of

people, the environments, and their actions. Recreation, for some people, exists in the mind and takes place in an environment." (URL 1.1)

"Generally recreation is examined by dividing into three parts:

a) house activities b) indoor activities other than house c) outdoor activities." (Kurdoglu 2002) In this thesis outdoor recreation is studied which is related with forest area.

"Outdoor recreation involves protecting, preserving, developing, using, and enjoying scenery, water, primitive or natural landscape, wildlife, natural phenomena, and archaeological and historical sites. Any physical or psychological revitalisation through the voluntary pursuit of leisure time. **Forest recreation** includes the use and enjoyment of a forest or wild land setting, including heritage landmarks, developed facilities, and other biophysical features." (URL 1.1)

1.1.2. Ecologic Sustainability

Forests are the most suitable areas for recreational activities. On the other hand they include many ecologically sensitive areas, habitats for many flora and fauna species.

Uncontrolled recreational activities in forests may cause damage to the forest ecology. The term 'sustainability' was arisen from this fact.

"The term 'sustainability' can be defined as the use of ecosystems and their resources in a manner that satisfies current needs while allowing them to persist in the long term. It is a key concept for the 1990s, promoted by the 1992 Rio Earth Summit, and subsequently G7/G8 conferences and governments at all levels. Essentially it is about living, working and ordering society in ways, which are environmentally 'sustainable', encouraging reduction of pollution, re-use of resources, promoting biodiversity etc. The core idea is that 'current generations should meet their needs without compromising the ability of future generations to

meet their own needs'. It is also in some quarters associated with promoting social justice and a fairer society.

Sustainability is the concept of meeting the needs of the present without compromising the ability of future generations to meet their needs. In nature conservation terms, it refers to the use of a natural resource in a way where it can be renewed, such that the environment's natural qualities are maintained.

Concept was developed in 1980 by the International Union for the Conservation of Nature and taken up by the Brundtland report in 1987. Sustainable development means a form of development 'that meets the needs of present generations without compromising the ability of future generations to meet theirs'." (URL 1.1)

1.1.3. Timber Production

Forests are also the only sources for wood, timber, paper and other forest productions. For an efficient forest management, forest productions must be taken into consideration. Because these productions are important for country economy. It is needed to determine areas having high potential for timber production.

Consequently, forests are multi-purposed areas, which are needed for recreational activities and forest productions. At the same time forests need to be protected in order to sustain their potential for these usages.

1.2. The Problem

The problem is how to balance the these usages (recreation, conservation and timber production) in a forest area. Forests are excellent areas for recreational use. They provide clean air. They have opportunities for walking, trekking, climbing, biking, camping, rafting...etc. It is possible to observe nature, to examine different kinds of flora and fauna, to take photographs of them. In the light of this view, it can be said that forests should be permitted for recreational usage. But from another point of view, in the case of opening whole forest area for recreational usage, it will

be impossible to maintain the properties of the area that are necessary for recreation. In order to provide sustainability of recreational usage in a forest area, protection is needed. If the forest area is completely taken under protection, it is impossible to benefit from it for recreation. If the forest area is opened for recreational usage then it will be very difficult to protect its natural properties. Furthermore, there is a third usage, which is provided from only forests: timber production. Forests are only sources for timber, wood, paper and other yields such as resinous, peanut, sweetgum (Liquidambar orientales) oil...etc. These three usages for forest areas must be balanced in an efficient way. How to provide this efficiency is the problem.

1.3. Aim and Scope of the Study

Aim of this study is to propose a method that provides efficient decision-making in multi-objective subjects. Forest area is a good example for a multi-purposed subject. As mentioned before, there are two usages of forest areas:

- Sociological needs (Need of recreational areas)
- Forest products (Economic benefits)

Additionally to these, ecologic sustainability must be provided by considering the ecologically sensitive areas.

In this thesis it is aimed to generate a method which takes into consideration the two usages (recreation and timber production) of forest areas while considering the ecological sensitivity and which proposes an efficient way for decision making in forest management. Data management is provided by using geographic information systems (GIS). GIS is used for storage of data, spatial analysis on data and presentation of the results. For decision-making process, two methods of multi attribute decision rules were used, in order to compare the results. Simple Additive Weighting and Ideal Point Methods were applied to the study with the aid of GIS. Finally the differences and similarities between the two methods were determined. Some interpretations were done for the two methods in order to find out which one

should be more helpful for what kind of studies and which one could give more efficient results for certain studies.

The study will be presented in six chapters.

The first chapter is introduction and it includes aim and scope of the study, methodology and general information about the study area.

The second chapter is literature survey part. In this chapter previous studies about the subject will be introduced. Their effects on this study will be argued.

The third chapter is about methodology, materials and study area. In this chapter, information about data will be given. Sources and types of data, conversions made on data and produced data will be presented. General information and current circumstances of the study are also given in this chapter.

The fourth chapter is about data analysis. In this chapter GIS is used efficiently for spatial analysis, data queries and map production. Potential maps for recreation and timber production and map for ecologically sensitive areas will be presented in this chapter. For decision making from these potential maps two decision making methods will be applied and presented.

The fifth chapter includes results and discussions of the multi attribute decision rules methods. Two multi attribute decision rule methods; Simple additive weighting and Ideal Point Methods will be compared according to the results.

The sixth chapter is conclusion. In this chapter general interpretations about the methodology will be given. Additionally interpretations for the decision making methods and their integration with GIS and will be argued.

CHAPTER 2

LITERATURE SURVEY

Rapidly growing cities and fast changes in life styles, bring also the change in land uses and selection criteria for land uses. Outdoor recreation as a land use is a result of that rapid growing and changing. Living in crowded and noisy cities, more and more people need to rest, play and make sports in recreational areas in their spare times. Consequently, forest areas gained a new usage -recreation-, besides their economic yield -timber production-. Site selection for these areas has many aspects such as sociological, ecological, economic, transportational and so on. Each of these aspects must be taken into consideration in order to provide sustainability. In 1998, Ferrerio et al. mentioned that the term 'sustainability' has suddenly become so popular in the context of scientific debate. This term emphasises the critical importance of developing land use / landscape development methods that will not jeopardise the future generations' ability to fulfil their needs. (Ferrario et al., 1998).

In recent years many studies are done relational with the terms recreation, forest management, sustainability, nature tourism, and ecotourism. In more recent years, these studies are done with the aid of Geographical Information Systems (GIS).

Literature survey studies are done for gathering information about methods used for recreational studies and timber production studies. On the other hand the studies considering acological sensitivity while determining recreational suitability and studies considering ecological sensitivity in the study area are examined.

2.1. Recreational Purposes

Sociological needs of people means the activities done by people at their spare times. This can be called as “leisure” or “recreation”. Recreation and site selection for recreational areas are the popular topics in literature since many years. But in recent years usage of GIS techniques for site selection for recreation is a more popular topic.

Literature about recreational studies is surveyed in order to examine the criteria selection. Many of the studies used multi-criteria decision analysis and determined some criteria.

One study that uses GIS and Remote Sensing (RS) techniques for determining recreationally suitable areas, was done by Banerjee et al. (2002). They examined the area in three criteria and produced three maps; ecological attribute map, land use map and soil productivity map. Ecological attributes were generated from NDVI of IRS 1D LISS III satellite data. Land use map was also acquired by the classification of satellite image. This study is a typical example for using GIS applications for recreational suitability.

Yılmaz (2004) determined the potential for the recreational usage in Serçeme Valley. After defining the ecologically sensitive areas, she examined the area under four criteria; reservoir and other water source existence, topography, plateaus and natural vegetation cover. This study considers a second aspect of the subject. Because, initially ecological sensitivity was determined and these area were avoided from any damage. Additionally the selected criteria are more detailed. This study does not use any information system but it is useful for thesis study for criteria definition.

Vries and Goossen (2002) made a study about modelling recreational visits to forests and nature areas. Their aim was to find the quantity of visits to recreational areas but in order to make this calculation they initially determine recreationally suitable areas. They indicated that walking and cycling are the most popular activities for recreation. For this reason suitability for these activities would mostly adjust with the criteria for recreational use. Seven indicators were used to calculate

the quality of the forests and nature areas for walking and cycling. These were; accessibility, land use, tranquillity, density of walking and cycling opportunities (paths and quiet roads), relief, banks and shores, distance to cities. (Vries and Goossen, 2002)

Köchli and Brang (2005) in their study “Simulating effects of forest management on selected public goods and services” made a literature survey for the criteria selected for recreational suitability. According to them prerequisites for successful recreation are having a break from stress, sufficient time, purposeful activities and suitable space.

“Based on a literature review, we concluded that recreational space is the most important service in this catchment. Ecological services (e.g. purification of water and air, biodiversity, etc.) are also important, and timber production is of secondary importance. The reviewed studies applied a variety of methods to rank the different forest goods and services but generally identified a similar trend.” (Köchli and Brang, 2005)

In the light of their literature survey, criteria for recreational suitability can be compiled like that:

Walking, hiking, horseback riding and cycling are popular activities in forests. For this reason forest roads and paths are crucial for recreation.

Forest characteristics necessary for recreation are controversial. Generally; stands with broad-leaved trees, with conifers, with a variety of species and multi layer stands and old trees are presumed as suitable for recreation.

Infrastructure is often but not always important. By the word infrastructure; campgrounds, facilities for varied sports and activities, walking paths and etc. are implied.

Good accessibility plays a role. Generally areas near to roads and forest roads are selected. Forest edges and forest openings are often followed.

Both Vries and Goossen's (2002) and Köchli and Brang's (2005) studies present determination criteria needed for recreational planning. However, determination of the criteria is not enough for planning process. An efficient methodology is needed to evaluate these criteria. There are many studies proposing such methods.

One study that offers a methodology for recreational suitability was done by Nakamura et al. (1995). They followed two steps in their study, which also used the integration of GIS and multi-criteria methods. In the first step the criteria were defined: Age of trees, nearness to roads, existence of public facilities (camping ground, forest roads), existence of flora- fauna, geomorphologic properties (valleys...etc.). These criteria were produced by using GIS spatial analysis and stored in GIS layers. By evaluating and overlaying these layers, recreational potential of forest was determined. Second step was to define the suitability of infrastructure for recreational uses. For this purpose the area was identified according to nearness to public roads, forest roads, walking paths and camping sites. After defining recreationally suitable areas in respect of infrastructure, recreationally potential areas, which were determined at first step, were re-evaluated. Finally suitable recreation areas were acquired.

"Forests that have a high ranking both in terms of their high timber potential and their suitability for comprehensive use, have to be studied to determine how they can be best used. These problems have to be considered taken into account the condition of the surrounding forests and a comprehensive judgement formed based on the result of the three evaluations. For this reason, it is felt that the use of GIS to form these evaluation was effective." (Nakamura et al., 1995).

It is a reasonable approach to determine recreational suitability in two steps. In the first step general criteria for recreation are used and a general recreational suitability map is reached. As a second step more particular criteria are used for re-evaluating recreational suitability. This is a reasonable method because second criteria should change from place to place according to its properties. For the second evaluation part, criteria, which are specific to the study area, can be used.

Another study, which is done by Conine et al. (2003), proposes a more efficient methodology for recreational suitability with the aid of GIS. First they assessed the site suitability for recreation. " Site suitability assessment involves the creation of suitability maps that identify areas most suitable for a certain activity. The map is based on suitability scores. The final suitability score is actually a factor of an area's capability score multiplied by a weight, which represents its subjective importance in the overall suitability analysis. Map overlays are a common method for delineating suitable areas. Therefore, this technique can be easily applied utilising a GIS." (Conine et al., 2003)

Secondly they assessed the accessibility. They sub-categorised this process into two smaller steps: approachability analysis and proximity analysis.

According to Connine et al. (2003) site selection should be a two stepped process. First alternative scenarios should be generated. Secondly these are re-evaluated, in order to choose optimal sites. In the first step prior criteria for interested subject should be used. In the second step it would be useful to consider certain needs about the subject

Both Conine et al. (2003) study and Nakamura et al. (1995) study propose to determine recreational suitability in two steps. The first step is determining appropriate criteria and selecting suitable areas in the light of these criteria. The second step is re-evaluating selected suitable areas by a certain necessary criterion. Re-evaluating criteria can be defined by using proximity analysis.

Broadhurst's book on "Managing Environments for Leisure and Recreation" (2001) provides information about many aspects of recreation. The scope of leisure and recreation and histories of recreation are the initial information in the book. There are also some economic knowledge about recreation, such as benefits, costs, settings and trends of recreation and socio-economic aspect of recreation. Though the most helpful information about the thesis study was about managing environment and preparing to manage, planning from research to design parts. According to Broadhurst (2001), recreational suitability can be examined under three titles; nature, culture and management. These criteria can be summarized as below:

Natural:

- List/ distribution of species
- Topographical features /slope/Aspect)
- Geology (hard and soft)
- Climate (macro, micro, temperature and humidity)
- Hydrology

Cultural:

- Archaeology
- History (including social history)
- Myths, legends and stories

Managerial:

- Leases and other constraints
- Present uses
- Accessibility
- Risk assessments

One other study is Gunn and Var's book on Tourism Planning (2002). Tourism planning is a comprehensive subject and in the book many subjects about tourism planning are defined. One of these subjects, discovery of the tourism potential, is related with the thesis study by means of giving necessary criteria for recreational suitability. According to Gunn and Var (2002), criteria for recreation are:

- Water
- Topography, soils, geology
- Vegetation, wild life
- Climate, atmosphere
- Aesthetics
- Existing attractions, institutions
- History, ethnicity
- Service centres
- Transportation

These criteria defined in the two books and other criteria which are used in the articles are considered for the thesis study. In the light of these studies necessary criteria for the thesis study is determined by the affects of local properties. More explanation about determination of criteria could be found in chapter four. Additionally, the articles were useful for determining methodology for selecting recreationally suitable areas. As explained more detailed in chapter four, analyses for recreational suitability is generated in two steps, in the light of literature surveyed.

2.2. Ecological Importance

Ecologically sustainable tourism is a discussed subject in recent years. A conference about “tourism and sustainable economic development” which is supported by World Bank was made in Italy, in 2003. Costantino and Tudini (2003) presented their study “How to develop an accounting framework for ecologically sustainable tourism. According to them sustainable development requires the consideration of economic, environmental and social issues at the same time. They introduced types of analytical and statistical frameworks for ecologically sustainable tourism.

That study has a more economical and social view about the subject. However, in this thesis it is aimed to study the physical dimension of the subject.

Yılmaz (2004) determined ecological sensitivity and biological diversity in her study area, before determining the recreational suitability. Because as a recent and nature friendly approach, “sustainability” is an important term. In order to provide sustainability of the recreational activities in an area, its natural properties must be protected. For this reason, determining ecologically sensitive areas before deciding recreational areas is an appropriate approach. While determining ecological sensitivity, Yılmaz got the aid of previous studies for the study area and new studies done by academics from Atatürk University biology department.

In this thesis also previous works are examined for the ecological sensitivity part.
Tunca 2003 made his study “Defining priority areas for nature conservation studies using geographic information systems” in Eastern Black Sea Region.

In this study a conservation site suitability evaluation over large areas for national park definition is improved. Site selection requirements are characterized as map layers in GIS. Multi-criteria decision analysis and spatial GIS tools are used for defining priority zones.

Demirci (2005) gathered the knowledge of indigenous plants in Turkey from literature and transferred that data into GIS database. In this study the affects of different factors on the distribution patterns of these plants are investigated by means of GIS and multivariate analysis. As a result distribution of these endemic plants on Turkey is acquired. Eastern Black Sea part of this study is used in this thesis in order to define ecologically sensitive areas.

Study on the Regional Development Plan for the Eastern Black Sea Region in the Republic of Turkey (DOKAP) (2000), volume about environment is a good source for ecological considerations of the thesis. In this report, there are brief information about the conservation politics in Turkey and laws about protection. Furthermore, information about current ecological sensitivity of the region, flora and fauna species, protected areas which are defined by state authorities (national parks, nature parks and nature reserves) and protection needed areas which are defined by non governmental organisations and academicians (Key Biodiversity Areas) could be found in the report.

2.3. Economic Benefits

The economic benefits from forest area means the timber production potential of the forest. One very effective study for identifying the forest areas capable for wood production is done by Nakamura et al. (1995). Forest area was examined under two titles:

- Timber resources
- Ease of using forest.

In order to identify timber resources of a forest, two criteria must be taken into consideration: volume of the trees and type of the trees.

Ease of using forest means, the ease using the machinery and carrying the forestry equipment. It is impossible to use the machinery at the areas with steep slope. For this reason slope is one criteria. Another criterion is distance from roads because it is needed to determine the ease with which forestry equipment could be brought in.

Next step is the evaluation of the criteria and determination of the potential areas for timber production.

Second study, which was helpful for economic benefits of forests, is the report "Forestry Outlook Study For Turkey Towards The 100th Anniversary Of The Republic Of Turkey" which is published in February 2005 by General Directorate of Forestry. In this report, General information about Turkey's forest management politics is defined. According to the report traditionally forests were considering with only their economic opportunities like wood production and other forest products. However more recently it is recognized that forest serve many opportunities for many other usages like recreation, hunting. Also ecological sensitivity is another subject to be considered. Protection is done more consciousness in recent years. According to this report it can be said that while acquiring timber products, ecological sensitivity and sociological usage of the forests are also taken into consideration. In the report it is also mentioned that GIS is an effective tool for forest management studies.

Study on the Regional Development Plan for the Eastern Black Sea Region in the Republic of Turkey (DOKAP), volume of economic sectors (2000) is another source used for taking information about forestry in Eastern Black Sea Region. In this report, it is possible to find out brief explanations about the current conditions of forests and timber production in the study area.

2.4. Use of Geographic Information Systems and Multi-criteria Decision Analysis

There are many studies in the literature that integrates the GIS applications and multi-criteria decision models. In 1998 Ferrario et al. presented their study on

sustainable development of rural areas. With the aid of GIS and multi-criteria methods they determined suitable areas for urban and suburban green areas.

In 1999 Pettit and Pullar proposed a method that integrates decision-making procedure with multi criteria evaluation techniques and GIS. They emphasise the importance of GIS analysis in their study.

They mentioned that despite the widespread usage of GIS in local government for parcel mapping and asset management, the full potential of GIS has not yet been realized. Especially spatial analysis that can be done by using GIS tools should be very useful for many studies. Also GIS would be very useful when integrated with decision making analyses.

This study is another example for relating multi criteria decision analysis and GIS techniques, which is done at late 1990s.

In 2001 Bukenya was also combined GIS and multi-criteria decision-making framework, in order to identify the most ‘valuable’ national parks in Uganda (Bukenya, 2001). Application of GIS In Ecotourism Development Decisions titled study is related with the thesis because it defines a decision making frame for comparing the national parks with each other. Differently, he compared selected recreational areas according to defined criteria. In this thesis aim is to find possible recreational area.

Store and Kangas (2001) proposed a habitat suitability model, which uses both GIS and spatial multi-criteria evaluation methods.

In these multi-criteria subjects, it is initially needed to define the criteria for the related topic. Secondly these criteria are put in an importance order, usually by using pair wise comparison. After, according to its importance and by using expert knowledge each criterion takes a weight. These weighted criteria are stored at different layers in GIS.

In their study, most of the variables needed in the evaluation process were collected and they were then stored into a database of a GIS application. Some of the evaluation criteria were elaborated by spatial analysis functions using GIS operations. The collected data and acquired data from GIS analyses were then integrated and stored in different layers. By overlaying these separate layers desired suitability map is acquired.

Başal and Güneş (2002) aimed to determine a totalitarian management approach that will minimise the conflict between human activities and protection of the values the area have, in the circumstance when the area is opened to recreational use. They define the criteria for the usage types of the area and evaluate their GIS data layers by using multi-criteria methods.

In 2003 Kangas et al. (a) made a study that used stochastic analysis in order to evaluate the alternatives for a forest area. (Kangas et al., 2003, a)**.** In their study "Evaluating The Management Strategies of a Forestland", they explain some of multi criteria decision methods for selecting one of them for the study. In this study, for assessing criteria weights ranking method is used, which provides comparison of different alternatives.

Chackar and Martel (2003) mentioned the necessity for integrating GIS with multi-criteria decision techniques, in their study " Enhancing Geographic Information Systems capabilities with multi-criteria evaluation functions."

They recommended that GIS is a powerfull tool for acquisition, management and analysis of spatially-referenced data. On the other hand GIS stays limited for spatial decision aid.

For this reason it is strictly necessary that multi criteria decision methods must be used with GIS analysis for spatially decision-making processes.

Morinoni (2003) proposed a method that integrates a stochastic spatial multi decision support system with GIS techniques.

Geoscientists and spatial planners are faced decision problems which involve a set of geographically defined location alternatives. One or more of these alternatives are selected generally by using related multiple criteria. Various decision supporting tools and multi-criteria approaches heve been developed in order to analyse that complex decision problems. However, non of these methods is perfect. Each of the methods should be used for specific problems. For this reason it is reasonable to categorise multi-criteria decision aid methods.In this study decision making methods are distinguished between three categories: (i) outranking techniques, (ii) multi-attribute utility techniques and (iii) mathematical programming techniques. GIS technologies facilitate decision-making processes based on their spatial analytical capabilities.

As Marinoni (2003) mentioned, there are many decision making methods and none of them is a perfect method. Quality of a method changes according to its suitability to the study. In this thesis two methods of multi attribute decision rules are applied and compared with each other.

Başkent and Keleş (2005), made a brief review for spatial forest planning. In this study they focused on the spatial considerations of spatial configuration of patches including their size, and distribution, shape, adjacency or green-up delay, connectivity, proximity, and core area that make the conventional forest management planning “spatial” powered by GIS. They comprehensively reviewed literature about forest management and emphasize the necessity of GIS for forest management studies.

They mentioned that spatial structure of forest landscape is easily expressed and grasped through graphic or cartographic representations. Although GIS, global positioning systems, remote sensing, image processing, and other tools can assist spatial forest-planning efforts, these tools are typically used to provide spatial data for the planning processes or to perform posterior analyses of forest plans. The vital function of GIS is the ability to answer geographical questions based on the information in digital maps with associated attribute database. It has traditionally been used in forestry to store maps in electronic form and to make calculations, such as area and distance. More recently, its use has been extended to analyses of

potential land uses and other complex problems, which have a spatial context. (Başkent and Keleş, 2005)

Doing another study that integrates GIS and decision support systems, Hans et al. (2005) emphasised the importance of GIS for decision makers. They proposed a decision support model for forest management.

“With increased pressure on public land managers to provide economic and ecological justification for harvest projects, the use of analytical tools has become critical for efficient planning. Planning tools need to be flexible, fast, easy-to-use and address the relevant economic issues for efficient planning. The only efficient, organised way of meeting these needs is to utilise Geographic Information System (GIS) technology.” (Hans et al., 2005) In order to make correct decisions in forest management it is needed to make optimisations and using multi criteria decision methods will be helpful.

They proposed a study that produced a software, which supports GIS with spatial decision support systems. In this study some optimisations were done for forest area and stochastic simulation methods were used for some important outputs. In order to define selection criteria accurately and to evaluate those criteria efficiently, it is needed to make optimisations for the related area.

The other study that will be introduced is “socioecological landscape planning approach and multi-criteria acceptability analysis in multiple-purpose forest management” (Kangas et al., 2003, b).

In that study forest area was discussed in three dimensions. Ecological sensitivity, sociological opportunities and economic potential of the area are determined. According to these three properties alternative plans for the forest area were produced with the aid of GIS. Some of these alternatives were more sensitive for ecological values whereas some were more convenient for recreational uses. Next step of the study was to evaluate these alternatives. The evaluation criteria were measured on ordinal scale, and they were ranked according to their mutual

importance. Stochastic multi-criteria acceptability analysis with ordinal criteria was used in the holistic comparison of alternative landscape-level plans.

The method used in this study is a reasonable way for forest management. Because the method gives opportunity to examine the forest area with its three important aspects. Producing alternative maps provides to see what should be do future land use of a forest area according to different points of view.

A more explanatory study on stochastic multi-acceptability analysis is “ordinal criteria in stochastic multi-criteria acceptability analysis (SMAA)” (Lahdelma et al., 2002)

One last article that will be introduced is “ A GIS Based Multi Criteria Decision Making Approach to Forest Conservation Planning at Landscape Scale” (Phua and Minowa, 2005) In this study forest conservation planning is formulated by using Analytical Hierarchy Process technique.

In their study, they use GIS, remote sensing for evaluating criteria and indicators with the help of field data and literature. The scores are standardized in order to make equivalent all the criteria. Preferences on the criteria and indicators are expressed as weights that are assigned by decision makers. Combining the weights and the indicator maps generates forest conservation priority maps of the decision makers. Compromise programming techniques are used for integrating priority maps and calculating seperation distance. Potential conservation areas are defined by using threshould values on seperation distance. Generated potential conservation map is used for forest conservation plan. (Phua and Minowa, 2005)

In this study, integration of forest conservation priority of decision groups using compromise programming techniques part is interesting. Because, this method provides a whole integration between GIS and multi attribute decision rules methods. Operations of the methods are directly applied on GIS raster datasets.

A book of Malczewski, GIS and Multi Criteria Decision Analyses (1999), is a study which gives detailed information about decision making process and different

methods that can be used. In this book there are brief explanations for evaluation criteria, decision alternatives and constraints, criterion weighting, decision rules and sensitivity analysis.

Another source for decision making problem is the book written by Thill, “Spatial Multi Criteria Decision Making And Analysis” (1999). This book is composed of articles of different writers which are written in their own speciality subject. Many decision making approaches are introduced with samples. In this book chapters “Spatial Multi Criteria Decision Analysis” (Malczewski,1999) and Spatial Dimension of Multicriteria Analysis (Marjan and Rietveld, 1999) were useful for the study.

2.5. Eastern Black Sea Region

There are many other studies done for Eastern Black Sea Region. The common point of all these studies is that, they all emphasise the necessity of protection of this special region in order to provide the sustainability of its properties.

Study on the Regional Development Plan for the Eastern Black Sea Region in the Republic of Turkey (DOKAP), master plan (2000) is a main source for taking information about the study area. The plan is prepared by State Planning Organisation, in order to introduce current conditions of Eastern Black Sea Region and to provide development of the area by planning decisions. This report provides much information about study area.

Özyaba (2000) determined the tourism supply at Eastern Black Sea plateaus and the affects that conducts the touristic demand over these plateaus. In this study five plateaus, that takes place at Ordu, Giresun, Trabzon, Gümüşhane and Rize, were examined.

Demirel (2004) also studied at Eastern Black Sea Region at Çoruh watershed and determined the general tendencies of native and foreign tourists in this area.

According to Demirel (2004) existence and long-term success of tourism depends not only on the management of cultural resources, human built attractions and

structure, but also on the conservation and protection of the natural environment in which tourist experiences take place. The natural environment is crucial to the attractiveness of almost all travel destinations and recreation areas. The environmental dimension in tourism is an important factor, because in areas where nature is spoiled and polluted are less attractive to tourists.

Consequently, new tourism terms and approaches are created at recent decade. Nature tourism and ecotourism are new terms for tourism industry. The term 'green tourism' is generated for maintaining nature friendly activities which can be done in rural areas. The terms 'Nature tourism', 'ecotourism', alternative tourism' can be used as terms of green tourism, which are all purpose natural activities. (Demirel, 2004)

Ozyaba (2000) also takes into consideration the term "alternative tourism". According to him, it is thought that the "alternative tourism" -which is brought up by people who tried to coalesce with nature in spite of the exhausting and suicidal attitude of mass tourism that developed at Europe in recent 20 years- should be done at plateaus. Besides sea-coast-sun combination, the landscape, extraordinary vegetation, natural life, caves, mountains, water sports, folkloric properties, native identity...etc. became more attractive for tourists. (Özyaba, 2000)

When these properties are considered, Eastern Black Sea Region is completely suitable for this type of tourism. For these reason, in recent years there is an increase at the touristic demand to the area. In this content, it must be thought that the touristic activities at this region are oriented towards natural and cultural properties of the area. Therefore, the only way to provide sustainability of the touristic action at the region is the protection of the natural and cultural values. At Eastern Black Sea region, development an insensible tourism must be avoided. A tourism approach that will provide the protection of natural and cultural heritage must be developed.

Kurdoğlu (2002) made his PhD thesis on "Natural source management over Kackar Mountain and environs". In this study a comprehensive examination was done over the region.

Demirel (2004) performed a questionnaire over the foreign tourists who came to Çoruh region. A high percentage of the tourists point out that the transportation, accommodation and guidance services at the area are insufficient. This shows the necessity of a comprehensive tourism plan at the region. By the word “comprehensive”, it is implied that a plan that considers both ecological and sociological needs and economical benefits of the area. In this thesis study it is also proposed a model to determine the area usage decisions of an area where there are two choices for two different purposes, for instance timber production and recreation.

CHAPTER 3

METHODOLOGY, MATERIALS AND STUDY AREA

In this study a methodology is proposed for decision making in multi-purposed areas. By the word multi-purposed area it is intended that, the areas which are needed for various usages. In such areas a decision making process is needed in order to determine future usages of certain parts of the area. The methodology, which will be described below, is proposing a solution for this problem.

Forest areas are multi-purposed areas. Because they are suitable areas for outdoor recreation activities and also they are only sources for timber and wood production. Besides these, they are needed to provide oxygen for world and they are home for many species of flora and fauna. So that forests must be protected as well as they are used for recreation and wood production. For ensuring sustainability of forests, comprehensive forest management plans are needed which are considering these three aspects; outdoor recreation, timber production and protection. In this thesis a methodology is proposed as an initial study for forest management plans, for decision making in forest management, by considering these three aspects of forests.

3.1. Methodology

The framework of the study is composed of three stages. The first stage is suitability determination for three aspects of the study area. The second stage is decision making. Decision making is done according to suitability results, by using two different multi attribute decision rules methods. The last stage is comparison and

interpretation. In this stage results of two different methods are compared and interpretations for the results are done.

3.1.1. Suitability Determination

The first stage is determination of suitable areas for outdoor recreation and timber production. Additionally ecologically valuable and protection needed areas are defined according to earlier studies and governmental protection zones. The determination is done for three aspects of forest:

- **Ecological Sensitivity**: Ecologically sensitive areas are defined by means of determined protection zones by state authorities, non-governmental organisations and academic studies. There are many national parks, nature parks and nature reserves which are defined protection zones by state authorities in the light of laws and regulations. Besides, there are also many defined protection zones by the studies of non-governmental organisations. These protection zones are defined by the association of international and national organisations and academic studies of different universities. Academic studies are also used for defining ecological sensitivity.

- **Suitability for outdoor recreation:** For analysing recreational suitability of the area, the initial study was to define required criteria. For this purpose a literature survey is done in order to examine selected criteria for defining recreational suitability in earlier studies. The criteria are gathered from different studies and compared with the properties of the study area and then required criteria are determined. In this stage of the study GIS is efficiently used in order to relate selected criteria with study area, and to make required analyses for selecting recreationally suitable areas.

- **Timber production:** In order to be able to determine areas having high potential for timber production, literature is surveyed and required criteria are defined. GIS analyses are used for the application of defined criteria on the

study area and finally the areas having high potential for timber production are determined.

3.1.2. Decision Making

The second stage of the methodology is decision-making part. In this stage the aim is to provide an efficient decision making process by using two different multi attribute decision rules methods.

For the first method, maximum and minimum circumstances of the area for suitability for recreation and timber production are considered. According to this consideration, six alternatives are generated which are changing in their usage proposals from minimum to maximum. These areas are compared with protection zones. After, it is possible to make suggestions for future usages of the area.

In the second method, the aim is to define ideal areas for both usages; recreation and timber production. By using a GIS and MCDA integrated method, distances of the each pixel to minimum ideal are calculated and ideal areas are defined. After ideal areas for both recreation and timber production are reconsidered according to protection zones. Finally suggestions are done for the study area for the ideal situation.

3.1.3. Comparison and Interpretations

The two multi attribute decision making methods are generated and results of two methods are compared with each other. Similarities and differences between results of two methods are detected. Areas suggested for protection, recreation and timber production are compared. Finally, interpretations are made for the two methods in order to define which one is suitable for what kind of studies. Figure 3.1. shows the framework of the thesis study.

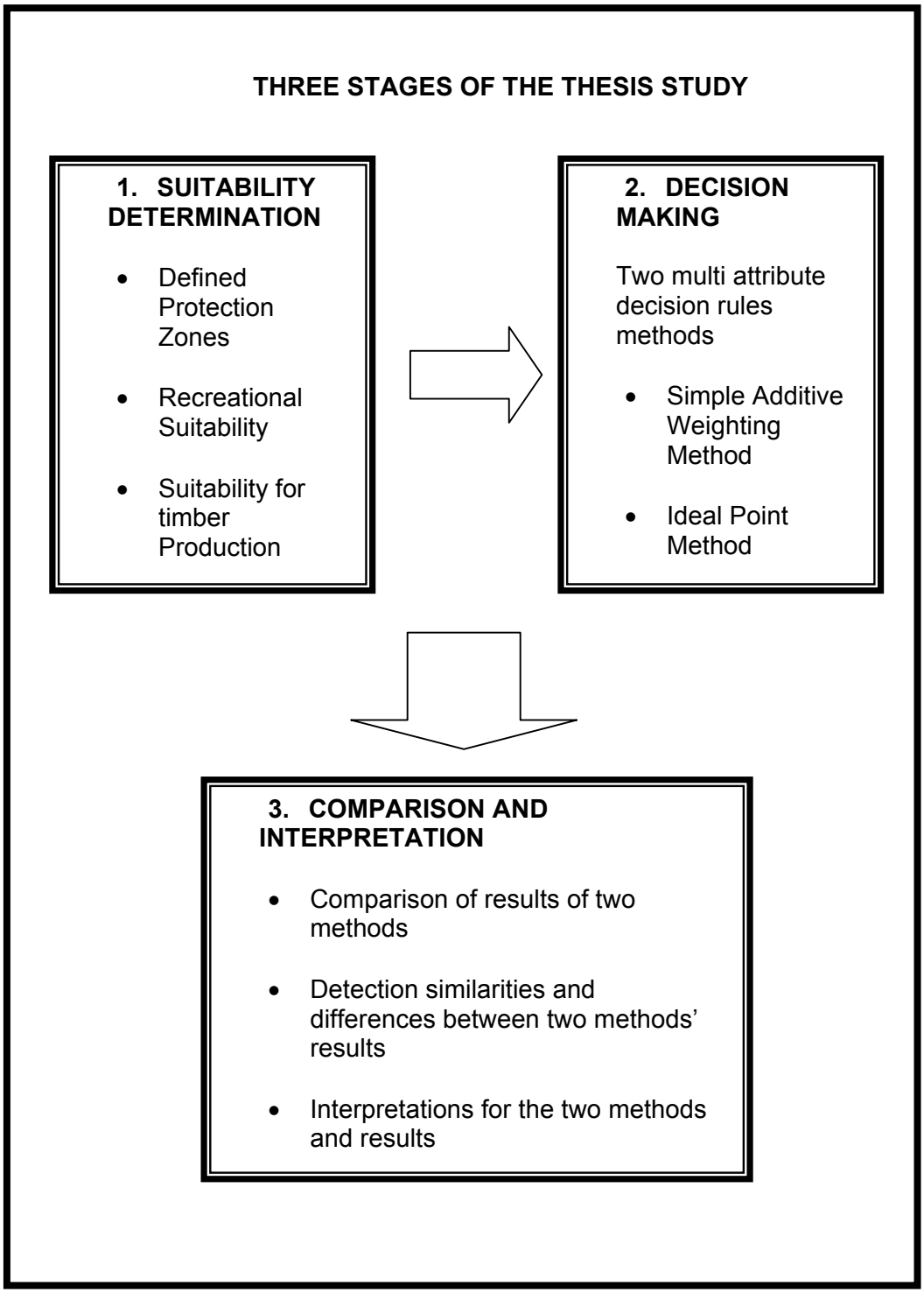


Figure 3.1. Framework of the Thesis Study

3.2. Use of GIS

Geographic information systems (GIS) can be defined as “a system of hardware, software, data, people, organisations and institutional arrangements for collecting, storing, analysing and disseminating information about areas of the earth.” (Chrisman, 1997) It is an excellent tool for relating graphical geographical data with non-graphical data. This speciality provides the opportunity for collecting the information of a specific area together and produce new data by analysing these data.

In the study, data management is provided by using geographic information systems (GIS). GIS is helpful for data storage, spatial analysis and necessary quarries. All the suitability analyses and Multi Criteria Decision Analyses applications are done with the aid of GIS.

In this thesis GIS is initially used for gathering data from different sources together. These data are organised and graphically arranged. But more efficiently it is used for defining potential areas for outdoor recreation and forest production by making consecutive spatial analysis. One other advantage of using GIS is the ability of relating the values, which will be gathered from statistical methods, with graphical data by using their attributes.

Model builder tool of ArcGIS is used for modelling the analyses. Model builder provides to organise consecutive analyses and generate a model from these analyses. The most important advantage of using model builder is that it is possible to see consecutive analyses as a flow chart. By this way, it is easier to follow sequence of the analyses and their results. One other advantage is that, it is possible to save the model in a script mode by using a programming language. All the analyses of the thesis study are done by using model builder tool and these analyses could be presented as suitability models for related studies. In chapter four, more information about model building and flow diagrams of the analyses could be found.

3.3. Use of Decision Making Analyses

Decision making is a difficult and complex process. Many methods have been generated for solution of this problem. In the literature survey part of the study, different studies using different decision making methods are introduced. Malczewski's article in Thill's book (1999) was a good guide to select suitable methods. In this study two Multi Attribute Decision Rules methods are used and comparison between them and their results are done. The main point while using these methods was their possibility to integrate with GIS tools. So, the two methods; simple additive weighting method and ideal point method, are applied with the aid of GIS and the results are compared.

3.4. Data

The data needed for the thesis study is collected from various sources. Collected data was in different formats. Some were hardcopies, some were in different digital format from thesis study's format. So, collected data were first converted into usable format for thesis study. Hard copy maps were scanned and georeferenced into the study georeferencing system (Lambert Conformal Conic). Necessary parts are digitised into shape files. Different formatted vector data are converted into shape files and georeferenced.

For the georeferencing system Lambert Conformal Conic is selected. This system is a conic projection system. This projection is one of the best for middle latitudes. It is best for regions predominantly east-west in extent and located in the middle north or south latitudes. (Kennedy and Kopp, 2000) Study area exists in the middle of north latitudes. It extends at the east-west direction. So, Lambert Conic Conformal projection is suitable for study area. One other reason is that the study area extends a large area which contains two different zones of UTM. In order to overcome this problem, Lambert Conic Conformal projection is used which is also suitable for large areas.

The sources and types of the collected data for this study are shown in Table 3.1.

Table 3.1. Collected Data

Data	Type	Taken From
Boundaries of National Parks and Natural Parks	Map (1/500000 scaled)	General Directorate Forestry
Boundaries of Nature Reserves	Maps (1/5000 scaled)	General Directorate Forestry
Turkey Roads Map	Digital Map	General Directorate of Highways
Boundaries of Key biodiversity Areas	Shape File	Nature Foundation-Doga Dernegi, GIS officer Engin Gem
Endemic Species at the Area	Shape File	GGIT Department, (Demirci, 2005)
Reservoirs of Turkey	Shape File	General Directorate of State Hydraulic Works
Forest data	Vector Data (.rvc format)	GGIT Department, (Tunca, 2003)
Recreationally suitable areas which are defined by Atlas Magazine	Vector Data (.rvc format)	GGIT Department, (Tunca, 2003)
Elevation contours of the area	Vector Data (.rvc format)	GGIT Department, (Tunca, 2003)
Province and district boundaries of the area	Vector Data (.rvc format)	GGIT Department, (Tunca, 2003)
Roads of the area	Vector Data (.rvc format)	GGIT Department, (Tunca, 2003)

3.5. Study Area

For application of the generated method, Eastern Black Sea Region is selected. Eastern Black Sea Region has a very special ecology all over the world. Its vast and dense forests include a wide range of tree types, valuable flora and fauna species and many endemic plants. This fact brings the necessity of protection.

In order to provide sustainability of these properties it is needed to define suitable protection zones and decide necessary regulations for these protection zones.

On the other hand this region also carries great potential for many recreational activities. These opportunities are come from its natural and geological properties. For this reason while proposing places for recreational activities in this region, the extraordinary nature of the area must be considered and protection areas must be defined.

Additionally according to statistics from General Directorate of Forestry this region has the most productive forests for timber production, after Aegean Region (URL 3.1.). So that, these forests also have great potential for country economy. These properties of the area make it very suitable for applying the method on it.

Study area exists at the north east of Turkey. In Figure 3.2. location of the study area on Turkey can be seen. It covers a total 38877 km^2 area. It includes Artvin, Giresun, Gümüşhane, Rize and Trabzon provinces and some districts of Bayburt and Erzurum. Totally 68 districts are included. Boundaries of districts and provinces are shown in Figure 3.3. The boundaries of study area were determined in order to contain existing protection zones (national parks, natural parks and nature reserves) and determined ecologically sensitive areas in the region. Black sea lies at the north boundary of the area. At eastern part; Georgia country boundary, at western part; Ordu and at southern area Eastern Anatolia Region takes place.

Comprising a very large region, the study area exhibits different geological structures, topography, climate and vegetation cover. In the study area, elevation reaches up to 3900 m above sea level. Mean elevation value at the area is 1635 m. Mean slope value at the area is 31%. Since the area have very steep topography it is very rarely possible to see wide plain areas. Therefore, plateaus have an importance in the area and the local people have been developed a plateau culture. So plateaus are important for the region not only being wide plain areas but also with their traditional and cultural properties.

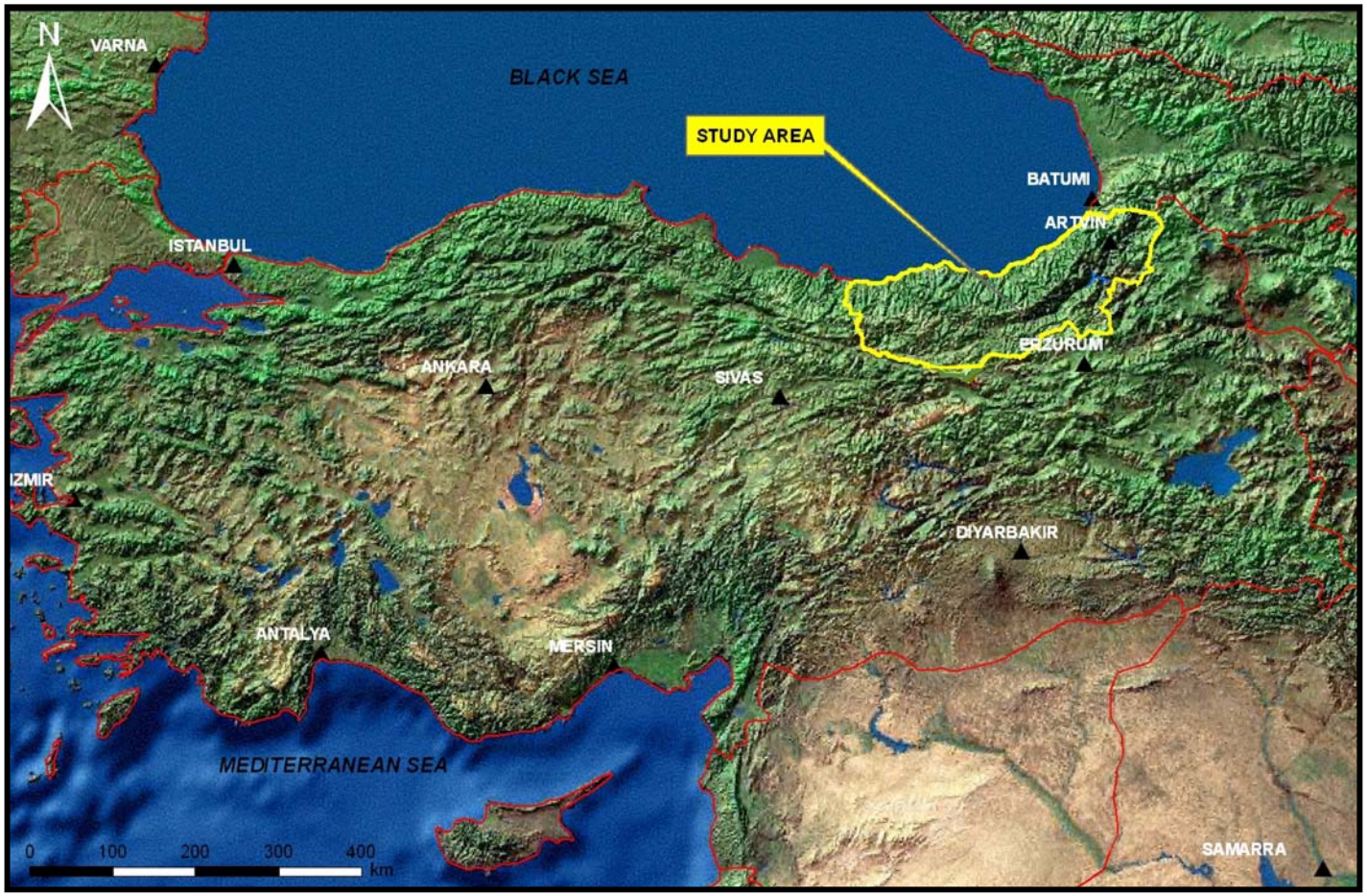


Figure 3.2. Location of the Study Area in Turkey

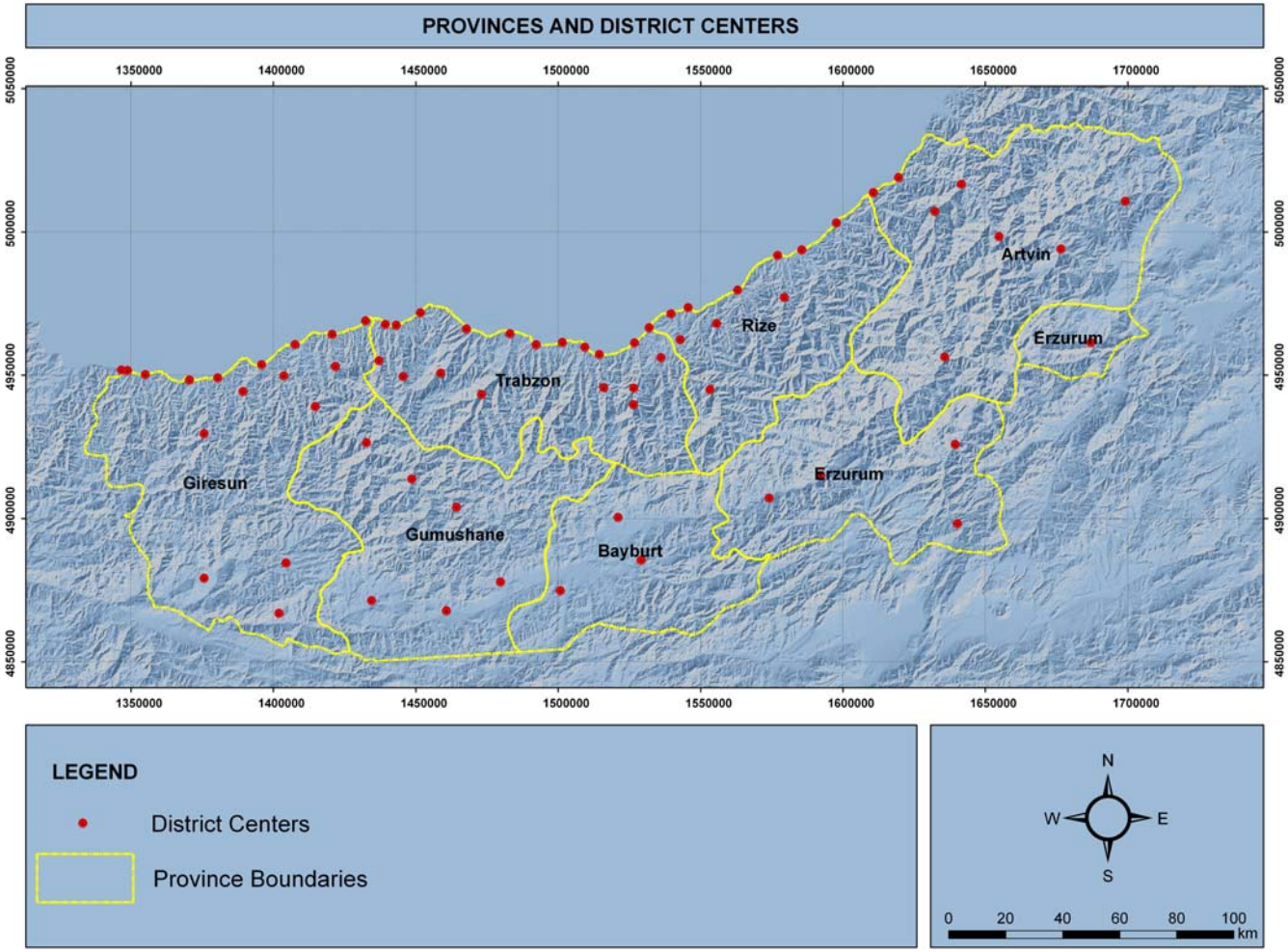


Figure 3.3. Province and District Boundaries of the Study Area

3.5.1. Current Ecological Properties of the Study Area

Eastern Black Sea Region has a worldwide glory. “The region has been determined as one of the 200 prior protection zones all around the world, by United Nations Educational, Scientific and Cultural Organization (UNESCO). A list prepared by WWF shows that there are 100 important sites all around the Europe that two of them, Fırtına Valley and Kırçal Mountains, which are in the Eastern Black Sea Region “. (Tunca, 2003)

According to information from Kurdoğlu (2002), region is one of the three procreation and migration areas of predaceous birds in Northern Hemisphere. Region is declared as one of the 100 important bird areas of Turkey, by Society for the Protection of Natural Life and Birdlife International. Its special vegetation species gave to the region speciality of being one of the 217 endemism areas that are prior for protection. In the report prepared by the support of International Birdlife and Wetlands Foundations, it is specified that the forest of the region is one of the 200 unprotected territorial ecological regions.

“This mountainous ecoregion in northern Turkey is particularly important for its intact forest cover and the diversity of flora and fauna that it supports. Situated south of the Black Sea coastal zone, the western areas support a high diversity of woody species, and the eastern areas host intact stands of old growth forests that provide food and shelter for a wealth of wildlife species.” (URL 3.2)

3.5.1.1. Protection zones defined by state authorities

The region contains four national parks, one nature park and four nature reserves which are determined by state authorities. Areas, declaration dates of these protection areas and the provinces that they are related with can be seen in Table 3.2.

Table 3.2. National Parks, Nature Park and Nature Reserves of the Area

Name and Type	Province	Area (ha)	Declaration Date
National Park			
Altindere	Trabzon	4,800	1987
Kaçkar Mountains	Rize	51,550	1994
Hatila Valley	Artvin	16,998	1994
Kara Göl	Artvin	3,776	1994
Nature Park			
Uzungöl	Trabzon	1,625	1989
Nature Reserve			
Camburnu	Trabzon	180	1993
Orumcek Forest	Gumushane	263	1998
Camili Gorgit	Artvin	491	1999
Camili Efeler	Artvin	1,453	1999
TOTAL		81,136	

Source: General Directorate of National Parks, Game and Wildlife, Ministry of Environment and Forestry

In Turkey, National Park concept was used first time in Forest Law, which was revised in 1956. After that date, ecologically important areas started to be declared as national parks.

“It was gradually recognised that the Forest Law alone could not provide a legal framework of protection for the superior resource values. In 1983, the National Park Law was enacted in response to the needs of protecting the land outside the forest regime that the Forest Law does not cover.” (DOKAP, 2000)

In National Park Law, protection zones are divided into five classes and their properties are defined:

a) National Parks

A National Park is an area that has, from the scientific and aesthetic points of view, nationally and internationally important natural and cultural values. The park is maintained for protecting nature, recreational use and tourism.

b) Nature Parks

A Nature Park is a natural area that maintains a significant vegetation, feature of wildlife and suitability for recreational activities.

c) Natural Monuments

A Natural Monument is a natural area that has characteristics and scientific values brought by phenomenal movements and activities of nature. These areas should be protected within the principles of National Parks system.

d) Nature Reserves

A Nature Reserve is a natural area designated only for scientific and educational purposes, which contains rare, threatened and endangered ecosystems and/or species. A Nature Reserve consists of highest level of biodiversity and natural values while the effects of human activities should be strictly minimised.

Within these four categories, Nature Reserve is the highest protection status where the area consists of highest biodiversity and natural value while the effects of human activities should be strictly minimised. National Park, Nature Monuments, and Nature Park follow, and in the latter three categories, limited human activities are permitted within the balance between protection and human use.

3.5.1.2. Protection zones defined by non-governmental organisations

Besides government authorities many other non-governmental organisations and academicians from several universities have been studying on ecological importance of the region. Definition of key biodiversity areas is one of these studies which is a very comprehensive and reliable one.

Key Biodiversity Areas are those areas which, according to the scientific criteria developed by Conservation International, BirdLife International, and PlantLife, have proven international importance. The identification of such areas in Turkey is conducted by BirdLife International and Doga Dernegi with the support of the Royal Society for the Protection of Birds, UK. The areas are determined with the use of two primary criteria:

Primary Criterion 1: Vulnerability

These areas accommodate substantial populations of threatened species. Whereas most members of threatened species tend toward expanding over large areas, today, due to anthropogenic pressure, they have been confined to isolated geographies whereby they can be easily detached from surrounding areas. For example, the great bustard (*Otis tarda*) was a specie that bred in almost all steppe and agricultural areas of Turkey until the last half century and today is to be found in only 20-30 sites, which generally consist of Anatolia's last steppes or agricultural areas where hunting is relatively less rife. Key Biodiversisty Area criteria utilise information about threatened species in the identification of vulnerable geographies.

Primery Criterion 2: Irreplaceability:

Some sites on earth display characteristics different from those of surrounding areas even without the presence of anthropogenic pressure and these differences usually surface by themselves via natural boundaries. For example, the Salt Lake stands out as a different formation in the middle of the Central Anatolian steppe at first sight. The Salt Lake carries the biogeographic characteristics of a small inland sea and boasts a great many number of plant and animal species not to be found elsewhere in the world. Important fractions of cranes (*Grus grus*), flamingos (*Phoenicopterus ruber*), and the white-fronted goose (*Anser albifrons*) abound around this lake certain times of the year and do not have an alternative in the event that the Salt Lake disappears. In the identification of irreplaceable geographies such as the Salt Lake, Key Biodiversity Area criteria evaluate data pertaining to communities in three categories: narrow-spread species, species endemic to a single biome, and crowding species.

These criteria have been used in the identification of Key Bird Areas around the world. In recent years, the same approach has been employed to other organisms, prime among them plants, to pave the way for the holistic approach of
Key Biodiversity Areas.

Key Biodiversity Areas are determined for only those species and habitats where in-situ protection will be beneficial. In-situ protection is not meaningful for some

species or habitats such as wide-spread mammals or continuous large forest areas. Areas or species of such characteristics do not satisfy the Key Biodiversity Area criteria and necessitate the employment of methods other than area protection for efficient conservation, such as sustainable forestry or environment-friendly development.

There are 266 Key Biodiversity Areas in Turkey. Antalya and Konya are the two richest provinces in this regard. Only 19% of Key Biodiversity Areas are under protection.

In this study, the greater portion of data regarding plants, fish, butterflies, mammals, reptiles, and amphibians has been brought together to identify Zero Extinction Areas in Turkey.

Turkey's internationally significant Key Biodiversity Areas and their boundaries have been researched since the 1980s. Turkey's first Key Bird Areas book was published by WWF-Turkey and BirdLife International (then ICBP) in 1989. Inventories on the habitats of the endangered species of the sea turtle (WWF-Turkey) and Mediterranean seal (SAD-AFAG) have followed this study. Turkey's Key Bird Areas inventory has been reviewed in 1997 by WWF-Turkey and in 2003 by Doga Dernegi. An inventory including Turkey's key butterfly areas was prepared in 2003 by InsectLife International. In the same year, an update on Turkey's key plant areas and sea turtle areas was published by WWF-Turkey. There also exist regional studies on Turkey's key biodiversity areas. These regions which have been studied in detail include the province of Istanbul, the Konya Basin, and Southeastern Anatolia.

In this study, all the above-mentioned inventories have been utilised. Moreover, many experts have provided data to be used for the first time in this study. All data pertaining to endangered plant, fish, butterfly, mammal, reptilian, and amphibian species, which inhabit a single site in Turkey, have been utilised in the creation of

the map. On the other hand, internationally significant areas for the damselfly have also been added to the map. (URL 3.3)

Table 3.3. presents information about names and areas of the key biodiversity areas in the study area.

Table 3.3. Key Biodiversity Areas of the Study Area

Name of the KBA	Code	Area (ha)	Percentage(%)
Giresun Mountains	DKD002	174033,05	4,48
Kop Mountain	DKD004	25451,40	0,65
Coruh Valley	DKD005	68956,62	1,77
Karcal Mountains	DKD006	140317,79	3,61
Yalnızcam Mountains	DKD007	148908,20	3,83
Total study area		3887737,00	100,00

3.6. Current Recreational Usage in the Study Area

“The region provides extraordinary richness with its cultural and recreational sources. Region is named specially as land of monasteries. In Trabzon: Sumela, Santa, Vazelon, Kuştul, in Artvin: İshan and Partal are the most important ones of the historical churches and monasteries in the region. Also the castles, bridges, mansions and the rich folkloric structure (traditional plateau life, plateau and grass cutting festivals in Çamlıhemşin are the notable cultural sources.

Although there are not enough organisations and planning, there is a great potential for recreation in the region. For instance Çoruh River has an international reputation being one of the best rafting areas in the world. Furthermore, there are many rivers which are suitable for canoeing and many racecourses which are suitable for skiing. Among these, the region provides opportunities for hang gliding, mountaineering, trekking, mountain biking, sportive fishing, photo-safari and picnicking.” (Kurdoğlu, 2002)

The area provides many types of outdoor sports having a steep topography and reaching to very high elevations. Mountain climbing, rock climbing, ice climbing, trekking, mountain biking, horse riding...etc. are some of these sports. Especially on

Kackar Mountains there are many trekking and climbing routes which are used by international and national tourists and sporters currently.

The area is also very rich by the means of streams. The most important river basin in the region is Çoruh River Basin. It originates from Mescit Mountains (3225m) and reaches to Black Sea. It has a 466 km length. Çoruh River is known as one of the fastest flowing rivers in the world by any rafting specialist. It passes through spectacular canyons and lush fertile valleys, wonderful natural landscapes, ancient castles and other historic sites. “Some local tour operators organise up five days, 135 km stretch rafting trips on the river, to which tourists from many countries are attracted.” (Study on the Regional Development Plan for the Eastern Black Sea Region in the Republic of Turkey - DOKAP) Especially in may and early June, Çoruh River flow is at its highest.

According to information taken from Kurdoğlu, 2002 and various internet sources existing recreational activities in the region can be listed as:

Nature Walking: Nature walking is divided into two as hiking and trekking. Trekking can be defined as hard nature walking. In this type of walking the walking routes contain steep and rocky areas. Hiking is a sport which is done in more smooth walking routes. In the study area, there are many hiking and trekking routes which are being used by sporters and tourists. The common point of all these routes is that they are strictly related with plateaus. Each route certainly contains a plateau area. This fact shows that plateaus are very suitable areas for resting and camping facilities for this type of sports.

Mountain climbing: With its steep topography the study area contains favourite climbing routes for national and international climbers. Especially Kackar and Vercenik peaks have international favour. As hiking and trekking routes, again plateaus have great importance for mountain climbing serving suitable areas for camping and resting**.**

Canoeing: There are suitable rivers for canoeing in the study area. Ayder creek and Hemsin creek are suitable for this sport having high flow speed. Especially spring and midsummer are best seasons for canoeing in this area.

Photo safari: Study area presents wonderful views. With its vegetation, creeks, falls, glacier lakes and topography the region provides beautiful scenes for photography.

Horse riding: Horse riding is an activity which can be done in plain areas or areas having a smooth topography. For this reason plateaus and surroundings are used for horse riding in the region.

Plateau (culture/Festivals): In the plateaus of the region there are many villages which can be called museum villages. Natural life of the villagers and their foods are being interesting for international and national tourists. Also some festivals are being done in plateaus every year at specific seasons. For this reason plateaus are recreationally very suitable areas for this region.

Hang gliding: This activity is rarely done in the region and generally international tourists are come to the region for hang gliding. In the region the topography reaches to 4000 m a.s.l and it abruptly arises from sea level. For this reason the topography present good opportunity for this activity.

Skiing: There is one ski center in Zigana. However, according to many publications, Ayder and Kavron Plateaus are also very suitable areas for skiing. Also Kaçkar Mountains are referred as one of the priority areas for ski sport. Recently, there is only one ski center in the region.

Picnicking: Picnicking is the most common recreational activity in the region. Especially local people use forest area by daily visits. However there is no planned area for picnicking with forest furniture like tables, sittings, trash barrels or infrastructure like water, lighting, etc.

Camping: There are many groups who come to the area for camping. Generally these groups camp in three main locations. Öküzyatağı which is used for climbing to Kaçkar mountains from north part, Dilberdüzü and Blacksea Lake which are used for climbing to Kaçkar mountains from south part. On the other hand it is known that the camping groups can camp where ever they want. There is no restriction. This situation causes pollution and it is harmful for ecological sensitivity.

Mountain Biking: This sport is being done mostly in recent years, in the region. For mountain biking current roads, forest roads and forest paths are used. There should be regulations for forest roads and paths as signboards for information.

Wildlife observation: Wildlife observation is a very general activity in other countries. In recent years Kaçkar Mountains are used for bird observation and botanic observation. Although Eastern Black Sea Region is very suitable for this kind of activity, there is no enough local guidance and technical planning in the region.

Besides these activities, Table 3.4. shows the places having recreational opportunities in the region. This information is taken from DOKAP (Study on the Regional Development Plan for the Eastern Black Sea Region in the Republic of Turkey, 2000). DOKAP is a regional plan, which was made by State Planning Organisation. It contains the cities Artvin, Gümüşhane, Ordu, Rize, Trabzon, Bayburt and Giresun. In the report, many information about natural, cultural, social and economic conditions of Eastern Black Sea Region.

According to information taken from various sources, the region has a great potential for outdoor recreation activities. Some of this potential is being appreciated by some tourism agencies and sports societies. However there is a lack of recreational organisation in the region. It is an urgent necessity in the region to define recreationally suitable areas in order to orientate current recreational organisations and avoid causing any natural damage.

Table 3.4. Current Recreational Activities in Eastern Black Sea Region

	Artvin	**Giresun**	**Gümüşhane**	**Rize**	**Trabzon**	**Bayburt**
Archaeology/ History	İşhan/ Barhal Yusufeli	GiresunCastle, TireboluCastleAndoz Castle, Espiye Castle	Imerd Monastery	Zil Castle Bala Castle Rize Castle	Sümela, Aya Sophia, Boztepe, Atatürk mans.	Bayburt Castle, Aksar Mound, Aydın Hill
Culture/ Folk Life	Kalfasor Festival (Bull fights)	Aksu Art Festival	Roseshipsyrup Kadırga Festival	Tea Plantation Anzer (honey)	Akçabat Uzungöl	Dede Korkut Festival
Plateau Experiences	Kocabey Veliköy Şavşat	Bektaş Kümbet	Zigana	Ayder	Hamsiköy Hıdırnebi Sultan Murat	
Nature/ Scenery/ Flora&Fauna	Hatilla,Karagöl Sahara N.P. CamiliGörgit, CamiliEfeler		KaracaCave, Artabel Lakes, Torul Tomara Fall,Uluköy	Kaçkar Mountains Çamlıhemşin	Altındere N.P. Araklı, ÖrümcekForest, Çamburnu	Ammonikito Rosso Fossils Sırakaya.Fall
Sports/ Soft Adventure	Çoruh River (rafting)		Zigana (skiing)	Kaçkar M(cimb /trekng)Fırtına Creek,İkizdere (hang gliding)		

Source: Study on the Regional Development Plan for the Eastern Black Sea Region in the Republic of Turkey (DOKAP), 2000

3.7. Current Economic Usage of Forests in the Study Area

Information about current conditions about forests of study area is taken from DOKAP (Study on the Regional Development Plan for the Eastern Black Sea Region in the Republic of Turkey, 2000) and webpage of General Directorate of Forestry.

General Directorate of Forestry presents the annual forest statistics in its internet site. There are 27 Regional Directorate of Forestry in Turkey. Three of them are related with the study area (Artvin, Giresun and Trabzon). Table 3.5. shows 2004 annual statistics for forests of Artvin, Giresun and Trabzon Regional Directorates. Also total Turkey values are given in order to provide comparison.

Table 3.5. 2004 Annual Forest Products Statistics

Regional Directorate	Industrial Wood (m^3)	Percentage (%)	Firewood (Ster)	Percentage (%)
ARTVIN	108.144	1,31	155.195	1,91
GIRESUN	250.775	3,04	138.254	1,70
TRABZON	76.773	0,93	78.040	0,96
TURKEY TOTAL	8.253.277	100,00	8.119.555	100,00

Source: Ministry of Environment and Forestry, General Directorate of Forestry, Forestry Management and Marketing Department 2004 Statistics

Forests of Muğla and Bursa have greatest statistics in forest production. Eastern Black Sea Region comes after these two areas. Although having many tree species and dense forests. Eastern Black Sea Region does not allow gathering too much forest product because of its steep topography. However Eastern Black Sea Region forests provides great potential for forest production in Turkey. For this reason it is necessary to consider this potential while planning Eastern Black Sea forests.

Dominant tree types vary from province to province. In Artvin and Gumushane, coniferous high forests are dominant, while in Trabzon, broadleaved forests represent the largest area. Giresun has almost same area for coniferous and for broadleaved forests, respectively. Rize has the largest mixed forests.
In Table3.6. distribution of tree types in the study area can be seen.

Table 3.6. Forest Area by Type

Unit: ha

	Artvin	Giresun	Gumushane	Rize	Trabzon	Bayburt
High Forest	277650	225388	122549	134230	157487	5205
Coniferous	166368	92218	109177	19019	45224	4808
Broad leaf	52716	96157	4441	46018	73346	97
Mixed	58566	37013	8931	69193	38917	300
Coppice	112799	19922	43110	24187	26589	8959
Total	390449	245310	165659	158417	184076	14163

Source: DOKAP

Major tree species found in the study area are scotch pine and spruce in coniferous trees, and beech, alder oak and chestnut in broad leaf trees. Other tree species include firtree, juniper, hornbeam, poplar, etc. Distribution of tree types in the study area can be seen in Table 3.7.

Table 3.7. Tree types found in Study Area

Tree type	Area (ha)	Percentage
Juniper	52184,26	1,34
Ashen	3067,94	0,08
Fir tree	126655,55	3,26
Hornbeam	23082,27	0,59
Lime tree	449,75	0,01
Larch	275,77	0,01
Poplar	1703,10	0,04
Beech	325628,02	8,38
Chestnut	62877,18	1,62
Alder	63562,69	1,63
Turkish Pine	1353,83	0,03
Spruce	147209,85	3,79
Oak	9014,60	0,23
forest rose	1475,20	0,04
Scotch pine	201802,98	5,19

Some of these tree types carry more potential for timber production. For this reason tree type discrimination of the forest is used as an attribute for assessing timber production potential analyses. In chaoter four more information can be found about potential of tree types.

Forest area has been classified into two categories in terms of condition: normal forest and degraded forest. The degraded forests are defined as the forests affected by human activities such as logging, grazing, forest fire, etc.

Extend of degredation in the study area is shown in Table 3.8. Artvin and Trabzon provinces have relatively well-preserved high forest areas with degraded forest percentage ranging from 30% to 34%.

Table 3.8. Share of Degraded Forest Area

Forest Type	Artvin	Giresun	Gumushane	Rize	Trabzon	Bayburt	Turkey
High forest	33,4	46,9	53,8	66,6	31,1	89,0	42,9
Coppice	93,8	93,1	93,6	100,0	97,9	63,3	72,1
Total	50,8	50,7	64,2	71,7	40,8	72,8	51,9

Source: JICA Study Team based on the primary data from the Ministry of Forestry, DOKAP,2000

As a result, forests in Trabzon are relatively well-preserved while Gumushane, Rize and Bayburt need to pay more attention to forest degradation issues. While selecting areas for timber production, sensitive forests must be taken into consideration.

CHAPTER 4

ANALYSES AND DECISION MAKING

In this study, it is aimed to define suitable areas for outdoor recreation and timber production while considering protection needed areas. In order to be able to define these areas, consecutive analysis must be done. GIS is used efficiently at this stage of the study. The framework of the study consists of three stages. In the first stage the three aspects of the subject is considered.

Ecological consideration is needed because sustainability is an important issue for recreational planning. Since the natural beauties, topographic characteristics and variety of flora and fauna are the main sources for recreational alternatives, it is a necessity to protect these sources and to ensure their longer usage.

In order to extract recreationally potential areas in the study area, some analyses are done according to various defined criteria. Results of these analyses give suitable **recreational** areas for the study area.

Another issue to be considered is the **economic** position of the forests in the study area. Because forests are the only sources for timber and wood production and their economic yield should not be overlooked.

After these analyses, the second stage is decision-making part. For decision making from suitability maps, two different multi attribute decision rules methods are used

separately. Both of the methods are integrated with GIS and then applied. Finally, results of two methods are compared.

The framework of the study is given in Figure 4.1. This figure presents a summary of the thesis study. After examining this figure detailed information about stages of the study can be found in following pages of this chapter.

4.1. Suitability Determination

GIS applications are effectively used for suitability analyses. In order to determine recreational suitability and areas with high timber production potential consecutive GIS analyses are done with the aid of multi criteria evaluation methods. For the ecological consideration of the subject, earlier studies are used and combined.

4.1.1. Determination of Protection Needed Areas

Ecological sensitivity is related with the terms conservation, protection and preservation. Although these terms are known to have the same meanings, in fact they differ from each other by their methods.

'Conservation' has a meaning that contains the activities such as sustaining the existence of natural environment, taking care of it, management, sustainable usage, and restoration of it. 'Protection' means protecting natural sources from variant physical, chemical and biological harm or disease. 'Preservation' is a term that is used to define the activities, which contains the studies to keep a selected area away from human effects. (Kurdoğlu, 2002)

In this study it is needed to define protection zones for the study area. Aim of the study is to define suitable areas for outdoor recreation and timber production while considering the ecological sensitivity. In order to avoid area from physical and biological harm of these activities, it is needed to define protection needed areas initially. For this purpose, following three sources are used for defining ecologically sensitive areas.

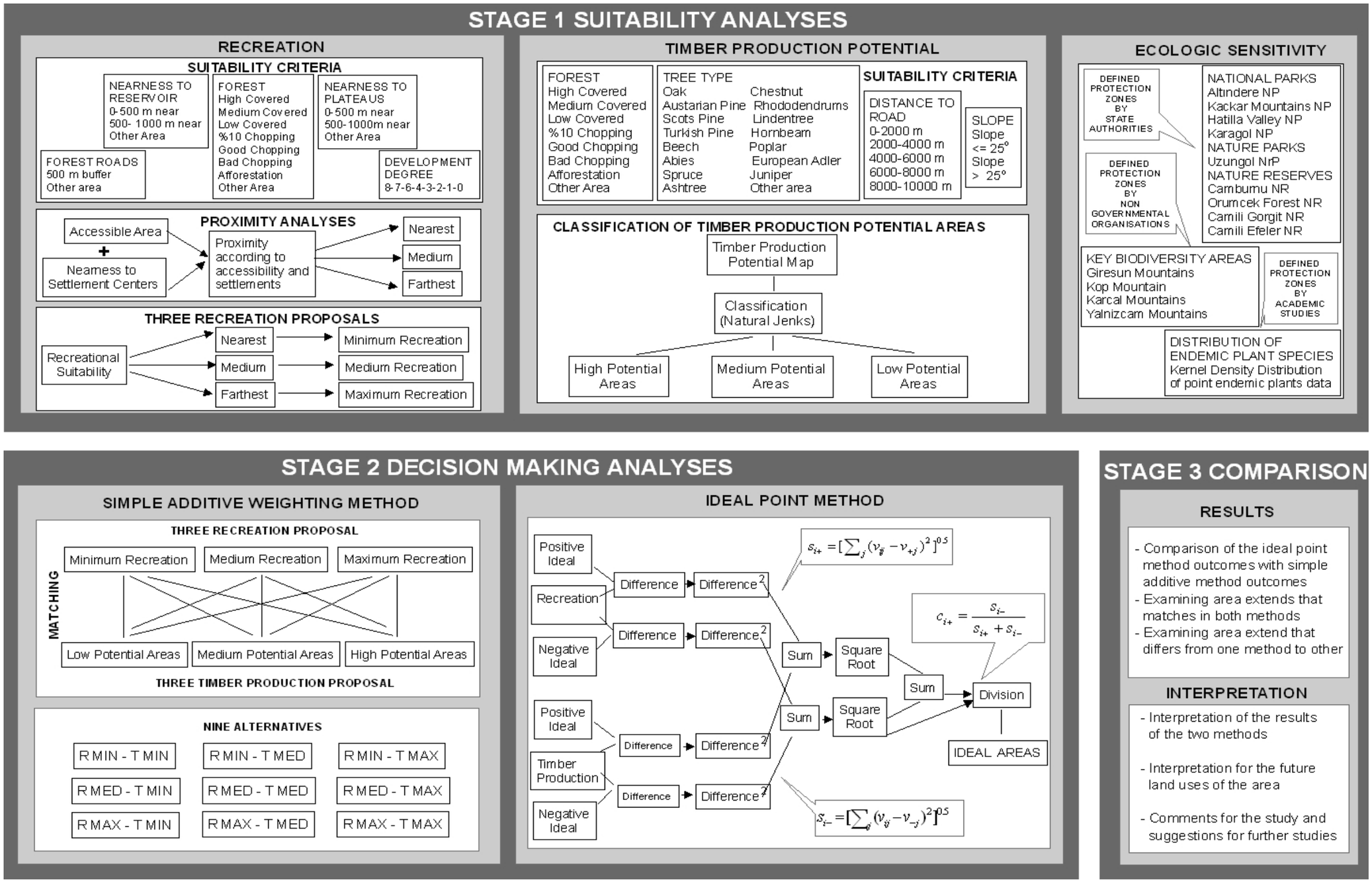


Figure 4.1. Framework of the Study: The Three Stages

4.1.1.1. Defined Protection Zones by State Authorities: National Parks, Natural Parks and Nature Reserves

There are four national parks, four nature reserves and one nature park in the study area. Information about these areas were given in chapter 3. Hard copy maps of these areas are acquired from General Directorate of National Parks. These maps are first scanned, after they are georeferenced. Finally boundaries of national parks, nature parks and nature reserves are digitised. These boundaries formed the first zones for protection of the area.

4.1.1.2. Defined Protection Zones By Academic Studies And Non-Governmental Organisations: Key Biodiversity Areas (KBAs)

Key Biodiversity Areas are the protection zones, which are determined by non-governmental organisations with the aid of academic studies. For this reason they are reliable areas for ecological sensitivity. Information about selecting criteria and studies about key biodiversity areas were given in chapter 3. Boundaries of Key Biodiversity Areas are acquired in shape file form. So they are directly used as the second protection zone for the study area.

4.1.1.3. Existence of Endemic Plant Species

Third protection zone for the study area, include distribution of endemic plant species in the region. So that additional to National Parks, Nature Parks, Nature Reserves and Key Biodiversity Areas, density of endangered endemic species in the study area are used. Endangered endemic species of Turkey are collected in a GIS database and defined in the thesis study “A geographic information systems tool development for geostatistical analysis of endangered endemic vascular plants of Turkey” by Barbaros Demirci. In this study, it is clarified that distribution of these point data for the endemic species, can be displayed best by using Kernel density. For this reason kernel density is applied on the point data, by using ArcGIS density tool. By this way, possible distribution of endemic species is defined.

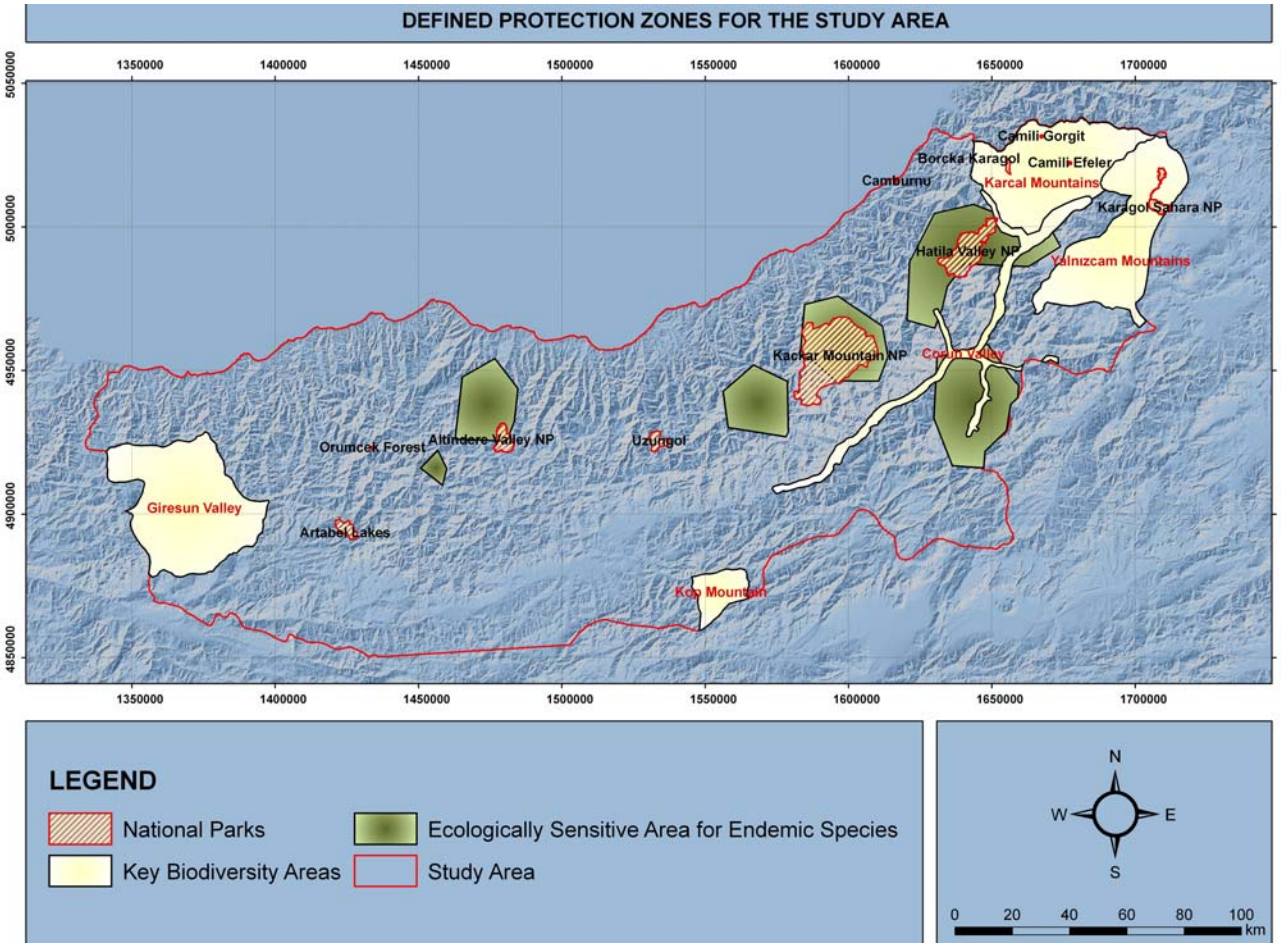


Figure 4.2. Defined Protection Zones For the Study Area

These protection zones are joined and one comprehensive protection zone is defined for the study area. By this way an ecologically sensitive area for the study area is defined. Figure 4.2. displays this ecologically sensitive area for the study area which is used for further analyses.

4.1.2. Analyses for Recreational Suitability

Analysis for recreational suitability is done in two steps. In the first step suitable areas for recreational usage are determined. In the second step, recreationally suitable areas are re-evaluated according to their proximity to settlement centers and accessible areas.

Consecutive analyses are done for creating recreational suitability map. Model Builder tool of Esri ArcMap 9.1. is used for generating these consecutive analysis. Model builder provides graphically modelling framework of the study. That brings easier application of the analyses.

Figure 4.3. shows the flow diagram of the model for recreational analysis. It is possible to follow the sequence of analysis, their results and relationships by examining this diagram.

4.1.2.1. Determination and Evaluation of Criteria

Defining suitable areas for recreational purpose requires initially defining the criteria. For determination of the criteria a comprehensive literature survey is done. As mentioned at literature survey chapter, various criteria are used for defining recreational suitability. In order to be able to select appropriate criteria for the thesis study, all the criteria used in earlier studies are considered. The criteria are searched from two books and four articles. Initially each study's criteria are examined individually. After the most frequently used criteria are selected by also considering the properties of the study area. Used criteria in earlier studies for recreation suitability can be seen in Table 4.1.

Table 4.1. Recreational Suitability Criteria Used in Earlier Studies

	Gunn & Var Tourism Planning, 2000	R.Broadhurst Managing Environment, (2001)	Köchli & Brang (2005)	Yılmaz (2004)	Vries & Goossen (2002)	Banerji et al. (2002)	Nakamura et al. (1995)
Accessibility	X	X	X		X		X
Fauna/ Flora/ Vegetation	X	X		X		X	X
Walking and cycling opportunities, paths,Existing Infrastructure	X	X	X		X		X
Water, Banks & shores	X	X		X	X		
Topography	X	X		X			
Forest characteristics			X		X		X
Soil productivity/ Soil suitability		X				X	
Land use					X	X	
Climate-atmosphere	X	X					
History-ethnicity	X	X					
Plateaus				X			
Nearness to settlements					X		
Tranquillity/ Relief					X		
Aesthetics	X						
Service centers, Development degree	X						

The criteria for recreational suitability which are used for earlier studies can be listed as below:

1- Gunn and Var, 2002

- Water

(suitability for resorts, camp grounds, parks, second homes, cruising, boating, fishing, hunting, historic redevelopment, organization camping, freedom from pollution)

- Topography, Soils, Geology

(Suitability for snow skiing, mountain climbing, hang gliding, scenic viewing, resorts, building construction, scenic roads, photography, freedom from erosion)

- Vegetation, wildlife

(Suitability for parks, campgrounds, hunting, photography, scenic viewing, organization camps, nature trails, second homes)

- Climate, atmosphere

(Freedom from severe storms, excessive humidity, cold or heat, excessive cloudiness, precipitation or fog and pollution, impact of high altitude, suitability for outdoor recreation activities)

- Aesthetics

(Suitability for nature appreciation, scenic beauty, photography, freedom from cluttered, ugly and abused landscape, adaptable to development of resorts, campgrounds, scenic drives, attractive streetscapes for urban activities)

- Existing attractions, institutions

(Extent of present tourism development and its image, extent of parks, marinas, resorts, campgrounds, urban attractions, freedom from dangerous industry)

- History, ethnicity

(Suitability for developing historic and ethnic sites, abundance of customs, legends, foods, crafts, places of prehistoric, historic and ethnic significance)

- Service centers

(Distribution, size and qualities of cities, infrastructure, urban attraction potential, extent and quality of services, downtown potential, accessibility)

- Transportation

(Location, modes and excess capacity, need for new routes, frequency, convenience and market match, distance and access to attractions and services)

2- Broadhurst, 2001

Natural

- List /distribution of species
- Topographical features (slope-aspect)
- Geology (hard and soft)
- Climate (macro, micro; temperature and humidity)
- Hydrology

Cultural

- Archaeology
- History (including social history)
- Myths, legends and stories

Managerial

- Leases and other constraints
- Present uses
- Accessibility
- Risk assessments

3- Köchli and Brang, 2005

Walking, hiking, horse riding and cycling are the most popular activities for outdoor recreation. A survey is applied on walkers, hikers, riders and cyclists. According to results of this survey, the criteria for outdoor recreation area are:

- Forest roads, forest paths
- Forest characteristics (tree type, variety of species and old trees)
- Infrastructure
- Accessibility
- Forest edges

4- Yılmaz, 2004

- Water
- Fauna
- Topography
- Plateau
- Flora

5- Vries and Goossen, 2002

- Nearness to settlements
- Forest
- Accessibility
- Land use
- Tranquillity
- Density of walking and cycling opportunities (forest paths)
- Relief
- Banks and shores

6- Banerjee et al., 2002

- Ecological attribute map (NDVI)
- Land use
- Soil productivity

7- Nakamura et al., 1995

- Geographical characteristics (pleasent scenery, existence of valleys)
- Biotic characteristics (percentage of coniferous trees, age of trees)
- Distance from roads/ accessibility
- The existence of public facilities
- Vegetation

With the help of comparison table, necessary criteria for the thesis study are decided.

After the comparison of the criteria and consideration of the properties of study area, necessary criteria for the thesis study is gathered up under five titles

- Forest,
- Forest paths and nearness to them,
- Existence of reservoirs and nearness to them,
- Existence of plateau and nearness to them
- Social and cultural development degree of settlements

After determining suitability from these five criteria, the suitability map is re-evaluated according to:

- Accessibility
- Nearness to settlements

Forest characteristic was one of the criteria that used in earlier studies. Flora, fauna and vegetation are also supposed to be considered under forest criteria.

Forest roads are directly used as another criterion.

Water element was another criterion used in earlier studies. Reservoirs and surroundings are considered having high potential for recreational activities.

Plateaus and surroundings are determined as another criterion by considering their topographical properties, cultural properties by means of ethnicity.

Development degree is another criterion selected. It includes also existing facilities.

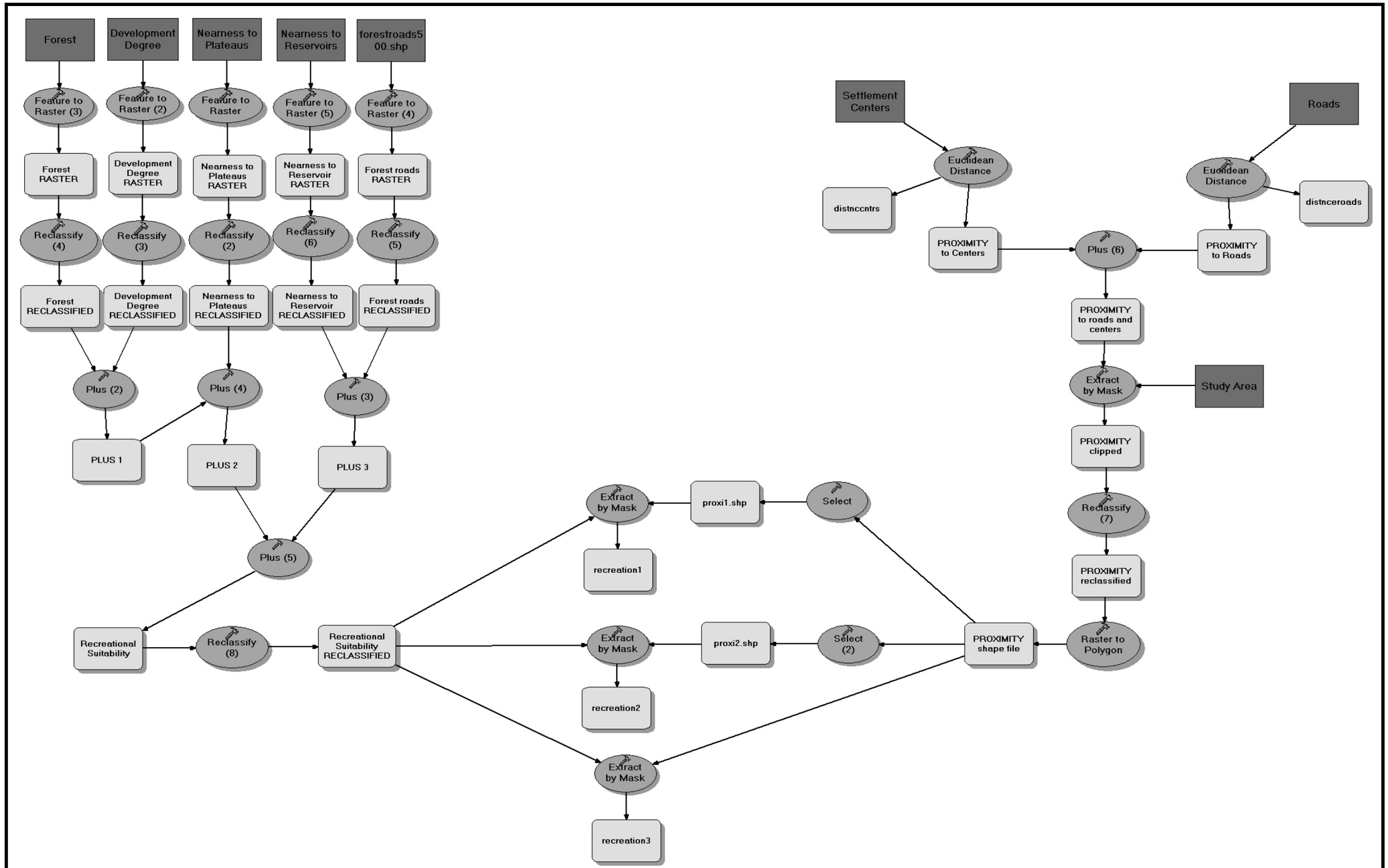


Figure 4.3. Flow Diagram For the Recreational Suitability Analyses

4.1.2.2. Determination of the Recreational Suitability

As seen in the diagram in Figure 4.3. data for these five criteria are prepared and used as inputs for the model. These input data are first converted into raster format by using feature to raster command. Because studying with raster data would be more advantageous in overlay process. It provides to avoid from complexity of many overlayed polygons and many confusing attributes. Secondly, the rasters are reclassified according to subclasses of each attribute and by this reclassification calculated values of each class are assigned. Subclasses of criteria are explained below:

Forest

According to the information, which is taken from forestry engineers in General Directorate of Forestry, forest data is grouped according to density of the trees and diameter of the trees. With this respect, it can be said that this classification gives information about the size, age and density of the forest. Table 4.2. shows sequence of forest classes and their importance rank.

Table 4.2. Forest Classes

forest	importance
high covered	8
medium covered	7
low covered	6
10% chopping	5
good chopping	4
bad chopping	3
afforestration	2
other	1

Forest Roads

Forest roads provide many opportunities for outdoor recreation activities. For this reason they are taken as another criterion. A 500 m buffer is from this roads are used and these areas take value. Table 4.3. shows sub criteria for forest roads.

Table 4.3. Forest roads classes

Forest roads	importance
500mbuf	8
other	1

Water Elements

Water is one of the most efficient elements for recreational activities. Besides providing a better landscape, they also give opportunity for many activities like canoeing, rafting, fishing etc. Lakes, reservoirs, rivers, water falls are the various types of water elements. In this study, waterfalls and rivers, being potentials for nature tourism and rafting, are pointed out at fifth criteria. Reservoirs are taken separately because the area around them should be very suitable to use for recreational purposes. For this reason, nearness to reservoirs is defined as another criterion. The data about reservoirs of Turkey is obtained from State Hydraulic Works' (DSI) map. In this map existing reservoirs, constructing reservoirs and planned reservoirs are displayed. All of them are taken into consideration because constructing and planned reservoirs are also potentials for future usage. 500 m and 1000 m buffers around the reservoirs are derived. Table 4.4. shows distances from reservoir.

Table 4.4. Distances from Reservoirs

distance from reservoir	importance
0-500m	8
500-1000m	5
other area	1

Plateau

At northeast region of Turkey, plateaus have great importance. Since that region has a very steep topology, plain areas are really valuable. Also indigenous people in that region have a traditional plateau culture. Every year at definite session they move to plateaus and live there. Camping near these plateau settlements and sharing and observing that plateau culture, should be an interesting recreational activity. Furthermore, plateaus should be used as camping areas after some activities like trekking, climbing, mountain biking…etc. Therefore Plateaus and areas around them are taken into consideration.

First of all plateaus in the region are determined by using some GIS analysis. By using raster calculator, plains and slight slope areas are selected from slope raster data. In the acquired raster data selected pixels have value 1 and other pixels have 0. By the same way, areas having 1500 m and higher elevation are selected from DEM (digital elevation model). Again in the acquired raster selected pixels have value 1 and others have 0. When these two rasters are added to each other areas having pixel value 2 are the plateaus. In that raster, pixels that have a value of 2 are selected and are defined as plateaus. After selecting plateaus, 500 m and 1000 m buffer analysis are done in order to find suitable recreational areas. Table 4.5. shows classes for nearness to plateaus.

Table 4.5. Nearness to Plateaus

distance from plateaus	importance
plateau	8
0-500m buffer	6
500-1000m buffer	4
other area	1

Social and Cultural Development Degree of Settlements

Study done by Ozyaba (2000) declares that social and cultural development degree of a settlement is really effective on touristic demands. People tend to select safe areas for their recreational vacancies. Although they prefer to go to desolated and natural areas for adventure tourism, they need to know that there is a settlement near them, which they can go or call for help if there would be an accident or any other trouble.

In order to determine social and cultural development degree of settlements, Prime Ministry State Planning Organization had given points to every district according to some defined criteria. These criteria are:

- Retail and whole sale activities and personal services
- Juridical Services
- Health and hygiene services
- Cultural functions
- Tourism and recreational activities
- Educational functions
- Trades services

Table 4.6. shows the degree of the settlements in the study area according to this sequence.

Table 4.6. Development Degree of the Districts in the Study Area

Development degree	importance	Development degree	importance
8	8	**3**	4
7	7	**2**	3
6	6	**1**	2
4	5	**0**	1

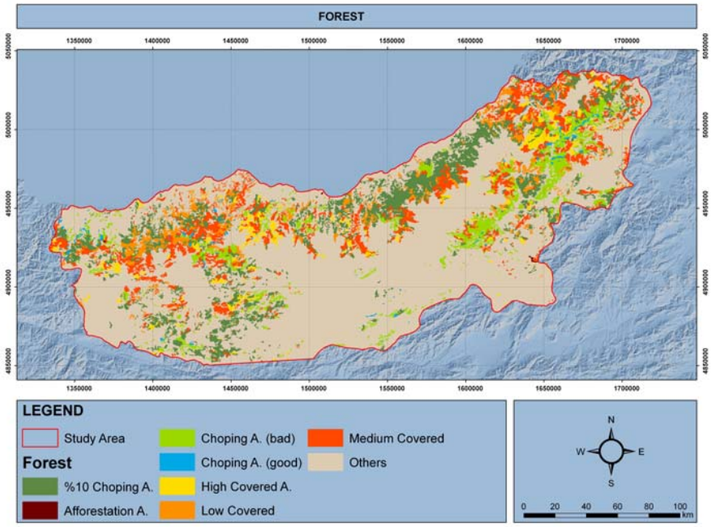
In Figure 4.4. maps of the five criteria can be seen.

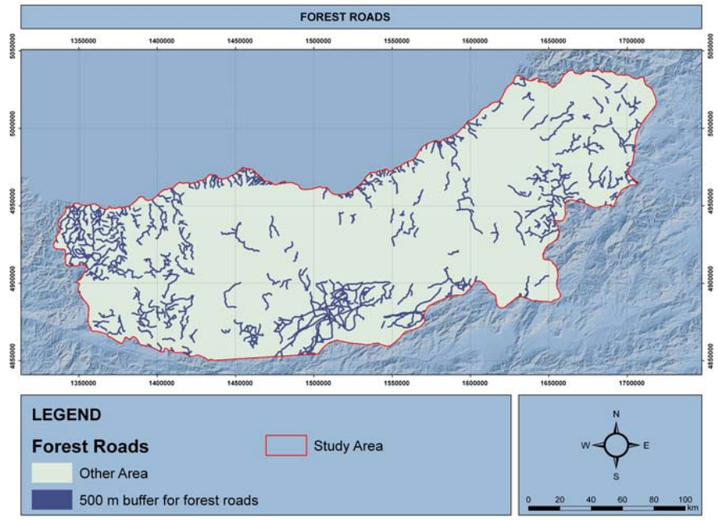
Result map

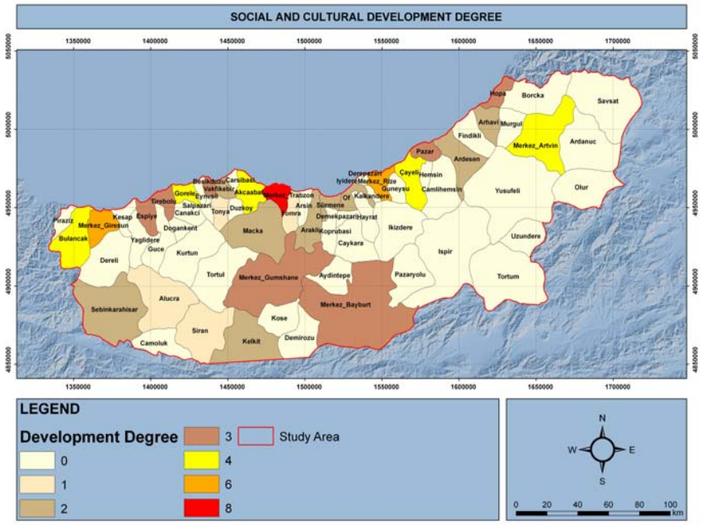
After forming five criteria map with calculated pixel values, five of them are added to each other. Simple additive weighting method is used while determining recreational suitability by using five criteria. Classes of the criteria are weighted by using ranking and rating methods according to properties of the criterion classes. No weight is assigned to criteria because they are considered as having same importance for recreational suitability.

Finally a result map is acquired showing suitable areas for recreational activities according to five criteria.

Figure 4.5. shows recreational suitability map.

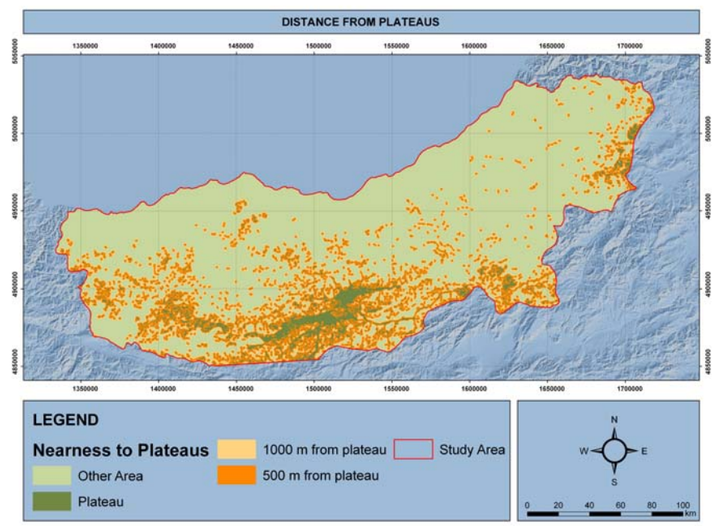






The five criteria for recreational suitability analyses.

- Forest
- Forest Roads
- Development Degree
- Plateaus
- Reservoirs



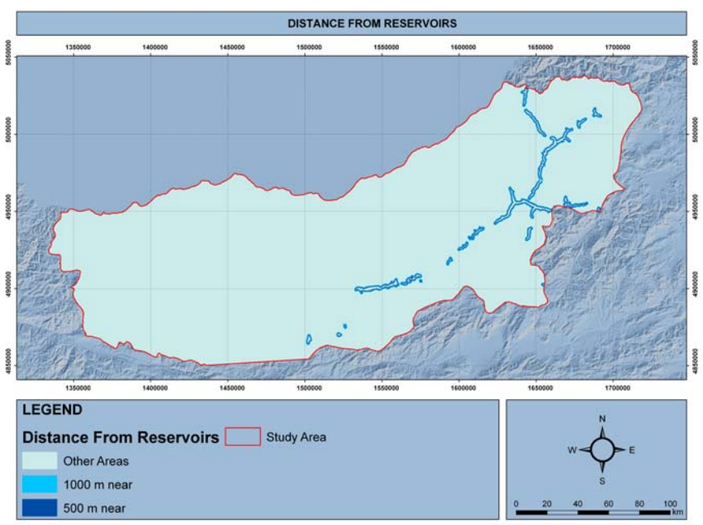


Figure 4.4. Used Criteria for Recreational Suitability Analyses

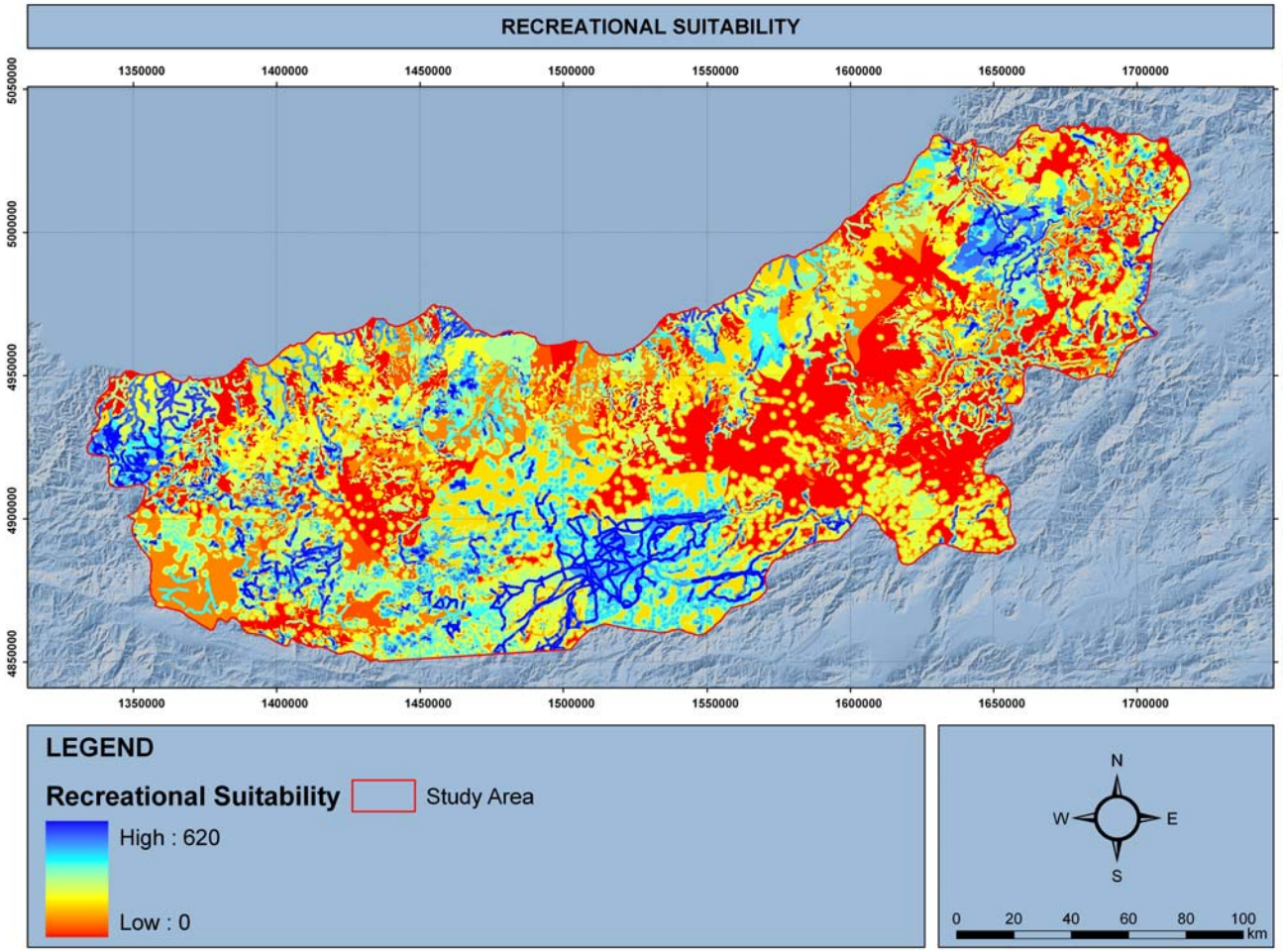


Figure 4.5. Recreational Suitability

4.1.1.3. Evaluating Selected Recreational Areas According to Settlement Centres and Accessibility

Suitable recreational areas are determined but their accessibility and distance to settlement centers, is another issue. A recreational area is a necessity for the people living in town or city centers. They should have an accessible open space area at a specific distance to them. In order to determine areas that needed to be recreational area, proximity analysis are done.

Accessible Area

Recreational area must be in an accessible area. If possible it should be near current roads; if not areas within a specific distance to current roads should be selected. For this reason proximity analysis are done over the road data, to define maximum 10 km distance from roads.

Proximity analyses were done for roads by using allocation cost tool of ArcGIS which makes operation on raster data set. “The cost allocation raster identifies the nearest source from each cell in the Cost Distance raster. It is conceptually similar to the Euclidean Allocation function, in which each cell is assigned to its ‘nearest’ source cell. However, ‘near’ is expressed in terms of accumulated travel cost.” (ArcGIS desktop help)

Distance to Settlement Centers

According to English Nature Recommends; people in towns and cities should have:

- An accessible natural green space less than 300 m from home
- At least one accessible 20 ha site within 2 km of home
- One accessible 100 ha site within 5 km of home
- One accessible 500 ha site within 10 km of home (Broadhurst,2001)

These standards are determined by English authorities by considering English life syle and land opportunities. For the study area distances are determined by considering

social life of indigenous people and natural and topographical properties of area. According to this consideration, in the study area there should be:

- One accessible green space within 10 km of settlement centers, which serves indigenous people and which have opportunities for picnicking and light sport activities like walking, bicycling, sportive fishing ...etc,
- One accessible green space within 30 km of settlement centers, which serves indigenous people and neighbour settlements' people, and which have opportunities additional to picnicking and light sport activities, cultural and natural excursions.
- One accessible green space within 50 km of settlement centers, which serves indigenous people and other tourist from Turkey or foreign countries, and which have opportunities additional to picnicking, light sport activities, cultural and natural excursions, hard sport activities like mountain climbing, rock climbing, trekking, mountain biking...etc. and adventure tourism activities like rafting, caving...etc.

Proximity Analysis

Both distance from roads and distance from settlement centers were added and finally a result map acquired which unites the results of both proximity analyses. In the resultant raster a data was acquired which is sensitive to both settlement centers and roads. In Figure 4.6. results of proximity analysis can be seen.

Union of Recreational Analysis and Proximity Analysis

By making recreational analysis recreationally suitable areas in the study area were selected. But these areas must be re-evaluated according to proximity criteria in order to consider maximum and minimum circumstances of the area for recreation. Results of proximity analysis were reclassified into three classes by using natural jenks method. Selected recreationally suitable areas were discriminated by using this classification. This classification matches approximately 10 km, 30 km and 50 km from settlement centers as mentioned before.

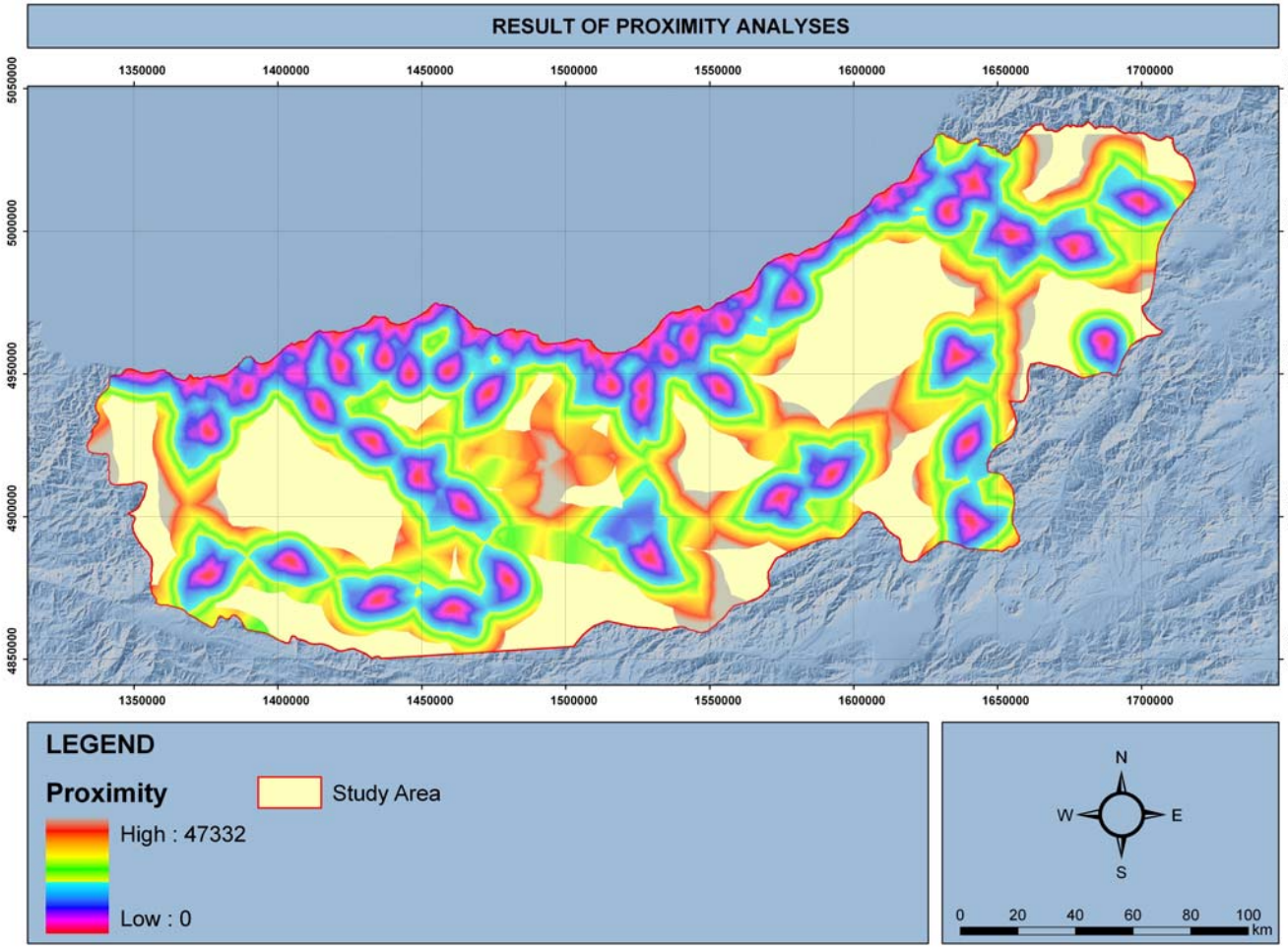


Figure 4.6. Proximity Analyses fFrom Roads and Settlemet Centers

4.1.3. Analyses for Forest Potential by Means of Timber and Wood Production

Besides their natural beauty and suitability for recreational activities, forests are also main sources for timber production. For this reason as a third dimension, productivity of the forest are must be considered. With this respect some analyses are needed to find out timber production potential of the study area. A similar study was done by Nakamura et al, 2000. According to their study:

“This analysis evaluated the forests in terms of their timber production potential. To make the most effective use of timber resources, if the distance from nearby roads was short, and the timber resources were abundant, the forest was considered a "high timber potential forest". Firstly, in computing the magnitude of the timber resources, the types of tree and timber volume were integrated. Considering the types of tree, those types useful as timber (cedar, cypress etc.) were given a high rating value. A rating value for the timber volume was also applied. Next, the slope determined the type of machinery that could be brought in and used, so the forests were divided into those having a steep slope and those with a gentle slope. Also, in order to determine the ease with which forestry equipment could be brought in, the distance from available roads was evaluated. Finally, all of the various values were integrated and the results were organised into five ranks.”

In order to determine potential timber production areas four criteria are defined:

- Density of forest
- Type of trees
- Distance to roads
- Slope

Flow diagram of the model applied for forest potential for timber production is shown in Figure 4.7.

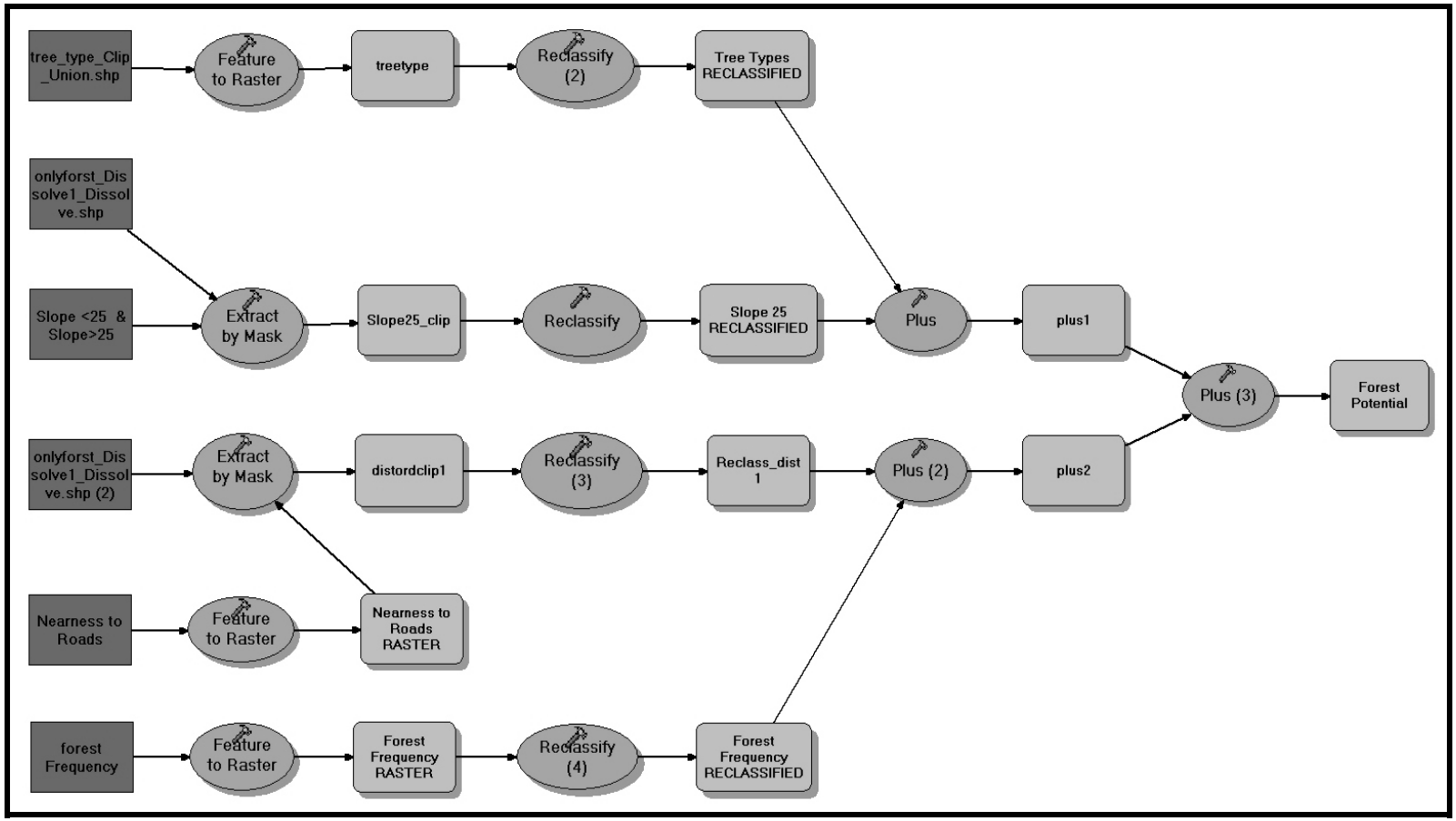


Figure 4.7. Flow Diagram of Timber Production Potential Analyses

For forest potential analyses a different weighting methodology from recreational analyses is used. In recreational analyses criteria are considered as having same importance for recreational suitability, however for forest potential analyses criteria can not be assigned same importance. According to interview with forest engineers in General Directorate of Forestry, the four criteria are ranked according to their importance and then by using pair wise comparison weights are assigned to them. When these weights are multiplied by their rank values, weighted values of classes of the criteria are calculated.

Forest

Density of forest is the most important criterion for determining timber production potential. For this reason it gets a higher weighted value according to other criteria. Table 4.7. shows classification for forest and its weighted values.

Table 4.7. Classification for Forest

forest	Weighted value
high covered	512
medium covered	419
low covered	373
10%choping	280
good choping	186
bad choping	140
afforestration	47
other	0

Types of Trees

As a secondarily important criterion is types of trees. Because some tree types are more suitable for timber production. In order to find out which tree type is more suitable for timber production, statistics of timber production according to tree type are examined. The forest statistics of 2004 are taken from internet site of General

Directorate of Forests. At these statistics annual timber volume that gathered from each type of tree are given. When their percentages according to total annual timber volume are calculated, the results are shown in Table 4.8.

Table 4.8. Statistics for Annual Timber Production According to Tree Type

Tree type	**%**	**Tree type**	%
Cedar	0,455	Oak	26,89
Juniper	0,011	Hornbeam	0,335
Turkish Pine	22,26	Beech	14,31
Other Pine	25,27	Poplar	0,198
Spruce	2,176	Europan Alder	0,085
Abies	5,555	Other deciduous trees	2,055
Other Coniferous trees	0,413	Total	100

By examining percentages of each tree type, their weighted values are determined. Table 4.9. shows the weighted values for tree types.

Table 4.9. Classes for Tree Types

Tree Type	Latin Name	Weighted value	Tree Type	Latin Name	Weighted value
Oak	Quercus	275	Chestnut	Castanea	125
Austrian pine	Pinus nigra	250	Rhododendrums	Rhododendron ponticum	125
Scots pine	Pinus Sylvestris	250	Linden tree	Tilia	125
Turkish pine	Pinus brutia	225	Hornbeam	Carpinus	100
Beech	Fagus	200	Poplar	Populus	75
Abies	Abies	175	European Adler	Alnus glutinosa	50
Spruce	Picea orientalis	150	Juniper	Juniperus	25
Ash-tree	Fraxinus	125	other	other	0

Distance to Road

Distance to road is calculated because it is easier to gather timber at the accessible area. 2, 4, 6, 8, 10 and greater than 10 km areas from roads are determined by proximity analysis and their weighted values are assigned. Distance to roads is the third important criterion for determining timber potential of forest. Table 4.10. shows classes for distance to roads.

Table 4.10. Classes for Distance to Roads

Distance to Road	Weighted value
0-2000 m	74
2000-4000m	61
4000-6000 m	47
6000-8000m	34
8000-10000m	20
10000+ m	0

Slope

Slope is the least important criterion for the timber potential consideration so it gets less weighted values rather than other criteria. But that does not reduce its effect on timber production. It is obvious that it is impossible to study with heavy machinery at very steep slope. So that area divided into two as greater than 25^{o} slope and equal and smaller than 25^{o} slope. Table 4.11. shows classes for slope.

Table 4.11. Classes for Slope

slope	Weighted value
=<25^{o}	138
>25^{o}	0

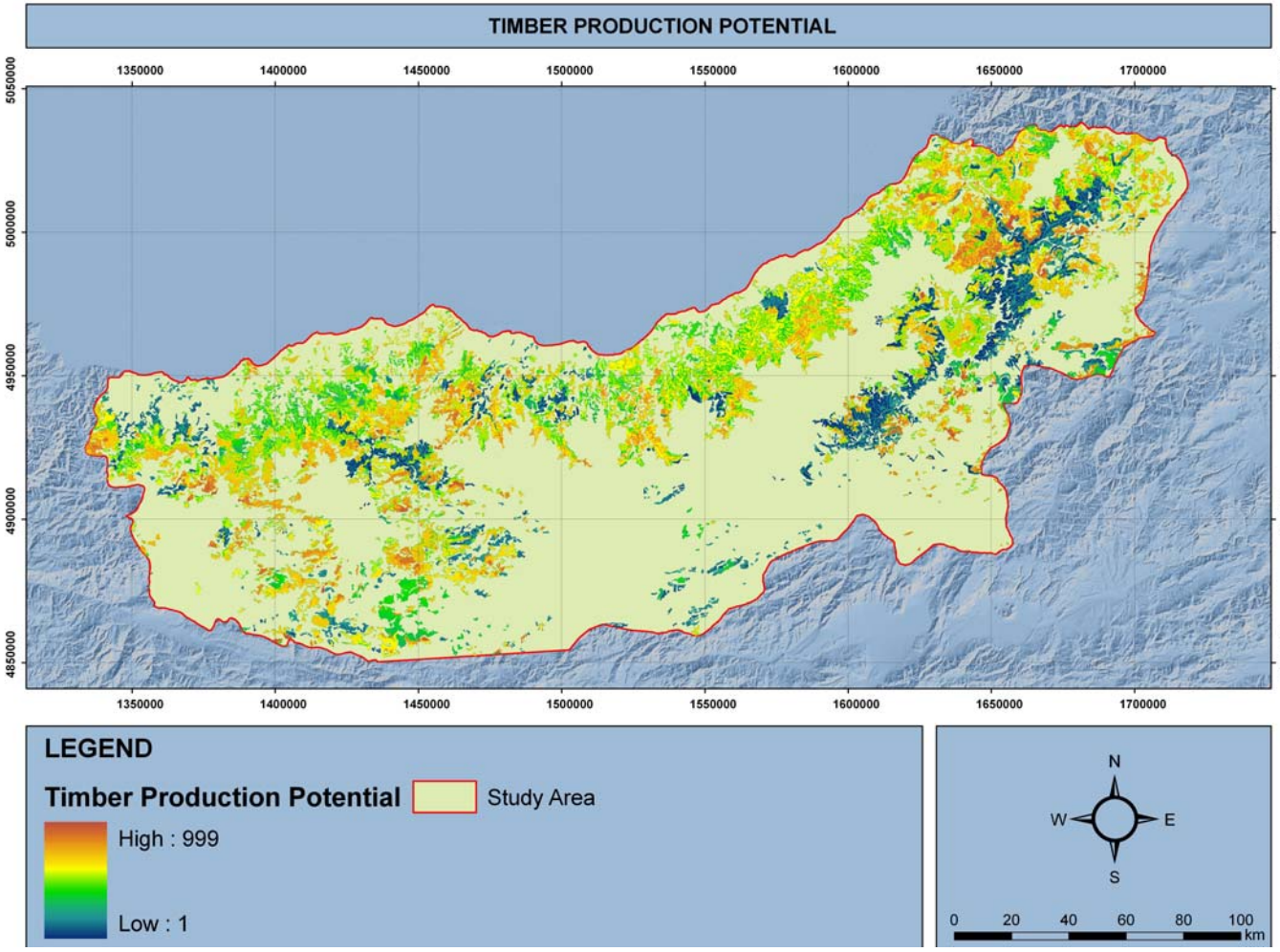


Figure 4.8. Potential Map for Timber Production

Result Timber Production Potential Map

Result values are between 0-1000 intervals. Figure 4.8. shows the results of forest potential analysis. The result raster was reclassified into three classes by using natural jenks method and the area for the first class was taken as timber potential area.

4.2. Decision Making

Decision-making is a complex process, which requires consideration of many evaluation criteria and comparison of them by assessed weights. Many decision-making methods have been generated since 1960s. All the methods are based on same simple basis, determining evaluation criteria and assessing weights to them in order to implement their importance. The larger the weight, the more important is the criterion.

There are many criterion-weighting procedures based on the judgement of the decision makers have been proposed in the multi criteria literature. (Thill, 1999) These procedures are ranking, rating, pair wise comparison and trade off analyses. Table 4.12. shows these criterion weighting methods and their properties.

In this thesis criterion weighting methods are used in recreational suitability and timber production potential analyses. For recreational suitability analyses five criteria are used. No weights are assigned to these criteria because they are considered as having the same importance. However, attributes of these criteria have to be standardized in order to be comparable with each other. For this purpose ranking and rating methods are used according to properties of the criterion. . Attributes of each criterion are ranked or rated and finally values are assigned to them by using its situation according to minimum and maximum values.

For this purpose the formula below is used.

$$x_{j*} = \frac{x_{ij} - x_{i\min}}{x_{i\max} - x_{i\min}} \qquad 4.1$$

In the formula 4.1. :

*Xj** = score of the attribute j

Xij = Jth attribute of alternative i

Ximin = Minimum level attribute of alternative i

Ximax = Maximum level attribute of alternative i

Table 4.12. Criterion Weighting Methods

Methods Features	Ranking	Rating	Pair wise Comparison	Trade-off analysis
Number of judgements	n	n	n(n-1)/2	<n
Response scale	ordinal	interval	ratio	interval
Hierarchical	possible	possible	yes	yes
Underlying theory	none	none	Statistical/ heuristic	Axiomatic/ deductive
Ease of use	Very easy	Very easy	easy	Difficult
Trustworthiness	low	high	high	Medium
Precision	approximatio n	Not precise	Quite precise	Quite precise
Software availability	spreadsheet	spreadsheet	Expert choice	Logical decision (LD)
Use in GIS environment	Weights can be imported from a spreadsheet	Weights can be imported from a spreadsheet	Component of IDRISI	Weights can be imported from LD

Source: Thill, Spatial Decision Making And Analyses,1999

For timber production potential analyses a different method is applied because in this case the criteria did not have the same importance. Importance of the four criteria are determined with the aid of experts from General Directorate of Forestry. After, by using pair wise comparison, weights are assigned to each criterion. Similar to the recreational suitability analyses, attributes of each criterion are valued by using the same formula.

Decision rules are needed to order the alternatives. The best alternative according to decision criteria could only be selected by using any type of decision rules. In this thesis study decision rules are used in order to select best areas for recreation and timber

production according to determined criteria. Two of the decision rules (Simple additive weighting and ideal point methods) are applied to the study. In Table 4.13. properties and used functions of these methods can be seen.

Table 4.13. Comparison of SAW and IP

Methods	Aggregation Functions	Decision Types	GIS-based implementations/ modules
Simple Additive Weighting	Max_i ($\Sigma_j x_j x_{ij}$; $w_j \geq 0$; $\Sigma_j w_j = 1$) x_{ij}=score of attribute j for alternative I; w_j= weight associated with attribute j	MADM - individual DM - Deterministic	Exists IDRISI SPANS
Ideal Point Methods	Min_i $\{[\sum_j w_j^p (x_{ij} - x_{*j})^p]^{1/p}; w_k > 0; \sum_j w_j = 1\}$ X_{ij}= the level of attribute j for alternative i ; X_{*j}= the ideal level of the jth attribute W_j= weight associated with attribute j ; P= a power parameter ranging from 1 to ∞	MADM - Individual and group DMs - Deterministic - Probabilistic - Fuzzy	Exists IDRISI GeoChoice

Source: Thill, Spatial Decision Making And Analyses,1999

4.2.1. Simple Additive Weighting Method

Simple additive weighting method is the most often used method in multi attribute decision rules. It is based on weight assessment to alternatives, which have standardised values. Final scores of the alternatives are calculated by multiplying the weights with standardised values. The last step is addition of the criteria scores.

This method can be integrated with GIS tools simply. GIS overlay capabilities are used in order to apply simple additive method. The method can be applied both on raster and vector.

In this method there are two necessities for attributes: linearity and additivity. “Linearity means that the desirability of an additional unit of an attribute is constant for any level of that attribute. The additivity assumption implies that there are no interaction affects (complementarities) between attributes.” (Thill,1999)

Ensuring these two requirements for attributes is not always possible. For this reason the disadvantage of this method is the necessity to bring all the attributes at the same format or do not use any different format criterion.

In this method calculating the product of weight and factor multiplied with all constraints at any location, and then summing up all products yields a total overall score. The score for each alternative A is:

A = SUM (wi * xi) or A = SUM (wi * xi) * SUM (cj) if a constraint is part of the decision
xi = criterion score of factor i,
wi = weight of factor i,
cj = criterion score of constraint j

In this study, suitability analyses for recreation and timber production potential are done by using simple additive weighting method. After three alternative proposals both for recreation and timber production are generated which differ in their proposal area extend. Matching these three alternatives with each other 9 different alternative proposals are acquired.

4.2.2. Ideal Point Method

Ideal point is a method which provides to compare alternatives according to their separation from ideal point. Ideal point represents the most desired alternative, which consists of ideal weighted standardized levels of each criterion. Ideal point is a

hypothetically desired situation. The closest alternative to this situation is selected as the most suitable one. (Malczewski, 1999)

Separation from ideal point is calculated by using a distance formula:

$$s_{i+} = [\sum_j w_j^p (v_{ij} - v_{+j})^p]^{1/p} \qquad 4.2$$

Also it should be another way to calculate distance from negative ideal. So that maximum distance to negative ideal give the most desired area, in other words “ideal” area.

$$s_{i-} = [\sum_j w_j^p (v_{ij} - v_{-j})^p]^{1/p} \qquad 4.3$$

For the integration of ideal point method with GIS, the technique for order preference by similarity to the ideal solution (TOPSIS) is used. In this technique, the alternative, which is simultaneously closest to the positive ideal alternative and farthest away from negative ideal, is determined as the ideal alternative. It is possible to apply this method by using both vector and raster data structure of GIS. However according to literature it is more applicable for raster data sets. In this thesis study the method is applied on raster data structure. A model is generated by using following steps (Malczewski, 1999):

- The two considerations for the study area outdoor recreation and timber production potential maps are prepared

- For both criteria negative and positive ideals are determined. In other words the most desired situation, which is hypothetical, and the worst situation for that criteria are decided.

- Next step is to calculate separations from these negative and positive ideals. The distance between ideal point and each alternative could be calculated by using Euclidean (straight line) distance metric.

$$s_{i+} = [\sum_j (v_{ij} - v_{+j})^2]^{0.5} \qquad 4.4$$

Similarly distance from negative ideal is calculated.

$$s_{i-} = [\sum_j (v_{ij} - v_{-j})^2]^{0.5} \qquad 4.5$$

This separation is calculated by using consecutive GIS analyses on raster data set.

- Final step is to calculate relative closeness to ideal point (c_{i+}) using the equation:

$$c_{i+} = \frac{s_{i-}}{s_{i+} + s_{i-}} \qquad 4.6$$

In Figure 4.9. flow diagram of these calculations on raster data sets can be seen. As a result of ideal point method, a map is acquired which substitutes maximum distance to negative ideal and simultaneously minimum distance to positive ideal. This raster have values in 0-1 interval where values closer to 1 show ideal area. Figure 4.10. displays result raster of ideal point method.

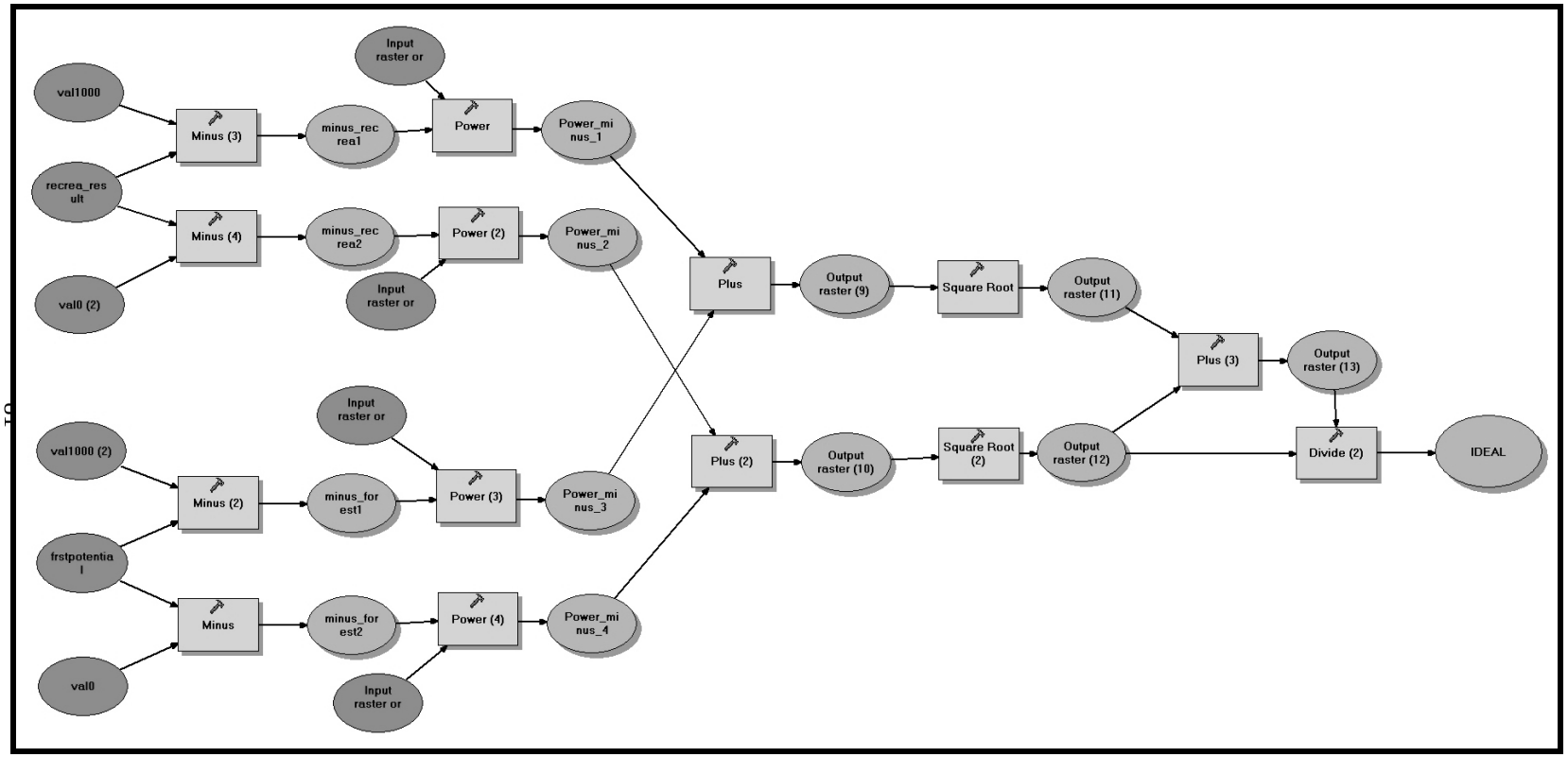


Figure 4.9. flow Diagram of the Application of the Ideal Point Method in GIS

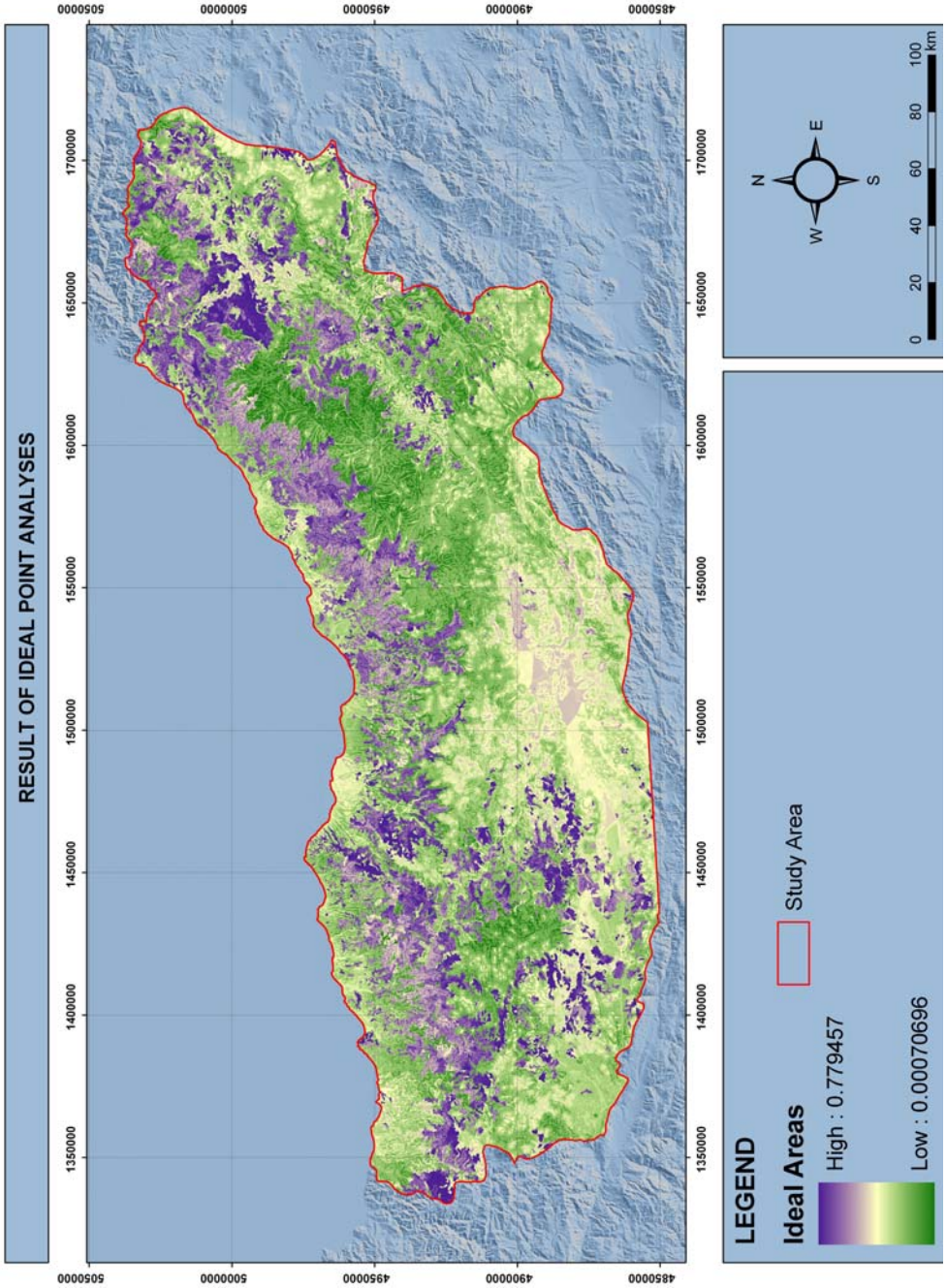


Figure 4.10. Result of Ideal Point Analyses

CHAPTER 5

RESULTS AND DISCUSSION

Decision making in multi purposed areas is a difficult process, which requires consideration of many aspects of the subject. In this study a methodology is proposed for decision-making in multi purposed areas. Eastern Black sea region was selected for application of the methodology. Having an extraordinary nature and vast forests this region was very suitable to be taken as a sample for multi purposed areas.

The methodology used in this study includes three stages. The first and second stages were described in earlier chapters. These stages are composed of *suitability* analyses and *decision making* analyses. The third stage of the study includes *comparison* part.

In the third stage of the study comparison of the two results from simple additive weighting method and ideal point method is done. Results of the two methods are compared according to extends of areas proposed. Finally interpretations are done for the two methods and their results.

5.1. Comparison of the Results of the Two Multi Attribute Decision Rules Methods

In order to compare outcomes of the two methods, initially outcome map of ideal point method is reclassified into three classes by using natural jenks method. By this way the area is divided into three as:

- Ideal area,
- Near ideal area and
- Far to ideal area

Ideal areas substitute the most desired area by means of recreation and timber production.

Figure 5.1. shows these three classes of ideal point method.

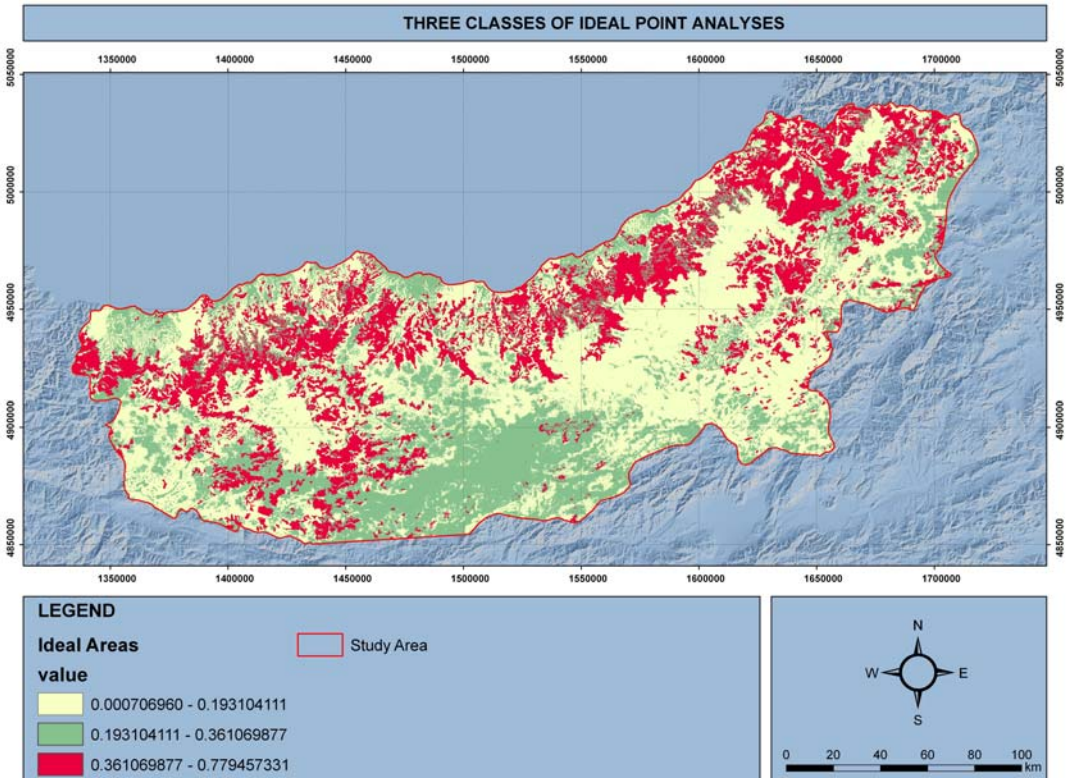
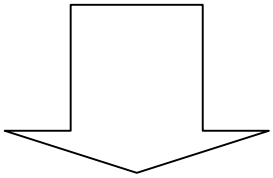


Figure 5.1. Three classes of ideal point method

Secondly nine alternatives, which are acquired from SAW method, are arranged in order to be compared with ideal point method. Nine alternatives are generated by matching three timber production alternatives (minimum, medium, maximum) with three recreation alternatives (minimum, medium, maximum). Desired areas both for recreation and timber production are taken from these alternatives. As seen in Figure 5.2. nine alternatives are ranked from maximum conditions to minimum conditions. Figure 5.3. shows maps of these alternatives.

MATCHING

RECREATION		TIMBER PRODUCTION
Maximum		Maximum
Medium		Medium
Minimum		Minimum



NINE ALTERNATIVES

Maximum recreation & Maximum timber production	Maximum recreation & Medium timber production	Maximum recreation & Minimum timber production
Medium recreation & Maximum timber production	Medium recreation & Medium timber production	Minimum recreation & Medium timber production
Minimum recreation & Maximum timber production	Minimum recreation & Medium timber production	Minimum recreation & Minimum timber production

Figure 5.2. Matching for alternatives

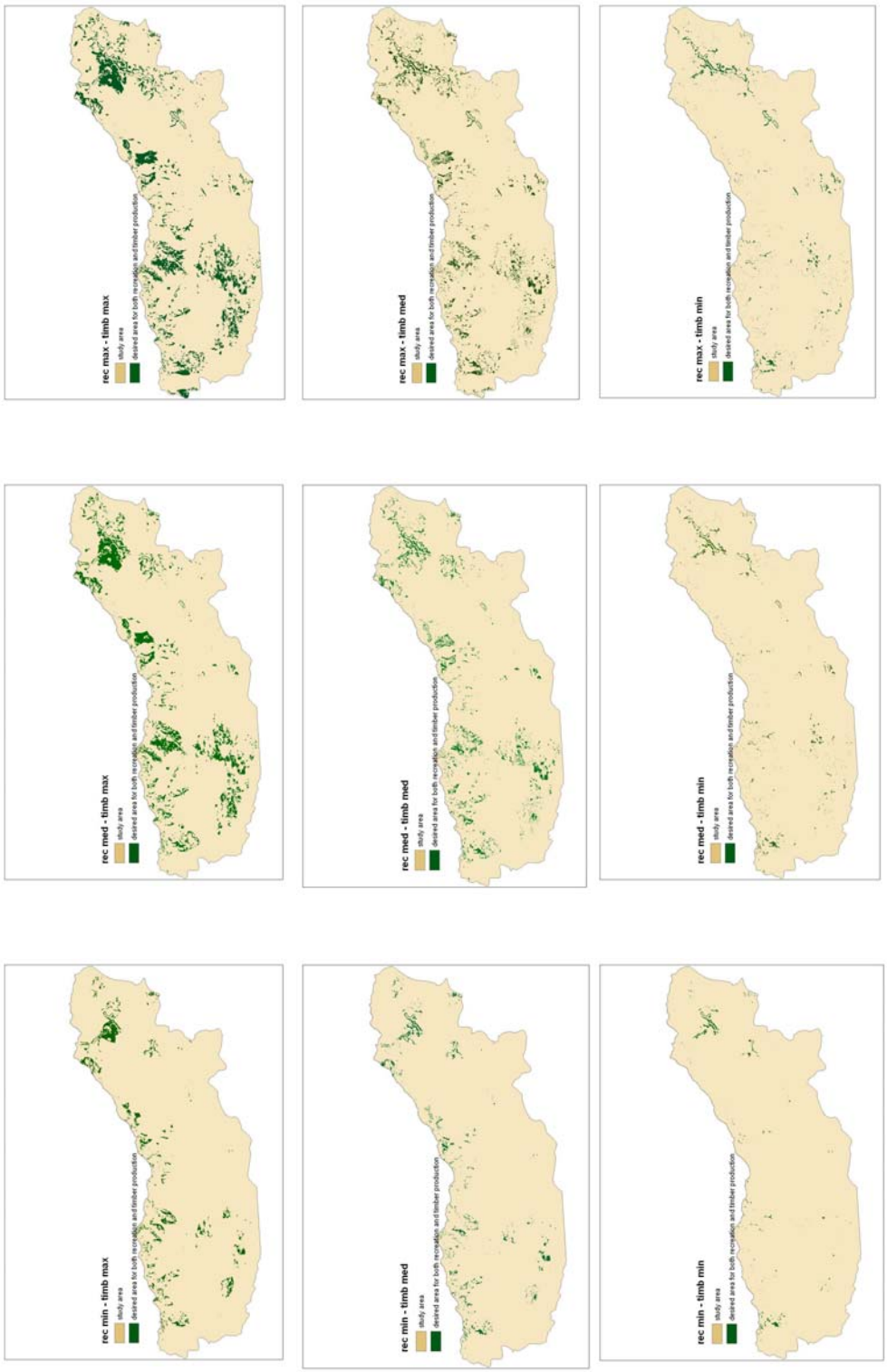


Figure 5.3. Nine alternatives acquired from saw method

Each of the alternatives is compared with three classes of the ideal point method separately. After areas that are matching for both methods are calculated. These areas and their comparison can be seen in Table 5.1. In this table recreation and timber production matching of alternatives are clipped with first, second and third classes of ideal point method.

Table 5.1. Matching areas for both methods

		rmax-tmax		rmax-tmed		rmax-tmin	
		area (ha)	%	area (ha)	%	area (ha)	%
ideal	1. Class	322063	82.4	119477	63.6	4633	7.4
ideal	2. Class	60450	15.5	60030	31.9	49594	79.2
ideal	3. Class	8496	2.2	8475	4.5	8371	13.4
	Total	391009	100.0	187982	100.0	62598	100.0
		rmed-tmax		rmed-tmed		rmed-tmin	
		area (ha)	%	area (ha)	%	area (ha)	%
ideal	1. Class	265243	83.4	100037	65.6	3808	8.0
ideal	2. Class	47246	14.8	46881	30.7	38177	80.2
ideal	3. Class	5691	1.8	5666	3.7	5598	11.8
	Total	318180	100.0	152584	100.0	47583	100.0
		rmin-tmax		rmin-tmed		rmin-tmin	
		area (ha)	%	area (ha)	%	area (ha)	%
ideal	1. Class	105070	81.0	45183	64.8	1787	8.2
ideal	2. Class	22719	17.5	22566	32.4	18133	82.9
ideal	3. Class	1968	1.5	1963	2.8	1952	8.9
	Total	129757	100.0	69712	100.0	21872	100.0

By examining Table 5.1. It can be seen that the three alternatives matching with maximum timber production, are closer to ideal point results. Because over 80 % of their area exists in the first class of ideal point method and the first class of the ideal point method substitutes to the ideal areas. Generally matching percentage of areas with third class of ideal point method, which substitutes farthest area from ideal, is very small (maximum 13%). This fact should demonstrate the similarity of the results

of two methods. However, for the matching areas with second class of ideal point method, it is not possible to see the same result. It is seen that alternatives matching with the minimum timber production areas, have over 80 % of their area in the second class of ideal point method. If ideal areas are taken into consideration these three alternatives which are matching with minimum timber production, are not reliable.

From these nine alternatives the best matching one is “medium recreation – maximum timber production” alternative. From this result it is understood that, medium recreation-maximum timber production alternative presents the closest situation to ideal areas. According to ideal point method, this alternative can be chosen for the study area.

5.2. Comparison of the Two Methods’ Results With Protection Zones

By using simple additive weighting method and ideal point method the area is examined according to recreational suitability and timber production potential. In order to provide sustainability of these activities ecologically sensitive areas must be taken into consideration too. For this purpose, protection needed areas were defined according to earlier studies done for ecological sensitivity. Three sources are used for this definition;

- Boundaries of current protection zones which are defined by state authorities
- Ecologically sensitive areas defined by non-governmental organisation with the aid of academic studies
- The academic study about endemic plant species and their distribution

Boundaries of these three sources are combined and one ecollogically sensitive area is defined for the study area. This protection needed area is overlayed with the results of two methods. Extends of matching areas are calculated.

Result maps of two methods are also compared with existing national parks. National parks are not strict protection zones. They are also currently used recreational areas for the region. However national parks are not determined by detecting only natural and topographical properties. For instance, determination of

Altındere Valley national park mostly relies on existence of Sumela Monastery. Although selecting criteria of national parks could differ from this study, being currently used recreational areas national parks are used for interpretation of the results.

In Figure 5.4. matching areas with result of ideal point method and protection zones and separately with national parks can be examined. Extends of these matching areas are presented in Table 5.2.

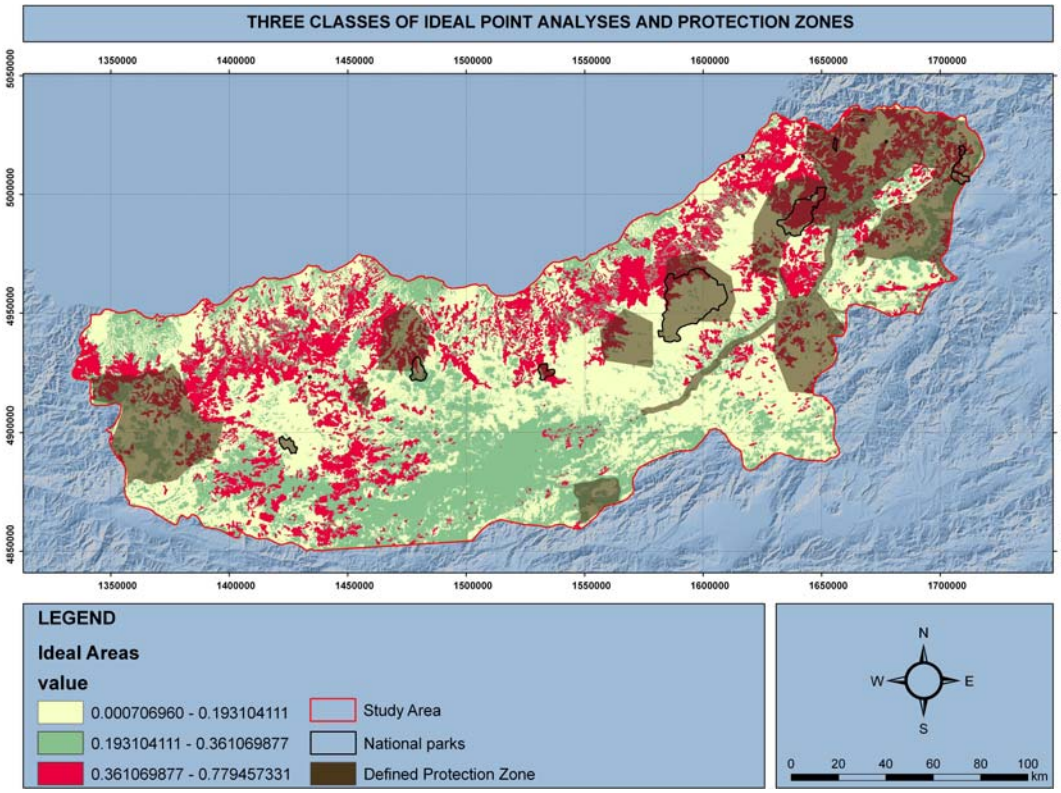


Figure 5.4. Comparison of Ideal Point Method Results with Protection Zones

Table 5.2. Comparison of Ideal Point Method Results with Protection Zones

	Matching Ideal Areas	Total prot. Zone/ total NP	% for total prot. zone	Total Ideal area	% for total ideal area
Protection Zones	433052 ha	901824 ha	48%	902037 ha	48%
National Parks	52165 ha	82480 ha	63%	902037 ha	6%

Comparison of ideal point method results with protection zones shows that nearly half of the ideal area is in protection needed area. In fact this is not so surprising because the region has an extraordinary nature and vast extends of areas are defined as ecologically sensitive areas. While determining activities for these areas for recreation or timber production, detailed etudes are required. For these areas protection should be the first aim, secondly recreation and timber production should be thought. In these areas recreation and timber production activities should be in minimum levels.

Only 6 % of total area of ideal areas is matched with national parks. However 63 % of existing national parks are matching with ideal areas. It can be interpreted from that, in the region there are many other areas than national parks, which are suitable for recreation. On the other hand, majority of the areas of existing national parks is matching with defined ideal areas in this study.

Alternative of medium recreation-maximum timber production matching was the closest one to ideal areas. For this reason this alternative is compared with protection zones. Figure 5.3. displays this comparison. More information about extends of matching areas can be found in Table 5.3.

According to comparison of the closest alternative to ideal area and protection zones 12 % of defined protection zone is matching with areas which are suitable for recreation and timber production. This 12 % part of the region should be examined more carefully. Ecological sensitivity of this area should be defined in detail. According to this definition only suitable activities for recreation and timber production should be permitted in this areas.

When the area is compared with national parks, it is seen that there is a little matching between national parks and suitable areas for recreation and timber production. That can be explained by considering the areas of the alternative map not only recreational proposal. Because defined areas in the alternative map are stand for suitable areas both for recreation and timber production. For this reason they may not be matching with existing recreational areas mostly.

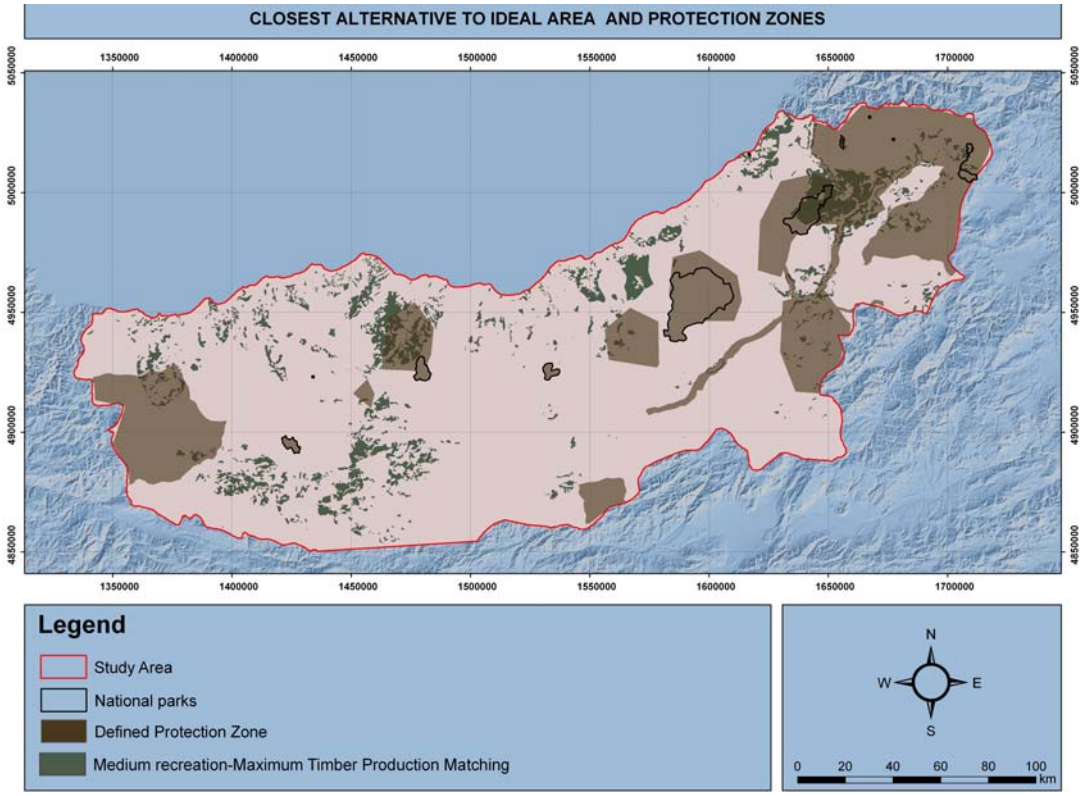


Figure 5.5. Comparison Of The Closest Alternative To Ideal Area And Protection Zones

Table 5.3. Comparison Of The Closest Alternative To Ideal Area And Protection Zones

	Matching areas with alternative rmed-tmax	Total prot. Zone/ total NP	% for total prot. zone	Total Ideal area	% for total rmed-tmax
Protection Zones	103298 ha	901824 ha	12%	902037 ha	12%
National Parks	11184 ha	82480 ha	14%	902037 ha	1.2%

5.3. Discussion

This study provides a general decision for large areas where there is multi purpose. As a result of the study, areas which are suitable for outdoor recreation and timber production are defined. These suitable areas are compared with defined protection zone in order to provide protection of ecologically sensitive areas and sustainability of the properties of the area.

Simple additive weighting method is a frequently used method for suitability or site selection analyses. It was also a suitable method for this study with its simplicity and efficiency. It is easy to apply simple additive weighting method within GIS. Each criterion of the simple additive weighting method is shown as a GIS layer. Then it is possible to overlay these layers with their assigned values. Although this is a frequently used method for GIS studies, in some steps of the method, it is needed to arrange the data in order to be applicable for GIS usage. This method is a conventional method which has been used in many studies.

Having a newer sight of view, ideal point method is used as another type of suitability analyses. Outcomes of this method are areas which are ideal for two aspects of a subject. By using ideal point method, ideal areas according to outdoor recreation and timber production are defined. Integration of ideal point method with GIS is efficiently provided. It can be said that this method is more applicable for GIS studies. The data first arranged in raster format in order to be suitable for the method. The method is applied on raster data, by this way calculations can be done by using pixel values. Once the method is built up, and then the results are obtained easily.

The two methods are different in nature but outcomes of the two methods have great similarity. There are specific areas that are proposed both in two methods. One of the methods (ideal point method) is found easily applicable in GIS. For further studies it should be possible to compare other types of multi attribute decision rule methods, in order to test their capability for integrating within GIS.

Importance of protection zones should not be underestimated. Presented areas which are both suitable for recreation and timber production and which are also in

a part of protection zone, should be examined more carefully. Detailed studies should be done for these areas before proposing any type of activity. In this study, analyses are done for recreational and timber production suitability. Ecologically protection needed areas are defined and compared with selected suitable areas for recreation and timber production, but they are not taken into analyses in the methodology. In further studies methodologies can be generated which are also analyzing ecological sensitivity.

In this study, criteria for suitability analyses are determined according to literature survey and information taken from experts. In this context defined criteria for recreational analyses and timber production analyses are thought to be sufficient for determining general areas. However, when topographical properties of the study area are considered, this region has high risk of landslide. For this reason in determining recreationally suitable areas, landslide risk should be one of the criteria to be considered in the methodology. The General Directorate of Disaster Affairs have a study about landslides in Turkey. In the study, earlier landslides are processed but risky areas are not determined. For this reason the data is not used in this thesis. Further studies should consider landslide risky areas, in order to process in recreational suitability analyses.

In the recreational suitability analyses, proximity analyses are used, in order to select suitable areas which are accessible and near to settlement centers. Proximity analyses are done by using euclidian distances. For further studies, it should be possible to classify road data according to properties of roads and slope. Especially for the rough terrains like this study area, this analyses should be very useful. By this way, instead of euclidian distance, time cost should be considered for proximity analyses.

The assessment of the results could not be performed due to the lack of necessarry data. A site visit can provide data in order to assess the results obtained in the study.

CHAPTER 6

CONCLUSION

Decision making in multi purposed areas is a difficult process. It requires consideration of many aspects of the subject. At the beginning of the study it was aimed to provide a solution for multi purposed areas. Forest areas are multi purposed areas which are needed for three usages. These usages are outdoor recreation by means of social needs, timber production by means of economic benefits and protection in order to be able to provide sustainability of these two usages. It was aimed to solve the problem of managing a forest area and surroundings in an efficient way. For this purpose it is needed to define suitability of areas for the three usages initially.

Outcomes of the study presents suitable areas for outdoor recreation and timber production while considering the protection needed areas. Furthermore suitability analyses are done by using two different multi attribute decision making methods. Using two different methods provides the comparison of the results. By this way a more reliable result is acquired. The ideal point method is not only used for comparison of the results. Results of this method also provide evaluation of alternatives of the simple additive weighting method. One of the alternatives was proposing very closer areas to ideal areas. For this reason it is selected as the final proposal map of the study.

The results acquired from this study and proposed methods for determination of recreational and timber production potential areas in this study, provides useful information for decision makers who study in multi-purposed forest areas. These information are also useful for forest management studies.

After concluding the study, it is interpreted that for decision making for future usages of an area, the initial study should be identification of ecologically sensitive areas. For this purpose defined protection zones by state authorities, such as national park, natural park and nature reserve should be considered. However in this study it is seen that considering only these protection zones would not be enough. There are many other ecologically protection needed areas in Turkey which are defined by non-governmental organisations and academic studies. It would be useful to investigate if there is any such defined protection needed area, in the area of interest.

In this study a comprehensive literature survey is done for determination of required criteria for recreation. This literature survey shows that there are international criteria which can be used for defining recreational suitability in any where on the earth. On the other hand most of the studies have used not only these international criteria but also have used criteria which are about local properties. For instance one study (Banerjee et al., 2002) defining recreational suitability in Kharagpur, India, has examined tracks for elephants, because elephants have a special importance in this country for recreational activities. Broadhurst (2001) have given standards according to London. Similarly in many other studies local properties have been considered. For this reason the importance of considering local properties for recreational suitability analyses is realized. Yılmaz (2004) have been used plateaus as one of the criteria in her study for Eastern Black Sea region. Also in this thesis plateaus are taken into consideration being one of the most important cultural elements of this region. Further more in definition of all other criteria and their subclasses local properties are considered besides international criteria. Methodology used for determination of recreational suitability is a synthesis of many other earlier studies. This method can be used for other areas by modifying the criteria according to local properties.

In order to define a methodology for determination of areas having high potential for timber production, literature survey and interview with experts are used. The information gathered from interviews and literature shows that until the last few years, timber production studies were not done in a systematic way. With the process of accession period for European Union, forest studies have gained more

exhaustiveness. Forest management plans are now sensitive to recreational usage and ecological sensitivity. The method proposed in this thesis for determination of potential areas for timber production should be useful for forest management studies. Furthermore, it is seen that proposed methodology in this thesis is generally parallel with the new forest management approach.

While trying to built up a methodology, one other aim of the study was to test the suitability of decision making methods with GIS. In this study two decision making rules; simple additive weighting method and ideal point method are used. Simple additive weighting method have been conventionally used within GIS. It is a simple and effective way to use this method within GIS. However in this study, it is interpreted that ideal point method presents more accordance with GIS. Especially with raster format, it provides more reliable results.

By the aid of GIS and decision making methods, as a result of the study a general plan is acquired which proposes suitable areas for outdoor recreation and timber production while taking care of the protection needed areas. Results of this study could be used as a primary information about a region. The results propose areas for three different aspects of forest areas. These maps could be thought as recommendations for a region in general. This study generates a general plan for forest areas and surroundings in order to assist for determining areas for outdoor recreation and timber production. Further studies should be detailed studies in defined ecologically sensitive areas for providing recreational activities and timber production while enabling sustainability.

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