J. Int. Environmental Application & Science, Vol. 4 (1): 125-135 (2009)

A study on the determination of the correlation between the natural vegetative cover distribution and soil characteristics of the sources (Buca/Izmir) area using GIS and remote sensing techniques

Funda Ünal Ankaya, Bahriye Gülgün*

Dept. of Landscape Architecture, Agriculture Faculty, Ege University, Bornova, İzmir, TURKEY

Received December15, 2008; Accepted April 16, 2009

Abstract: The natural vegetation, which forms spontaneously as a result of natural conditions, is changed by anthropogenic factors and over time may even be destroyed. On the other hand, conservation of natural areas is one of the most important concepts that mankind should take into account. Biological diversity of depending on natural vegetation, which is one of the most important components of nature, has been affected negatively in recent years. Rare natural resources are diminishing rapidly today. Natural areas surrounding cities are very important for the ecological balance and also they are a source of oxygen for the people who live in cities.

In this study the correlation between soil type and natural vegetation was studied with the aid of GIS and remote sensing techniques in the area surrounding Kaynaklar village (Buca/İzmir), which lies in the long-range protection area of Tahtalı dam. The aim of this research study is to give solution proposals for the treeless areas, with tree selection for revegetation aided by edaphic and vegetative data (caused by natural and / or anthropogenic factors). Thus, burned and cultured forest land could be revegetated.

Key words: Vegetative Cover, GIS (geographic information system), Remote Sensing, Land Use.

1. Introduction

Coastal towns are foremost amongst the areas where population increase and urbanization are most intensively experienced. Besides being a natural harbour, Turkey's third largest city, İzmir, which has been the site of many civilizations since the earliest periods of history, is also one of Turkey's most important metropolises both economically and socially.

Suitable climatic conditions, a rich historical past and natural beauty of the region have made İzmir and its environs into a centre for tourism.

While the richness of natural resources has formed the base for and thus accelerated economic development, as a result of increasing consumption linked to this economic development natural resources are rapidly diminishing. The damage caused to the environment by certain demands rising from necessity is extremely important from the point of view of our future. As in our own country, the erroneous use of natural resources is also a problem in many developed and developing countries.

The failure to strike an adequate balance between conservation and utilization and the fact that in land use plans the environmental aspect is not taken into account sufficiently are amongst the important problems connected with this subject.

Today, when environmental problems have reached global proportions, above all in areas in need of protection as in many other areas, in odder to determine existing natural resources and their potentials, to observe temporal changes and to bring information up to date, the use of appropriate remote sensing data in research work on this subject will allow correct information to be obtained rapidly and at a low cost. Studies carried out with the remote sensing technique are conducted according to the basic principle of the recording of energy reflected from objects by sensors and the evolution of these in the form of a digital image (Kurucu, 2002).

The fact that every plant has its own unique physiological structure, different cell form, and different growth time helps to determine the sites and densities in which plants are found in nature with the aid of the Remote Sensing Technic (Türkyılmaz et al., 2005).

* *Corresponding: E-mail: bahriye.gulgun@ege.edu.tr, Tel:+90 232 388 4000 ext:2616; Fax: 90 232 388 1864*

2. Previous Studies

Some examples of studies carried out on this subject in various countries are given below; in a study carried out in Finland, satellite images of aquatic vegetation colonies in a eutrophic lake pertaining to the years 1953, 1996 and 2001 were used to demonstrate variations among plant species in shallow (surface) parts of the lake and among the aquatic vegetation colonies in deep water. As a result, certain common species of reed were found to be growing rapidly and, thanks to the necessary steps being taken, a significant reduction in the spread of these species was observed (Valta et al., 2004).

In another study, the shrub species Triunia robusta, which had remained concealed in Australia's subtropic forests, was investigated. With the aid of satellite photographs from the year 1999 and the GIS method the relationship between this plant species and the soil structure, biotic and abiotic factors, and also the amount of area occupied by this plant within the natural vegetative cover were investigated and a land classification was carried out (Powell et al., 2004).

In 2007, in a study carried out in order to reinforce forest ecosystems, use forest resources more efficiently, determine the distribution of plant species within forests and detect individuals within the species in this distribution which were not able to demonstrate good development, and to offer an answer to the confusion at the landscape level, by means of the GIS method the industrial forest maps of a city in the North-east USA, taken as a vegetation model, were examined. The most successful subhabitat species were determined and, by demonstrating the relationship of these species with the soil structure, diverse regressions and the disappearance of some species were observed (Andrew C., 2007).

In their study in 2002, Dumortier et al. compared plant species (particularly plants with leaves whose veins are distinct), the soil structure of areas of landscape where farming is practised and that in forests, diversity in forest habitats, forest age, and vegetative cover in forest areas using a GIS medium (Dumortier et al,2002).

In 1994, by classifying Landsat thematic maps, Lawrence Fox III and Steven A. Carlson, completed a classification of natural habitats using the GIS method, Thus, vegetation species and relationships of these species with each other were investigated , also the fish species found in the waterways were determined and measures were taken to protect these species. This type of research also guides landowners as to the most suitable projects to be carried out on their own land (Lawrence F. and Steven A.,1994).

In a study in Italy, once again with the GIS method, methods for the evaluation of park vegetation were defined and the compatibility between the topographic characteristics of landscape architecture maps and the visual qualities primarily expressed in the field was examined (Villa & Mazza, 1996).

In a study carried out in 2003, species found in the natural flora, the varieties of these species and the numbers of sub-species were investigated with the GIS approach, and soil, topographic structure, and mineral substances in soil were determined. The demographic and biological structures of these plant species were examined and the information was presented to the attention of the experts in the form of conceptual maps (Plemming & Jens- Christian, 2003).

In a study conducted in the town of Texas in the South of the U.S.A., by developing habitat models in a multiple environment, eight rare species growing in the regional landscape area were detected. Habitat models on a regional scale such as landscape conservation areas, main roads, buildings, and civil structures were transferred to a GIS medium, their distributions carried out, and the species present in the area were compared with the rare species (Ben, X. and Fred E.,2000).

In a study carried out in Ename, Belgium, an area used for agriculture in the years 1850 to 1869 and later abandoned and transformed into forest was examined (approximately 62 ha.). The characteristic soil values of 6 plant species (*Anemone nemorosa L.*,*Corylus avellena (L.)*, *Hyacinthoides non-scripta (L.) Chouard ex Rothm.*, *Paris quadrifolia (Par), mercurialis perennis(L.) , Vinca minor* (Lesser Periwinklw)) which have survived to the present day out of 466 plant species in those years, the phosphate concent of the soil, Ph values, agricultural land areas, the length of continuity in the agricultural areas, the relationship between plant species in the old forest areas, and the land use capability classification were examined in a GIS medium. The relationships between soil structure and natural plant cover were presented for afforestation projects to be carried out accordingly (Honnoy *et al*., 1999).

In another study, the restoration of tidal salt marsh areas on Barn Island and the vegetation trends in the course of this restoration were examined using the GIS method (Barett & Niering, 1993).

In the generation and management of information which will be helpful in the problem – solving and decisions making process, the use of two disciplines such as remote sensing and GIS together is of great importance from the point of view of following up and monitoring the information obtained (Güleryüz & Aslan, 2001).

3. Material and Method

3.1. Research material

A 4x4 m. resolution, IKONOS satellite multiple band scanner images of Kaynaklar (Buca/ Izmir) and the surrounding area, 30x30 m. resolution LANDSAT-5 satellite images, 1/25.000 scale geological map from the M.T.A. Izmir Regional Directorate, 1/25.000 scale digital isotopic maps X from the Cartography General Agency of the Turkish Republic, 1/1000 scale current plants obtained from the municipal Bank, soil maps from the General Directorate for Rural Affairs within the ministry of Agriculture, and 1/25.000 scale topographical maps from the State Water Board were used.

In the interrogation of the data obtained during research and in the generation of thematic maps, GIS (Geographic Information System) featured software (Geomedia professional 5,0) was used, and image analyst and microstation software programmes were utilized in the processing of satellite images.

3.2. Research method

In the realization of the study, the soil map of the village of Kaynaklar and its environs was digitalized and the different soil boundaries were determined. In order to determine sufficiency, the 1/25.000 scale afforestation map showing the vegetative cover distribution of the study area, obtained from the Izmir Regional Forestry Directorate, was digitalized in geomedia software and the species present in the area were determined. Data related to the boundaries of these species and their requirements regarding soil and terrain characteristics were entered into geomedia, which is a programme with GIS features, according to layering, logic, and a database was formed for the interrogation to be carried out. The same process of digitalization also formed a database for the characteristics of the major soil groups found on the soil groups map which was produced. The relationship between the soil and terrain characteristics of the land in the study area and the soil and terrain requirements of the vegetative cover species currently present or which could grow in these soil groups was determined by interrogation in geomedia software, and for each relationship defined through interrogation thematic maps were produced. As a result, the natural vegetative cover species, ground cover plants, maquis and bush groups, as well as the tree and shrub species best able to grow in each soil group found in the study area were determined. Thus, it was shown that the present plant species are insufficient and that there could be new plant species able to grow in this area. It was found that by making use of these data, revegetation projects will be able to be carried out in this area in the future in the most appropriate and effective way.

4. Findings

4.1. Geographic structure and climatic characteristics of the study area

The village of Kaynaklar, which was chosen as the study area, is a settlement area attached to the Buca district of the province of Izmir in the Aegean region. It is situated on a plateau 9 km. to the south-east of Izmir and on the southern spurs of mt. Nif. Its surface area comprises 180 km^2 and its height above sea-level is 38 m. The village of Kaynaklar is also 4 km. from Buca and according to the 2000 census has a population of 3755. The general fabric of the village is that of a mainly rural settlement area. It is 13 km. from the city centre of Izmir (Anonim, 2001).

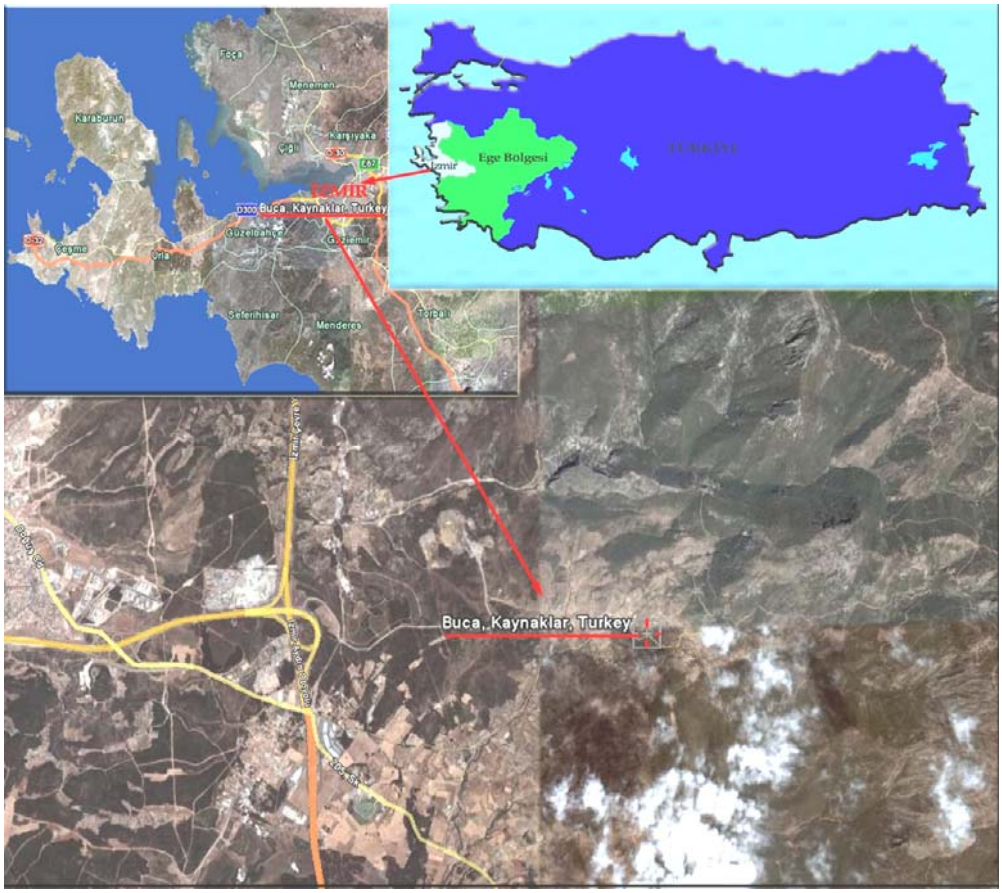

Figure 1 Regional Position and Transport Connections of Kaynaklar (Google Earth)

Kaynaklar, which has a predominantly rural character, is expected to receive a high level of migration within the next 10 years. The main reason fort this migration is the pressure and impact exerted by the outward spreading development of the Izmir metropol on the district town centre. This region, which is at present used for recreational purposes, is increasingly being used as a site for primary housing with a natural environment of high Standard (Anonim, 2001).

4.2. Soil characteristics

The soil groups most widely found in the Kaynaklar region and their characteristics were determined by means of fieldwork and with the aid of soil maps produced by the General Directorate of Rural Affairs. In the specification of the different soil groups and terrain characteristics in the basin of the Küçük Menderes river, where the study area is situated; zone, incline and soil constitution criteria were taken as a basis and each criterion was separated into classes within itself.

The soil groups found in the study area were : red-brown Mediterranean soils; found in zones with altitudes between 50-1250 metres (Anonymous, 1998): colluvial soils; in the zones where these are found the incline varies from level-almost level to medium (Ahrens, 1976) they are generally soils covering the spurs or slopes of steeply inclined mountainous land (Akalan, 1968): non-calcareous Brown soils (Alfisol); these are poor in the plant nutrition substances nitrogen and phosphor and have a medium degree of fertility (Hızalan, 1969): Terra-rosa soils; these occupy an area of approximately 1.800.000 ha. overall in Turkey and 22% of this, that is 400.000 ha. is used for agriculture (Anonymous, 1998):Reddish-Chestnut Coloured Soils (mollisol); these are generally poor in lime, being of a loamy or clayey constitution. Their reaction may be slightly acidic, neutral or slightly alkaline (Anonymous, 1998).

4.3. Plant species appropriate for the soil structure, which may be recommended in the study area

4.3.1. *Ground cover plants*

The variety, species and family names of the plants included in this group are given below; *Sarcopoterium spinosum (L.) (Rosaceae), Ballota acetubulosa Benth. (Labiateae), Stachys cretica L. (Labiatae), Origanum onites L. (Labiatae), Salvia fruticosa Mill. (Labiatae), Rubia peregrine L. (Rubiceae), Hypericum perforatum L.(St. Jhon's wort) (Guttiferae), Prasium majus L. (Labiatae), Lavandula stoechas (Labiatae), Micromeria juliana L. (Labiatae), Coridothymus capitatus L. Rchb. F. (Labiatae), Silybum marianum L. (Compositae), Scolymus hispanicus L. (Compositae),Onopordum Illyricum L. (Compositae)* (Durmuşkaya, 2006).

4.3.2. *Bush and maquis plant species*

The variety, species and family names of the plants included in this group are given below; *Phyllyrea latifolia L. (Oleceae), Juniperus oxycedrus L. (Cupressaceae), Pistacia lentiscus L. (Anacardiaceae), Juniperus sabina L. (Cupressaceae), Juniperus excelsa Bieb.(Cupressaceae), Juniperus phoenicea L. (Cupressaceae), Berberis cretica L. (Berberidaceae), Reseda lutea L. (Resedacae), Erica arborea L. (Ericaceae), Erica manipuliflora Salisb.(Ericaceae), Rosa canina L. (Rosaceae), Rubus canescens DC Rank (Rosaceae), Rubus sanctus Hussein S.A.M. (Rosaceae), Anagyris foetida L. (Fabaceae), Myrtus communis L. (Myrtaceae), Paliurus spina-christi L. (Rhamnaceae), Nerium oleander L. (Apocynaceae), Jasminum fruticans L. (Oleaceae), Verbascum sp L. (Scrophularıaceae), Styrax officinalis L. (Sytracaceae), Amygdalus orientalis Miller (Rosaceae)* (Durmuşkaya, 2006).

4.3.3. *Tree and shrub plants species*

The variety, species and family names of the plants included in this group are given below; *Cupressus sempervirens L. (Cupressaceae), Cedrus libani (A. Rich.) (Pinaceae), Pinus sylvestris L. (Pinaceae), Pinus nigra Arnold (Pinaceae), Pinus brutia (Ten.) (Pinaceae), Pinus pinea L. (Pinaceae), Laurus nobilis L. (Lauraceae), Morus alba L. (Moraceae), Castanea sativaP. Mill. (Fagaceae), Alnus orientalis Geri. (Betulaceae), Platanus orientalis L. (Platanaceae), Ulmus minor Mill. (Moraceae), Ficus carica L. (Moraceae), Juglans regia L. (Juglandaceae), Quercus frainetto (Ten.)(Fagaceae), Quercus pubescensWilld. (Fagaceae), Quercus cerris L. (Fagaceae), Quercus ithaburensis Derne. (Fagaceae), Quercus ilex L. (Fagaceae), Quercus aucheri Iaub&Spach (Fagaceae), Quercus coccifera L. (Fagaceae), Tilia argentea Desf. (Tiliaceae), Tamarix symrnensis (Tamaricaceae), Populus alba L. (Salicaceae), Arbutus unedo L. (Ercaceae), Arbutus andrachne L. (Ericaceae), Pyrus amygdaliformis (Guss.)Bean (Rosaceae), Ceratonia siliqua L. (Fabaceae), Elaeagnus angustifolia L. (Elaegnaceae), Rhus coriaria L. (Anacardiaceae), Fraxinus ornus Linn. (Oleceae),Olea europeae L. (Oleaceae)* (Durmuşkaya, 2006).

4.4. Soil and terrain characteristics found in the study area and determination of suitable species according to soil and terraing requirements of the plants.

In this study, the ecological requirements of the plants were specified according to the fallowing criteria; large soil groups, soil texture, soil depth and incline of terrain. As a result of the interrogation which was carried out, plant implementation maps (PIM) were formed by matching the proposed plant species with the existing soil maps, and, in accordance with this, the plant species able to grow in each soil group were determined (Appendages 1,2,3 and 4).

The plant implementation maps (PIM), on which the proposed plant species suitable for being grown in the different soil groups are specified, were produced in the form of 12 different maps (PIM1-PIM 12).

In soils of 0-20 cm, a coarse (sandy) soil constitution, good drainage and a terrain incline >30%, the vegetative cover shown in PIM 1 is able to grow most effectively. Since, according to this, soil depth is 0-20 cm tree forms cannot grow here. All of the ground cover plants and maquis groups can. The proposed plant species shown in PIM 1 are specified in the tables in Appendages 2, 3 and 4.

In soils of land use capability class VII es with a soil depth of 20-50 coma coarse (sandy) soil constitution, good drainage and a terrain incline >30%,the vegetative cover shown in PIM 2 is best able to grow. As, according to this, soil depth is 20-50 cm, some shrub forms and some ground cover plants, as well as almost all of the maquis and bush groups are able to grow. The proposed plant species shown in PIM 2 are specified in the tables in Appendages 1, 2, 3 and 4.

In soils of the land use capability class VI es, with a soil depth of 20-50 cm, a coarse (sandy) soil canstitution, good drainage, and terrain incline of > 12-20%; the vegetative cover shown in PIM 3 is best able to grow. As, according to this, soil depth is 20-25 cm, some shrub forms and some around cover plants as well as almost all of the maquis and bush groups are able to grow. The proposed plant species shown in PIM 3 are specified in the tables in Appendages 1, 2, 3 and 4.

In soils of the land use capability class VI es, with a soil depth of 20-50 cm, a fine (loa my) soil constitution good drainage and s terrain incline > 6-12% the vegetative cover shown in PIM 4 is best able to grow. As, according to this, soil depth is 20-50 cm, some shrub forms and some ground cover plants, as well as almost all of the maquis and bush groups are able to grow. The proposed plant species shown in PIM 4 are specified in the tables in Appendages 1, 2, 3 and 4.

In soil of land use capability class IV es, with a soil depth of 20-50 cm, a fine (loa my) soil constitution, good drainage and a terrain incline >6-12%,the vegetative cover shown in PIM 5 is best able to grow. As, according to this, soil depth is 20-50 cm, some shrub forms and some ground cover plants, as well as almost all of the maquis and bush group are able to grow. The proposed plant species shown in PIM 5 are specified in the tables in Appendages 1, 2, 3, and 4.

In soils of land use capability class IV es, with a soil depth of 0-20 cm, a fine (loa my) soil constitution, good drainage and a terrain incline >6-12%, the vegetative cover shown in PIM 6 is best able to grow. As, according to this, soil depth is 0-20 cm, tree forms cannot grow. All of the ground cover plants and maquis group are able to grow. The proposed plant species shown in PIM 6 are specified in the tables in Appendages 2, 3 and 4.

In soils of land use capability class IV es with a soil depth of 90+ cm, a fine (loa my) soil constitution, good drainage and a terrain incline >6-12%, the vegetative cover shown in PIM 7 is best able to grow. According to this, tree forms requiring a soil depth of 90+ cm and a fine soil canstitution are able to grow. The proposed plant species shown in PIM 7 are specified in the tables in Appendages 1, 2, 3 and 4.

In soils of land use capability class II es, with a soil depth of 90+ cm, a medium (humus) soil constitution ,good drainage and a terrain incline of >2-6%,the vegetative cover shown in PIM 8 is best able to grow. According to this, the proposed plant species shown in PIM 8, which requires a soil depth of 90+ cm and a medium soil constitution, are specified in the tables in Appendages 1, 2, 3 and 4.

In soils of land use capability class IV es, with a soil depth of 25-50 cm, a coarse (sandy) soil constitution, good drainage, and a terrain incline >2-6%,the vegetative cover shown in PIM 9 is best able to grow. According to this, some shrub forms and some ground cover plants swell as almost all moquis and bush groups requiring a soil depth of 25-50 cm and a coarse soil constitution are able to grow. The proposed plant species shown in PIM 9 are specified in the tables in Appendages 1, 2, 3 and 4.

In soils of land use capability class III es, with a soil depth of 25-50 cm, a medium (humus) soil constitution, good drainage and a terrain incline >0-2%, the vegetative cover shown in PIM 10 is best able grow. According to this, some tree forms and some ground cover plants as well as almost all maquis and bush groups requiring a soil depth of 25-50 cm and a medium soil constitution are able to grow. The proposed plant species shown in PIM 10 are specified in the tables in Appendages 1, 2, 3 and 4.

In soils of land use capability class VIII, with o soil depth of 0-20 cm, a coarse (sandy)soil constitution, good drainage and a terrain >--%,the vegetative cover shown in PIM 11 is best able to grow. According to this, since the soil constitution is coarse and since there is bare rock with a soil depth of 0-20 cm, only herbaceous ground cover plants can grow. The proposed plant species shown in PIM 11 are specified in the tables in Appendages 3 and 4.

In soils of land use capability class VII es, with a soil depth of 0-20 cm, a coarse (sandy) soil constitution, good drainage and a terrain inclination >20-30%,the vegetative cover shown in PIM 12 is best able to grow. According to this, since the soil constitution is coarse and the soil depth is 0-20cm,

tree forms cannot grow. All of the ground cover plants and some of the maquis groups can grow. The proposed plant species shown in PIM 12 are specified in the tables in Appendages 2, 3 and 4.

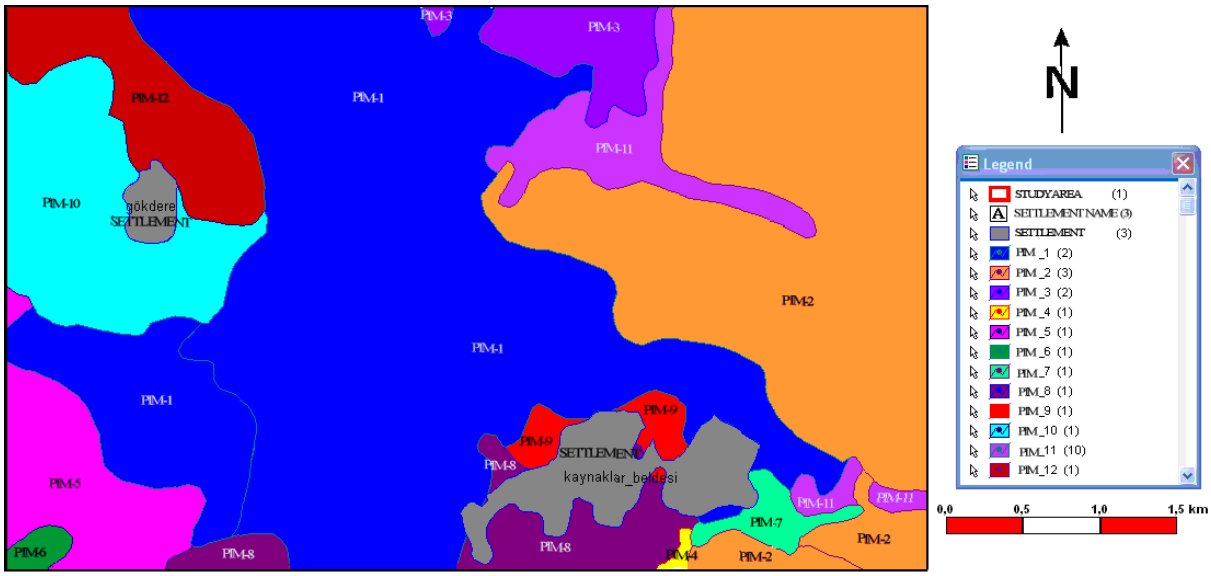

Figure 2 General "PIM" Map (Original)

5. Results and Recommendations

The village of Kaynaklar, where a rural lifestyle predominates and the use of land for agriculture is high, is today losing its agricultural and natural structure values at an increasing rate, because of anthropogenic pressures and a desire for economic gain. Due to erroneous land use and the failure to form an adequate balance in this use, the loss of natural resources will pose a threat for the future. In this study, by using two disciplines, remote sensing and GIS, together, alternative solutions have been proposed which will be help in the process of problem-solving and decisioncmaking and will ensure the protection, restoration and versatile utilization of natural resources necessary for maintaining sustainability. Thus, the relationships between the vegetative cover and soil groups found in the study are were determined as a result of information collected through fieldwork and by means of satellite images with different resolutions. The natural vegetative cover was found to be mainly maquis-scrub and forest in varying densities.

The characteristics of the vegetative fabric of the Kaynaklar vicinity have been determined as follows:

In the forest cover, group made up of *Pinus brutia* (red pine) were observed in varying densities, denotedas dense,medium (Quercus coccifera) and the species *Hypericum perforatum L., Sacopoterium spinosum L., Arbutus unedo L., Myrtus communis L.,and Arbutus andrachne L.* were found to be growing in various degrees of density under the pine cover or in clearings.

In the study region, it was observed that on medium and slightly inclined land dry farming is practiced, while on land with the characteristic of steep and very steep slopes, linked to erosion, there is very shallow, low density vegetative cover and bare rock.

As a result of this study, the natural vegetative cover types, ground cover plants, maquis and bush groups and the tree and shrub species which could best grow in each soil group found in the study area were determined. The plant species specified in these thematic maps will be of help to those in position of responsibility with respect to future revegetation projects, taking into account the protection of nature and sustainability.

Appendix 1 List of Tree and Small Tree Species According to Soil Group Characteristics

Plant Species	**Texture**			**Depth(Cm)**				**Content of Stone**		**Content of Rock**		**Content of Lime**		
	M	R	S	0-20	20-50	50-90	90 +	E	N	E	N	N	M	Ri
Cupressus sempervirens L.		x					x		x		x			x
Cedrus libani (A. Rich)	x	x	x				x	x			x			x
Pinus slyvestris L.		x					x		x		x	x		
Pinus nigra Arnold.		x	x				x		x		x			x
Pinus brutia Ten.	x	x	x				x		x		x	x		
Pinus pinea L.	x	x	x				x		x		x			x
Laurus nobilis L.	x						x	x			x			x
Alnus orientalis Geri.		x					x		x		x	x		
Platanus orientalis L.		x					x	x			x			x
Ulmus minor Mill.		x					x		x		x			x
Morus alba L.		x					x		x		x			x
Ficus carica L.	x	x	x				x		x		x	x		
Juglans regia L.		x					x		x		x			x
Castanea sativa P. Mill.		x					x		x		x	x		
Quercus frainetto Ten.			x				x		x		x			x
Quercus infectoria L.	x	x					x	x			x	x		
Quercus cerris L.		x					x		x		x	x		
Quercus ithaburensis erne.		x					x		x		x		x	
Quercus ilex L.		x					x		x		x	x		
Quercus aucheri Jaub&Spach		x					x		x		x		x	
Quercus coccifera L.	x	x	x				x		x		x	x		
Quercus pubescens Willd	x	x					x		x		x			x
Arbutus unedo L.		x					x	x			x			x
Tilia argentea Desf.		x					x		x		x			x
Cistus creticus L.	x	x	x		x		x	x			x			x
Tamarix symrnensis L.	x	x			x		x		x		x	x		
Populus alba L.	x	x					x		x		x	x		
Arbutus andrachne L.	x	x	x		x		x	x		x				x
Pyrus amygdaliformis (Guss.) Bean		x				x		x			x	x		
Ceratonia siliqua L.		x				x		x			x			x
Elaeagnus angustifolia L.		x	x			x			x		x			x
Rhus coriaria L.		x			x			x			x	x		
Fraxinus ornus Linn.		x	x				x		x		x			x
Olea europaea L.	x	x	x				x	x			x			x

M: Medium R: Rough S: Small E: Exist N: None H: High Ri: Rich

Appendix 2 List of Shrubs and Maquis According to Soil Group Characteristics

Plant Species	**Texture**			**Depth(Cm)**				**Content of Stone**		**Content of Rock**		**Content of Lime**		
	M	R	S	0-20	20-50	50-90	90+	E	N	E	N	N	M	Ri
Reseda lutea L.	x	x	x	x	x		x	x			x			x
Berberis cretica L.	x				x		x		x		x			x
Pistacia lentiscus L.	x	x	x		x		x		x		x			x
Erica arborea L.	x	x	x		x		x		x		x	x		
Erica manipuliflora L.	x	x			x		x	x		x				x
Styrax officinalis L.	x	x	x		x		x		x		x	x		
Amygdalus orientalis Miller.		x	x		x			x		x				x
Rosa canina L.	x	x	x		x		x		x		x			x
Rubus canescens L.	x	x	x	x			x	x			x	x		
Anagyris foetida L.	x	x	x		x		x	x			x			x
Myrtus communis L.		x			x				x		x			x
Paliurus spina-christi L.	x	x	x		x		x	x		x		x		
Nerium oleander L.		x				x		x		x		x		
Juniperus oxycedrus L.		x				x			x		x	x		
Juniperus sabina L.		x	x			x		x		x				x
Juniperus excels Bieb.	x	x	x			x		x			x	x		
Juniperus phoenicea L.	x	x	x			x		x		x				x
Phillyrea latifolia L.	x	x	x		x		x		x		x	x		
Rubus sanctus Hussein S.A.M.	x	x	x		x			x			x	x		
Verbascum sp.	x	x	x		x		x		x		x	x		
Jasminium fruticans L.	x	x	x		x		x	x			x	x		

M: Medium R: Rough S: Small E: Exist N: None H: High Ri: Rich

Appendix 3 List of Groundcover Plants According to Soil Group Characteristics

Plant Species	**Texture**			**Depth(Cm)**				**Content of Stone**		**Content of Rock**		**Content of lime**		
	M	R	S	0-20	20-50	50-90	90+	E	N	E	N	N	M	Ri
Ballota acetobulosa Benth.	x	x	x	x	x		x		x		x			x
Asparagus acutifolius L.	x	x	x		x		x	x			x			x
Ruscus aculeatus		x		x	x				x		x	x		
Onopordum illyricum L.	x	x	x	x	x		x	x		x		x		
Scolymus hispanicus L.		x		x	x			x			x			x
Silybum marianum L.		x		x	x			x			x			x
Stachys cretica L.	x	x	x	x	x		x		x		x			x
Origanum onites L.	x	x	x	x	x		x	x		x				x
Micromeria juliana L.	x	x		x	x		x	x		x				x
Thymus zygioides Griseb.		x	x	x	x		x	x		x				x
Coridothymus capitatus L. Rchb. F.	x	x	x	x	x		x	x			x			x
Rubia peregrina L.		x	x	x	x		x	x		x				x
Sarcopoterium spinosum L.	x	x	x	x	x		x	x			x	x		
Lavandula stoechas	x	x	x	x	x		x		x		x		x	
Prasium majus L.	x			x	x		x	x		x			x	
Salvia fruticosa Mill.		x		x	x			x		x				x
Hypericum perforatum L. (St. Jhon's wort)	x	x	x	x	x		x		x		x	x		
Paeonia mascula	x			x					x		x			x
Cistus parviflorus		x	x	x				x			x			x

M: Medium R: Rough S: Small E: Exist N: None H: High Ri: Rich

Appendix 4 List of Plant Species Growing on Different "PIM" Groups

Plant Species	PIM 1	PIM 2	PIM 3	PIM 4	PIM 5	PIM 6	PIM 7	PIM 8	PIM 9	PIM 10	PIM 11	PIM 12
Cedrus libani A. Rich.							x	x				
Pinus nigra Arnold.							x					
Pinus brutia (Ten)							x	x				
Pinus pinea L.							x	x				
Laurus nobilis L.								x				
Ficus carica							x					
Quercus infectoria							x	x				
Quercus coccifera L.							x	x				
Quercus pubescens Willd.								x				
Cistus creticus		x	x	x	x			x	x	x		
Tamarix symrnensis								x		x		
Populus alba L.								x				
Arbutus andrachne L.		x	x	x	x			x	x	x		
Rhus coriaria L.		x	x						x			
Olea europaea L.								x				
Reseda lutea L.	x		x	x	x	x	x	x	x	x		x
Berberis cretica L.								x		x		
Pistacia lentiscus L.		x	x	x	x		x	x	x	x		
Erica arborea		x	x	x	x		x	x	x	x		
Erica manipuliflora		x	x					x	x	x		
Styrax officinalis L.		x	x	x	x			x	x	x		
Amygdalus orientalis Miller.		x	x	x	x				x			
Rosa canina L.		x	x	x	x			x	x	x		
Rubus canescens D. C. Rank	x					x	x					x
Anagyris foetida L.		x	x	x	x			x	x	x		
Myrtus communis L.		x	x						x			
Paliurus spina-christi L.		x	x	x	x			x	x	x		
Phillyrea latifolia		x	x	x	x			x	x	x		
Rubus sanctus Hussein S.A. M.		x	x	x	x			x	x	x		
Verbascum sp.		x	x	x	x			x	x	x		
Jasminium fruticans L.		x	x	x	x			x	x	x		
Ballota acetobulosa Benth.	x	x	x	x	x	x	x	x	x	x	x	x
Asparagus acutifolius		x	x	x	x			x	x	x		
Ruscus aculeatus	x	x	x						x		x	x
Onopordum illyricum L.	x	x	x	x	x	x	x	x	x	x	x	x
Scolymus hispanicus L.	x	x	x						x		x	x
Silybum marianum L.	x	x	x						x		x	x
Stachys cretica L.	x	x	x	x	x	x	x	x	x	x	x	x
Origanum onites L.	x	x	x	x	x	x	x	x	x	x	x	x
Micromeria juliana L.	x	x	x					x	x	x	x	x
Thymus zygioides	x	x	x	x	x	x	x		x		x	x
Coridothymus capitatus L. Rchb. F.	x	x	x	x	x	x	x	x	x	x	x	x
Rubia peregrina L.	x	x	x	x	x	x	x		x		x	x
Sarcopoterium L.spinosum	x	x	x	x	x	x	x	x	x	x	x	x
Lavandula stoechas	x	x	x	x	x	x	x	x	x	x	x	x
Prasium majus L.								x		x		
Salvia fruticosa	x	x	x						x		x	x
Hypericum perforatum L. (St. Jhon's Wort)	x	x	x	x	x	x	x	x	x	x	x	x

References

Ahrens, E., 1976, Toprak Mikrobiyolojisi ve Biyokimya Ders Notları, E.Ü., Ziraat Fak., Toprak Kürsüsü

Akalan, İ., 1968, Toprak Oluşu Yapısı ve Özellikleri, Ankara Üniv. Yayını. No: 356

Andrew, C., 2007, Probabilistic Modelling An Mapping of Plant Indicator Species in a Northeast Oregon Industrial Forest, USA, Department of Forest Science, Cornvallis O 97331-5752.

Anonim, 1998., Toprak Su Genel Müdürlüğü, Toprak Etüdleri Standartları. T.C. Köy İşleri Bakanlığı, Toprak Su Genel Müdürlüğü

Anonim, 2001, Kaynaklar İmar Planı Araştırma Raporu

Anonim, 2009., Google Earth.

Barette, NE., Niering, WA., 1993, Tidal Marsh Restoration Tends in Vegetation Change Using a Geographical Information, Restoration Ecol.,Vol:1, No:1,128 pages

Ben, X. and Fred. E., 2000, Multiple-Scale Habitat Modelling Approach for Rare Plant Conservation, Landscape and Urban Planning Vol. 51(1), pp 11-28

Dumortier, M., Butaye, J., Jacquemyn, H., Camp N., C., Lust. N., Hermy, M., 2002 Predicting Vascular Plant Species Richness of Fragmented Forests in Agricultural Landscapes in Central Belgium, Forest Ecology and Management (158) 85-102

Durmuşkaya, C., 2006, Ege Bölgesinde Doğal Yayılış Gösteren Ağaç ve Çalılar, Ankara

Güleryüz, G. and Arslan, H., 2001, Doğal Alanların Korunmasında Vejetasyon Mozayiği ve Coğrafi Bilgi Sistemleri Teknikleri Önemi, Çev-Kor Dergi, Cilt:10 ,Sayı: 38

Hızalan, E., 1969, Toprak Etüd ve Haritalama 1., A.Ü. Ziraat Fakültesi Yayınları:379. Ankara

Honnay, O., Hermyond. M., Coppn. P., 1999, Impact of Habitat Quality On Forest Plant Species Colonization, Vital Decosterstruat 102-B-3000, Leuven, Belgium

Kurucu, Y., 2002, Tarımsal Uygulamalarda Coğrafi Bilgi Sistemi Kullanımı, Yüksek Lisans Ders Notları, Ege Üniversitesi Ziraat Fakültesi Toprak Bölümü, İzmir

Lawrence, Fox III and Steven, A., 1994, Using A GIS and Vegetation Cover Derived From Landsat-Tm Image Classification to Assess the Health of the Klamath River Hydro-Basin in North America, http://www.krisweb.com/biblio/gen_hsu_foxetal_1996.pdf

Mac Kinnon, K.J., Child G., Thorsell, J. 1986, Managing Protected Areas in the Tropics International Union for Conservation of Nature and Natural Resources and the United Nations Environment Programme, Gland, Switzerland.

Plemming, S., Jens-Christian, S., 2003, Predicting Plant Species Richness in a Managed Forest, Nordlandsvej 68, D-8240, Risskov-Denmark

Powell, M., Accad. A., Shapcott, A., 2004, GIS Prediction of Past Present Habiat Distribution and Areas for Re-Introducton Of The Endangered Subtropical Rainforest Shrub T.Robusto From South-East Quenn island Australia, Biological Conservation Vol. 123(2), pp 165-175

Türkyılmaz, B., Kurucu,Y., Altınbaş, Ü., Bolca, M., Esetlili., Özen, F., Gülgün. B., Gencer, G., Güney, A., Hepcan,Ş., Özden, N., 2005, Doğal Sitlerin Belirlenmesi ve Sınıflandırılmasında Coğrafi Bilgi Sisteminin Kullanılabilirliği ve Bir Örnekleme Alanında (Kaynaklar Beldesi-İzmir) Veri Tabanı Oluşturma Üzerinde Araştırmalar, Tübitak Projesi

Valta, H., Kanninen, A., Pellikka, P., 2004, Remote Sensing and GIS for Detecting Changes, in the Aquatic Vegetation of Rehabiltated Lake, North Savo Regional Environmental Centre, Neulaniementie 243 pages

Villa, F., Ceroni, M., Mazza, A., 1996, A GIS –Based Method for Multi-Objective Evaluation of Park Vegetation., Landscape and Urban Planning.,Volume 35.,Number 4.,203 pages