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Full Length Research Paper

Process analysis in landscape planning, the example of Sakarya/Kocaali, Turkey

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Landscape planning which is one of the fields of study that creates a balance between natural sciences and engineering sciences in the best possible way is also important for natural resource management. One of the main purposes is a balanced planning of people and nature, instead of people oriented planning. In landscape planning, the approaches in which landscape functions are analyzed and the structure and change of landscape is presented have been supported by ecology and landscape ecology sciences. Water, erosion and habitat function of landscape has been presented in the research by the help of Geographical Information System (GIS). The research area is Kocaali District that is situated on Western Black Sea basin. A landscape planning approach demand that is to function as a pre-study for the next planning studies from Kocaali Municipality is the strongest reason for choosing that area. As a result of water, erosion and habitat function analyses, it has been stated that the beach in the north of the area should definitely be conserved; the forested land in the southwest of the area has high conservation value and the hazelnut-groves that can be seen in many parts of the area needs a medium conservation. In conclusion, research findings and water, erosion and habitat function analyses about landscape can be used in the planning decisions related to agriculture, forestry, settlement, etc. separately. Additionally, evaluation of the all landscape functions all together will make important contributions to the planners in sub-region and region scale.

Key words: Landscape planning, patch corridor matrix model, landscape habitat function, landscape water function.

INTRODUCTION

Landscape planning is a tool that creates a balance between human and nature in terms of protection and improvement. The first landscape planning studies in our country were generally performed by developing planning methods formed by various planners abroad and practicing them in different areas (Lewis, 1964; McHarg, 1967; Buchwald et al., 1973; Hills, 1976; Kiemstedt, 1967). In the landscape planning studies that have been carried out in recent years, apart from the planning approaches of Steinitz (1995), Ahern (1999), Steiner (2000), Ahern (2006), landscape ecology and landscape function studies (McGarigal and Marks, 1994; Forman, 1995; Dramstad et al., 1996; Leitao and Ahern, 2002; McGarigal et al., 2009) and landscape character assessment methodologies (Swanwick, 2002; Washer, 2005) have gained importance. Landscape planning studies can be separated into five classes in our country:

1. Planning approaches that are formed by overlaying natural landscape elements and creating ecologic units (Başal, 1974; Başal et al., 1983; Başal, 1988; Uzun, 2003).
2. The studies in which mathematical modeling where all the probable cultural and natural landscape elements, based on plan squares and related to landscape planning according to the detail of the conducted scale are reflected to the plan (Altan, 1974, 1982; Ortaçesme, 1996; Mansuroğlu, 1997).
3. The studies that are carried out by questioning the field selection that measure up the demanded criteria in designing or planning with the development of Geographic Information System (GIS) (Karadeniz, 1995; Şahin, 1996; Dilek, 1998).
4. The studies that are conducted by analyzing the

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processes inside the landscape and presenting the structure (patch, corridor, matrix) of landscape (Uzun, 2003; Deniz, 2005; Tunçay et al., 2009).

5. The studies in which the decisions about land use are made by determining landscape character type by the help of landscape habitat and function analysis (Şahin, 1996; Şahin et al., 2007; Uzun et al., 2010).

In the studies that have been carried out in recent years both in our country and some regions of Europe and USA, not the studies for mathematical modeling of natural and cultural elements of landscape, but the studies for examining the process inside the landscape and as a result of these processes, taking planning decisions have gained importance. Within this context, as a parallel of the landscape ecology to its development in the world, the studies, in which cultural and natural data of landscape are examined by presenting the structure, function and change of landscape in landscape planning and the analysis of the structure of landscape and the processes such as water, erosion are made, are making progress.

In the analysis of water process, the assessment and evaluation of infiltration zones (Buuren, 1994; Şahin, 1996; Şahin and Kurum, 2002; Dilek et.al., 2008; Uzun et al., 2010) and in the analysis of erosion process (Mopu, 1985; Mapa/Icona 1983, 1991; Şahin and Kurum, 2002; Dilek et.al., 2008; Uzun et al., 2010), soil and bedrock assessments make great contributions to formation of planning decisions.

Patch-corridor-matrix model has been used in landscape planning, assessment of landscape, formation of protection and development policies such as management and restoration and landscape structure, landscape function and landscape change analyses (McGarigal and Marks, 1994; Forman, 1995; Dramstad et al., 1996; Hobbs, 1997; Opdam et al., 2002; Leitao and Ahern, 2002; Uzun, 2003). Some landscape metrics that are used in this scope are: patch density, size and variability metrics, shape metrics, edge metrics, core area metrics. (McGarigal and Marks, 1994; Forman, 1995; Dramstad et al., 1996; Marzluff et al., 2004; Munroe et al., 2007; McGarigal, et al., 2009; Olson and Andow, 2008; Leitao and Ahern, 2002; Winter et al., 2006).

The common side of all these studies is that a landscape planner makes landscape ecology based planning by synthesizing different natural and cultural landscape elements in physical planning. However, in almost every methodology, the main approach is to include measurable data as far as possible and to develop decision mechanism in this way (Uzun and Kesim, 2009). The planning decisions can be taken more easily and they can also be based on a scientific foundation by the help of landscape ecology based approaches in landscape planning process together with the landscape structure, function and change.

The reason for choosing the site as research area is a landscape planning approach demand that is to function as a pre-study for the next planning studies from Kocaali Municipality.

The purpose of the study is to present the use of analysis results in decision process by assessing water, soil conservation (erosion process) and habitat function of landscape which is one of process analyses in landscape planning. Also, another purpose is to take ecologic and scientific based decisions for the research area and immediate surrounding together with the integration of three processes inside the landscape. The functions of the research are to examine water and erosion process in the research area, to make analysis for landscape structure by using patch-corridor-matrix model with landscape ecology based approach and to integrate the obtained data with the data about water and erosion process.

MATERIALS AND METHODS

The district is located on an area that leans to Black Sea and the east and the west of the district is clipped by the valleys. Slope that starts form Black Sea reaches 900 m in the south. The district that is situated between Melen River that points the east border and Karasu basin, Maden Brook that forms the west border has 315 km^2 land and elevations from sea level is 20 m. There are two municipals and 29 villages in the area with one center and one town. The population of the district is 30.301. 25% (55.8 km^2) of the square measure of the district is covered with forested lands and there is generally *Pinus* sp., *Platanus* sp., *Fagus* sp. *Tilia* sp. *Castanea* sp., *Alnus* sp. (KB, 2009)

It is shown in Turkey Seismic belts map that the entire Kocaali district takes place in the firs-degree seismic zone (Figure 1). The rock types in the area are alluvium, sedimentary rocks, pebbles, sandstone, mudstone and limestone (KK, 2009). District economy is based on agriculture. The primary product is nut. 64% of the entire land is used as cultivated area and 95% of this area is used as hazelnut-grove. 60% of active workforce is occupied with agriculture. The main vegetation consists of hazelnut-grove in terms of land use (KK, 2009). Kocaali has a transition climate that is under the effect of two climates as it is situated in the area where Western Black Sea Region ends and Marmara Region begins (ÇOBMM, 2009).

While pointing the borders of the research area, current borders of the district have not been taken as a base. The processes inside the landscape generally take place ecologic borders. Within this context, Karasu Basin border that forms the district border in the south has been included to the research area. So the research area reaches 344.51 km^2 (Figure 1).

The method of the study consists of four stages (Figure 2). Firstly, the borders of the research area have been pointed by taking the basin borders as a base. Contour lines have been digitized in ArcGIS 9.3 environment by using 1/25 000 scaled topographic maps (HGK, 2005) to be used in the next stages of the method. Three dimensional terrain model of the area has been created by using 3D analysis program and later slope maps for the area have been formed. In the formation of slope maps, slope classes prepared by General Directorate of Rural Services which is on the service depending on Ministry of Agriculture and Rural Affairs have been taken as base.

Water process analysis

A method that can be named as water process and depend on

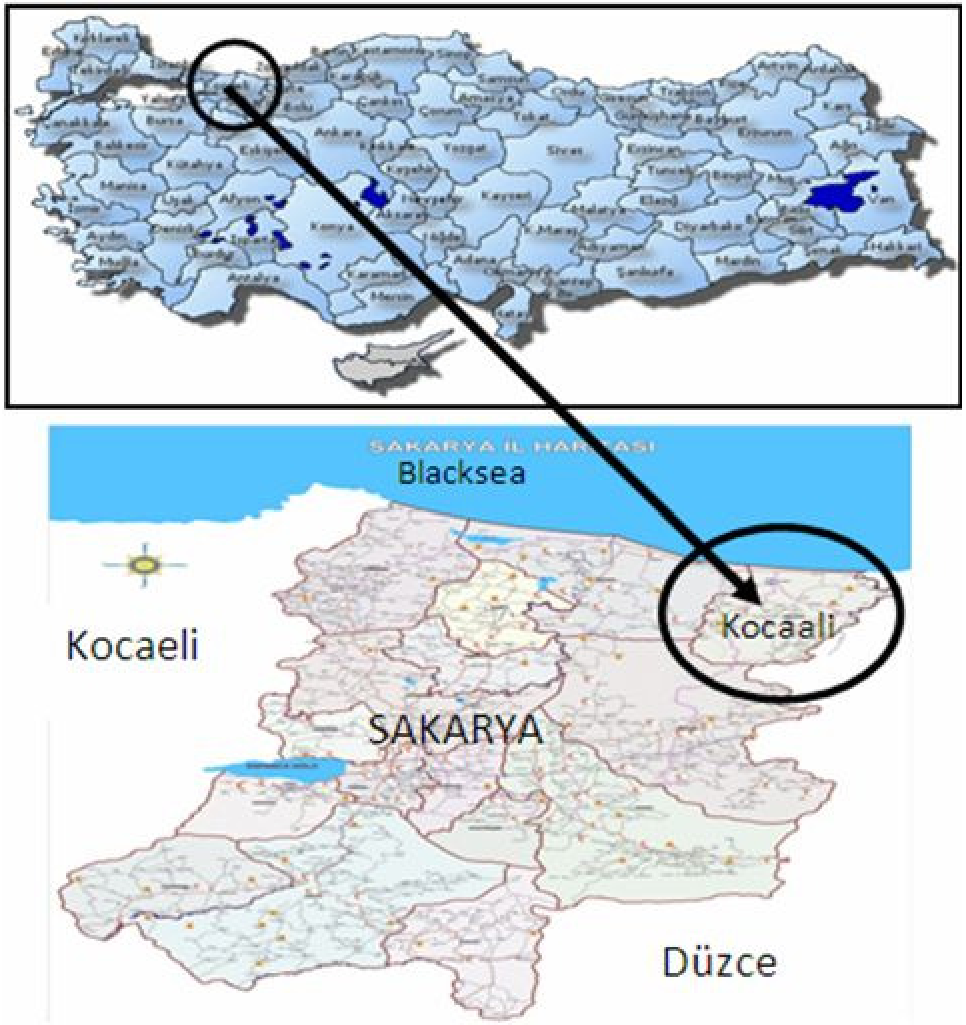

Figure 1. Research area.

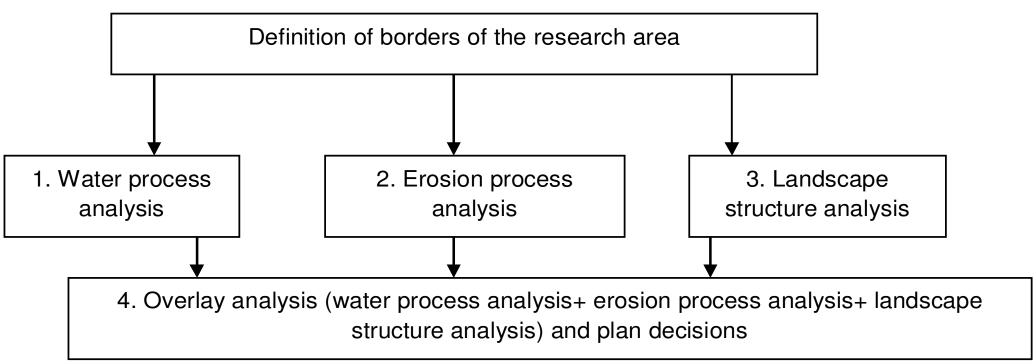

Figure 2. Method flow diagram.

presenting degree of infiltration zones that are used by Buuren (1994), Şahin (1996), Şahin and Kurum (2002), Uzun (2003), Dilek et al. (2008) has been applied. The amount of infiltration can be affected by different factors. Variable numbers are kept limited with soil textures and rock permeability values (Figure 3).

Erosion process analysis

Erosion process analysis includes the formation and synthesis of "soil conservation degree" maps that are formed by overlaying vegetation and slope maps and "erodibility maps" created by

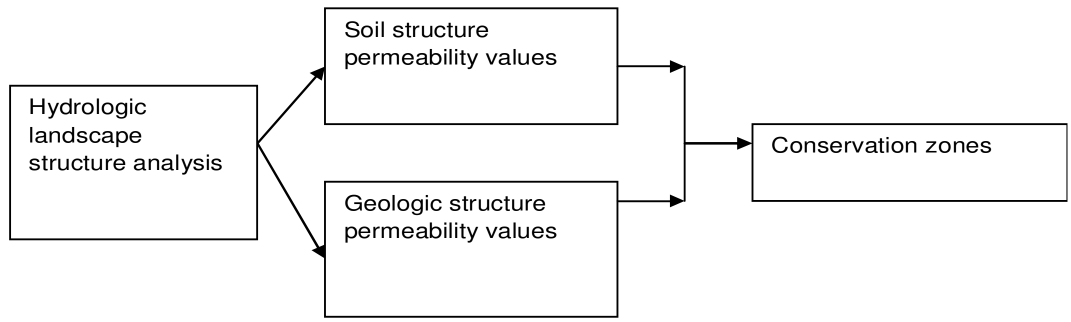

Figure 3. The method of pointing infiltration zones with hydrologic landscape analysis (Buuren 1994, Şahin 1996).

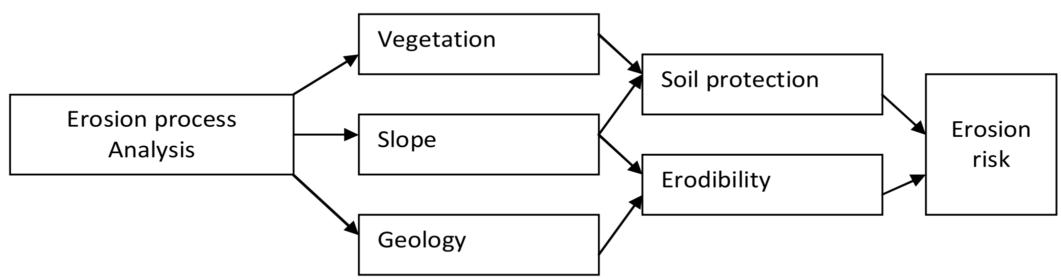

Figure 4. Erosion process analysis (Mapa/Icona, 1983, 1991; Mopu, 1985; Mapa/Icona, Şahin and Kurum, 2002; Dilek et al., 2008; Uzun et al., 2010).

overlaying slope and geology maps (Mapa/Icona, 1983, 1991; Mopu, 1985; Şahin and Kurum, 2002; Dilek et al., 2008; Uzun et al., 2010) (Figure 4).

Landscape structure analysis (patch-corridor-matrix model)

Patch-corridor-matrix model is used to state the structure of the landscape in landscape ecology based studies (Forman and Godron, 1986; Forman, 1995; McGarigal and Marks, 1994; Leitao and Ahern, 2002; Uzun, 2003; Rempel, 2010). Patch classes are stated in the first stage of the method. Forest development maps and Corine 2006 (ÇOB, 2010) datas prepared by Ministry of Environment and Forestry, 1/25 000 scale soil maps with land use sheet (TKB, 2008) are used as a base within this context. The obtained patch classes have been digitized in ArcGIS 9.3 which is a GIS program.

Landscape structure analyses can be carried out in the level of landscape, patch class and patch. By the help of these analyses, the structure, function and change of landscape can be figured out. In the research, analyses have been made in the level of patch class.

The patch classes within the forest and agricultural matrix in research area have been evaluated in terms of habitat patches within the frame of three criterions; patch size and number, patch form, patch edge. This approach has supported the studies of Forman and Godron (1986), McGarigal and Mark (1994), Forman (1995), Leitao and Ahern (2002), Uzun (2003) and Rempel (2010). The related criteria are given points on the basis of patch classes by the help of five point likert scale on the scale of five points. Landscape habitat function maps of Research areas have been obtained by the help of overlay analyses of the maps formed according to three criteria. “Patch Analysis 4” program (it contains analysis and modeling functions for polygons) which is created by Rempel (2010) and performed under ArcGIS 9.3 program has been used (Table 1).

Class (C), Class Area (CA), Total Landscape Area (TLA), Number of Patches (NUMP), Mean Patch Size (MPS), Median Patch Size (MEDPS), Patch Size Coefficient of Variance (PSCOV), Patch Size Standard Deviation (PSSSD), Total Edge (TE), Edge Density (ED), Mean Patch Edge (MPE), Mean Shape Index (MSI), Area Weighted Mean Shape Index (AWMSI), Mean Perimeter Area Ratio (MPAR), Mean Patch Fractal Dimension (MPFD), Area Weighted Mean Patch Fractal Dimension (AWMPFD) statistical values have been used for the evaluation three criteria which are patch size and number, patch form, patch edge and core areas. Fragmentation process has been taken as a base in the assessment of patch size and number. The amount of fragmentation in patch classes has been stated depending on the related statistics and the habitat values have been evaluated within this scope. While evaluating the patch form criterion, the statistics about the straight, round and pressed patches and folded, lobed and long patch classes have been used. The habitat values have been evaluated according to the fact that patch classes that have straight, sound and pressed forms create opportunities mostly for interior habitats and hence for the species that live in interior habitats. While evaluating patch edge criterion, it has been stated that the patch classes that has little density would probably shelter interior habitat species depending on the patch edge densities (Forman and Godron, 1986; McGarigal and Marks, 1994; Forman, 1995; Leitao and Ahern, 2002; Uzun, 2003; Rempel, 2010).

Overlay analysis and plan decisions

As a result of water process analysis, erosion process analysis and landscape structure analysis, overlaying of landscape functions that are related to the research area with ArcGIS 9.3 program has been

Table 1. The criteria that are used for stating habitat functions of research area (Forman and Godron, 1986; McGarigal and Marks, 1994; Forman, 1995; Rempel, 2010; Leitao and Ahern, 2002; Uzun, 2003).

Criterion	Exist situation	Function	Score
a. Patch size and number	Patch classes of little fragmentation	Very high valued function	5
		High valued function	4
		Medium valued function	3
	Patch classes of much fragmentation	Low valued function	2
		Very low valued function	1
b. Patch form	Straight, round and pressed	Very high valued function	5
		High valued function	4
		Medium valued function	3
		Low valued function	2
	Folded, lobed and long	Very low valued function	1
c. Patch edge	Little density for patch edge	Very high valued function	5
		High valued function	4
		Medium valued function	3
		Low valued function	2
	Much density for patch edge	Very low valued function	1
d. Core area	Much density for core areas	Very high valued function	5
		High valued function	4
		Medium valued function	3
		Low valued function	2
	Little density for core areas	Very low valued function	1

performed. Following this, some suggestions have been made regarding the research area.

RESULTS

Water process analysis

Infiltration means that rainfall water leaks in from soil surface (Balci, 1996). According to Okman (1994), infiltrations is defined as speed of water that leaks from soil surface and the amount of the water that leaks from soil surface is expressed as depth in time dimension. There are II, III, IV, VI, VII and VIII soil classes in the research area. When the reports about the quality of soil and the area are examined, it has been concluded that class II soil has a sandy and seated texture, class III soil has a loamy and sandy texture, class IV, VI and VII soil has a loamy texture and class VIII soil has a sandy texture. When soil texture infiltration values are examined, it has been shown that class II and VIII soil has high permeability level and class III, IV, VI, VII soil has medium permeability level (Okman, 1994; Yüksel, 1995; MTA, 1999; MTA, 2008) (Figure 5).

The studies of Uzun (2003) and MTA (1999) have been used while assessing the geological structure. The rocks in the research area have been arranged in importance order as high, medium and low in terms of groundwater yield (Table 2). Infiltration levels of the graywackes in the research area have been pointed and mapped according to Table 2 (Figure 6).

Infiltration levels have been finalized by comparing hydro geologic permeability and slope state according to the rock types (Table 3, Figure 7).

Table 4 that has also been used by Şahin (1996) has been developed to detect total infiltration zones. According to that table, transmission areas for infiltration values of geology and soil parameter sub-classes have been pointed and classified (Figure 8).

Erosion process analysis

In erosion process analysis of the research area, while geology and slope maps have been used for permeability of rocks, vegetation and slope maps have been used for soil conservation.

Erodibility map

The classification of rock erodibility has been made according to 1/25000 geology map (Table 5). Overlay analysis of slope layers and rock erodibility has been

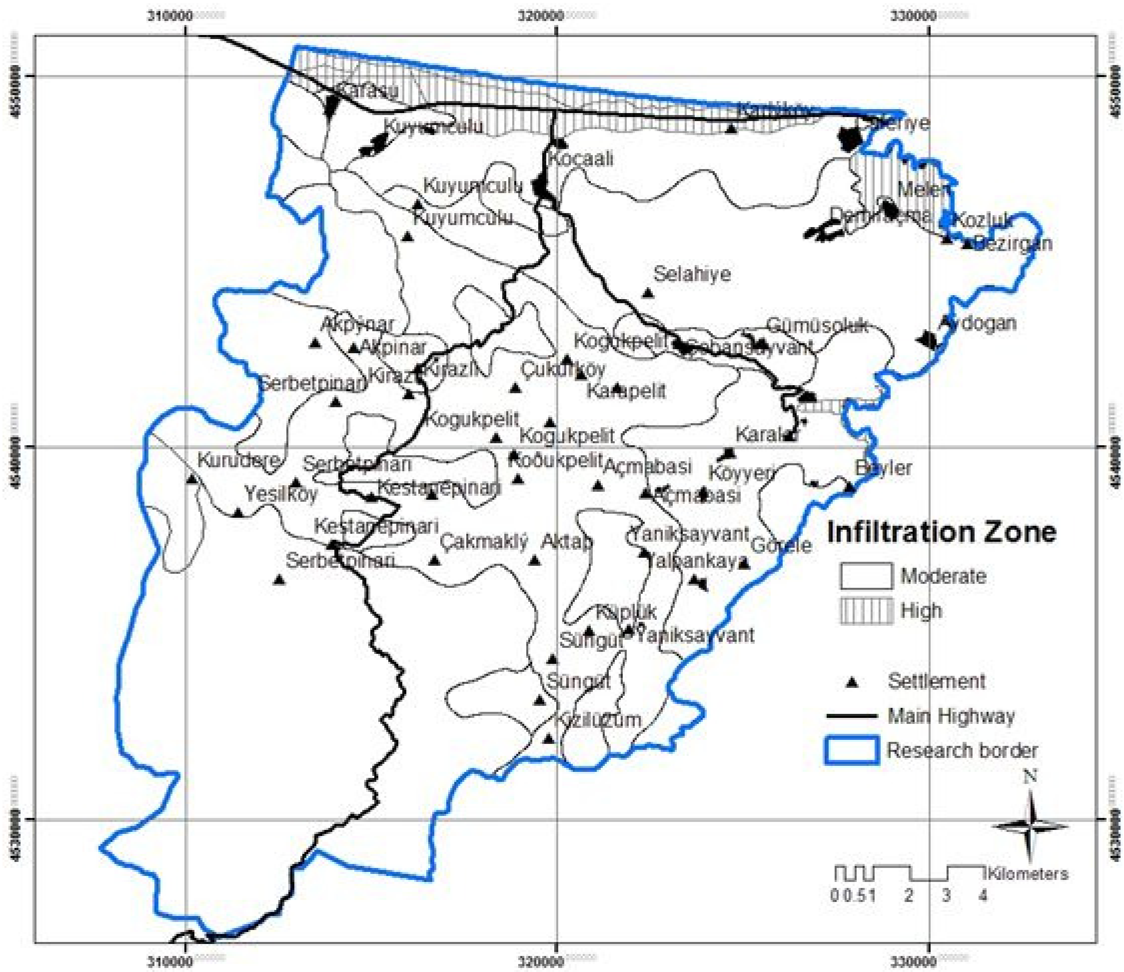

Figure 5. Soil texture infiltration zones in the research area.

Table 2. Permeability Values of the Graywacke in the Research Area Uzun (2003) MTA (1999).

Infiltration rate, permeability and degrees	Graywacke
High	Alluvium
Moderate	Clayey lime stone, lime stone, sand stone, sand stone-mud stone, sand stone-mud stone- lime stone, gravel stone- sand stone, gravel stone- sand stone-mud stone
Low	Shale

made and geologic erodibility has been presented in this way (Table 6) (Figure 9).

Soil conservation degrees

Forest and soil, Corine 2006 (ÇOB 2010), 1/25 000 scaled topographic maps (HGK, 2005) have been combined and overlaid with slope layer to state the soil conservation process (Tables 7 and 8) (Figure 10). FAO (1970), Spain-MOPU (1985) and Spain-LUCDEME projects and the studies of Şahin and Bariş (1996) and Şahin and Kurum (2002) have been used in the indexes that are used while the degrees are compared.

Geologic erodibility and soil conservation state have been overlaid and in this way, potential erosion degrees of the research area have been obtained (Table 9) (Figure 11).

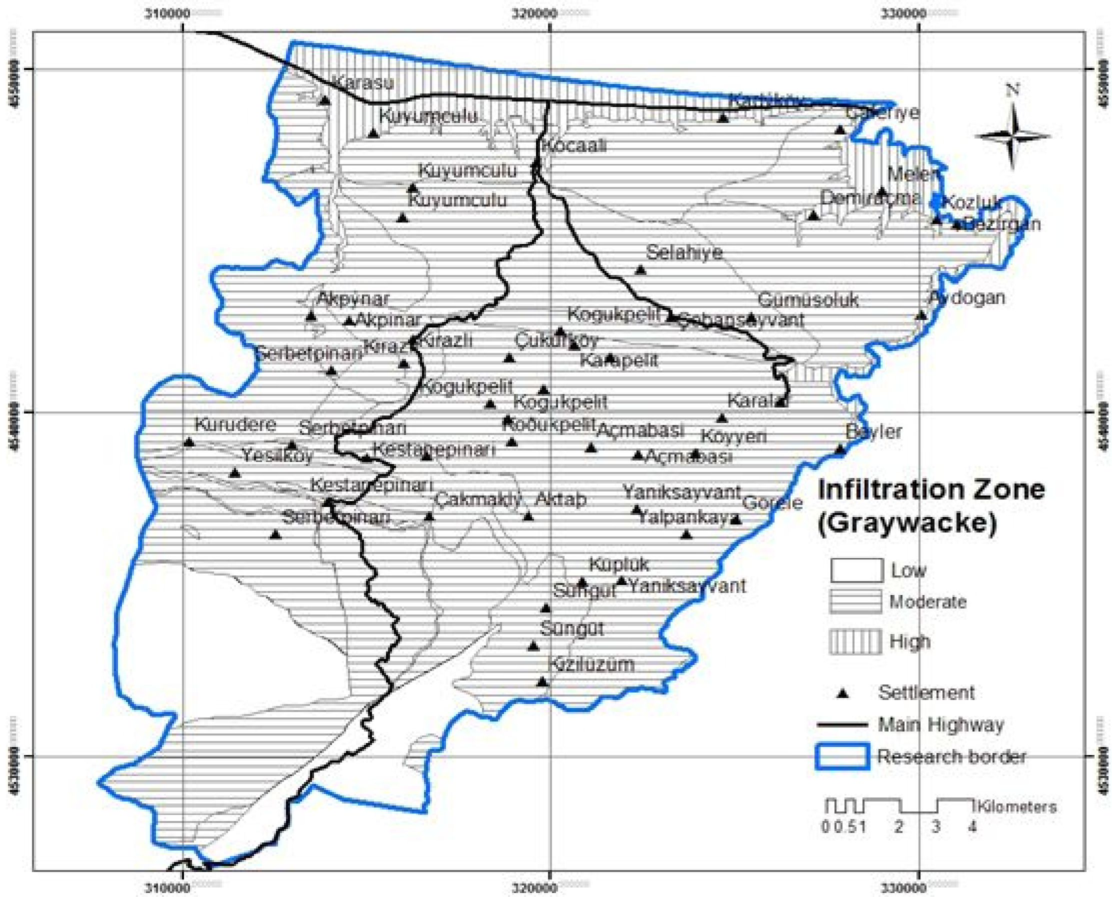

Figure 6. Infiltration zones of the Graywackes in the research area.

Table 3. Values in which define infiltration zones evaluating hydro geologic permeability and slope case all together in the research area.

Hydrogeology permeability	Slope %					
Hydrogeology permeability degrees	0-2	2-6	6-12	12-20	20-30	>30
L	L	VL	VL	VL	VL	VL
M	VH	H	H	H	M	M
H	VH	VH	VH	H	H	M

VH: Very high, H: High, M: Moderate, L: Low, VL: Very low.

Landscape structure analysis

Before making habitat patches analyses, matrix; patches and patch classes should be stated. The main matrix in the research area is forest and agriculture matrix. The southwest of the area consists of forested lands. There are hazelnut-groves that were formed as a result of forest destruction earlier in many parts of the area. Five patch classes have been identified in the research area.

(1) Mixed forest: That consists of leafy and coniferous plants
(2) Permanent crops and shrubs: Shrubbery and hazelnut-groves that cover many parts of the research area
(3) Sandy seashore: Seashore that shelters *Pancratium maritimum* plant inside
(4) Agriculture: Irrigated and non-irrigated cultivated areas that take place dispersedly in the area.
(5) Grassland: Pasture area that is situated on the northwest of the area

Land use layer in soil maps, Corine 2006 land cover data, 1/25 000 scaled topographic map (HGK, 2005), forestry

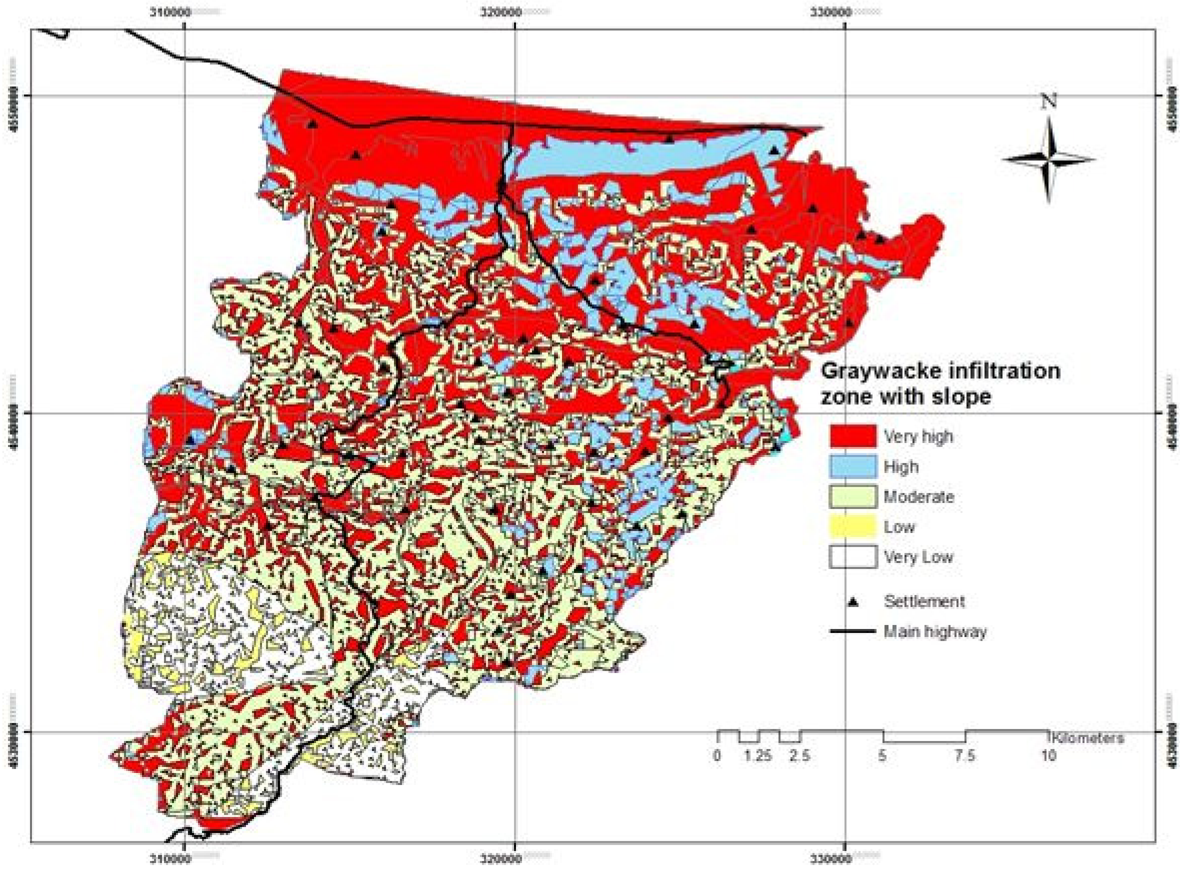

Figure 7. Graywacke permeability values in the research area (slope and rock permeability values).

Table 4. Comparison between geologic permeability and soil permeability layers for the infiltration state by modifying Şahin (1996).

Infiltration	Soil permeability degree				
Geology permeability degree	VH	H	M	L	VL
VH	VH	VH	H	M	L
H	VH	H	M	L	VL
M	H	M	L	VL	VL
L	H	M	L	L	VL
VL	H	L	VL	VL	VL

VH: Very high (5), H: High(4), M: Moderate (3), L: Low (2), VL: Very low (1).

development map and field observations have been used to define the exact borders of patch classes. The land use map and the road map that is formed by 1/25 000 scaled topographic map of the research area have been overlaid. Five meters tampon zone has been formed for the roads. In this way patch classes of the research area have been organized.

Analyses in class scale are considered to be enough as there is no other basin or landscape to compare and the studies would not be carried out in detail scale that would sink to the level of patch in the research. Habitat function of patch classes has been presented by showing fragmentation state of each class according to each other and interpreting these values in terms of fragmentation process. Within this context, an analysis made with "Patch Analysis 4" program that was developed by Rempel (2010) on the basis of classes and the criteria that have been stated in the method have been evaluated and transferred to the map (Table 10).

The studies of Forman and Godron (1986), McGarigal and Marks (1994), Forman (1995), Uzun (2003), Rempel (2010) have been used while evaluating the patch analysis results. The points that the related patch classes get as a result of five point likert scale can be seen in

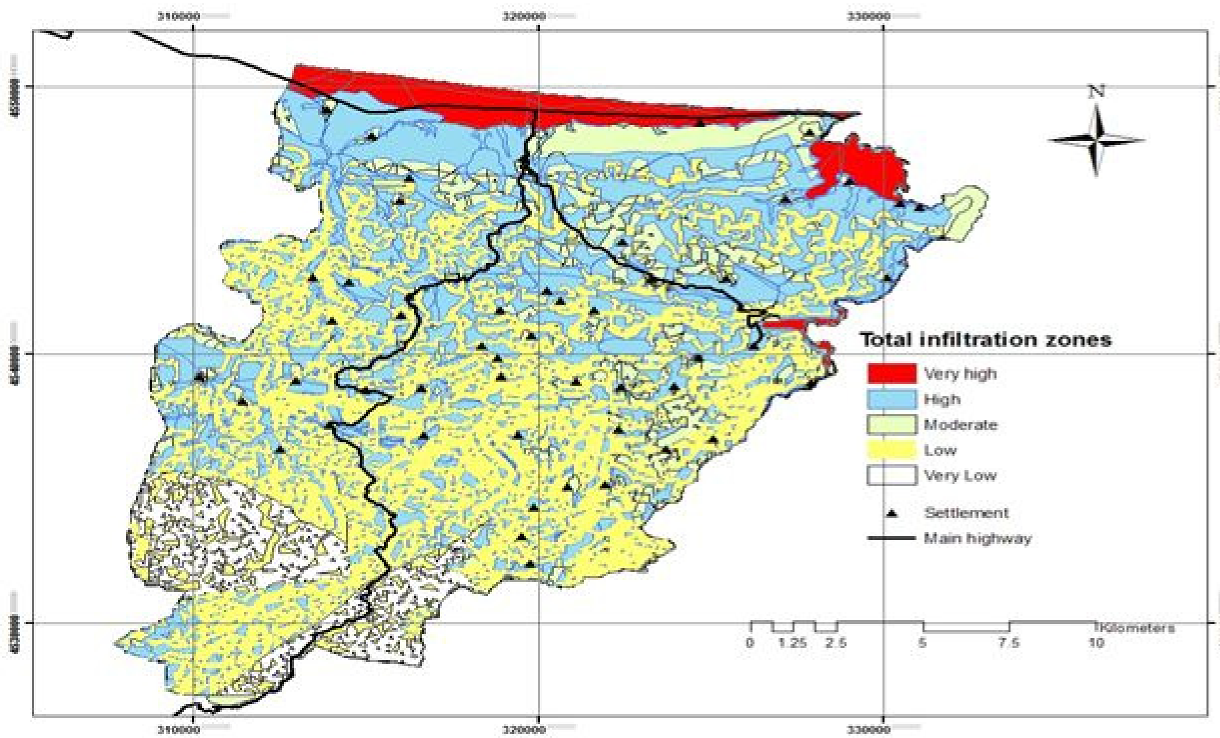

Figure 8. Research area total infiltration zones.

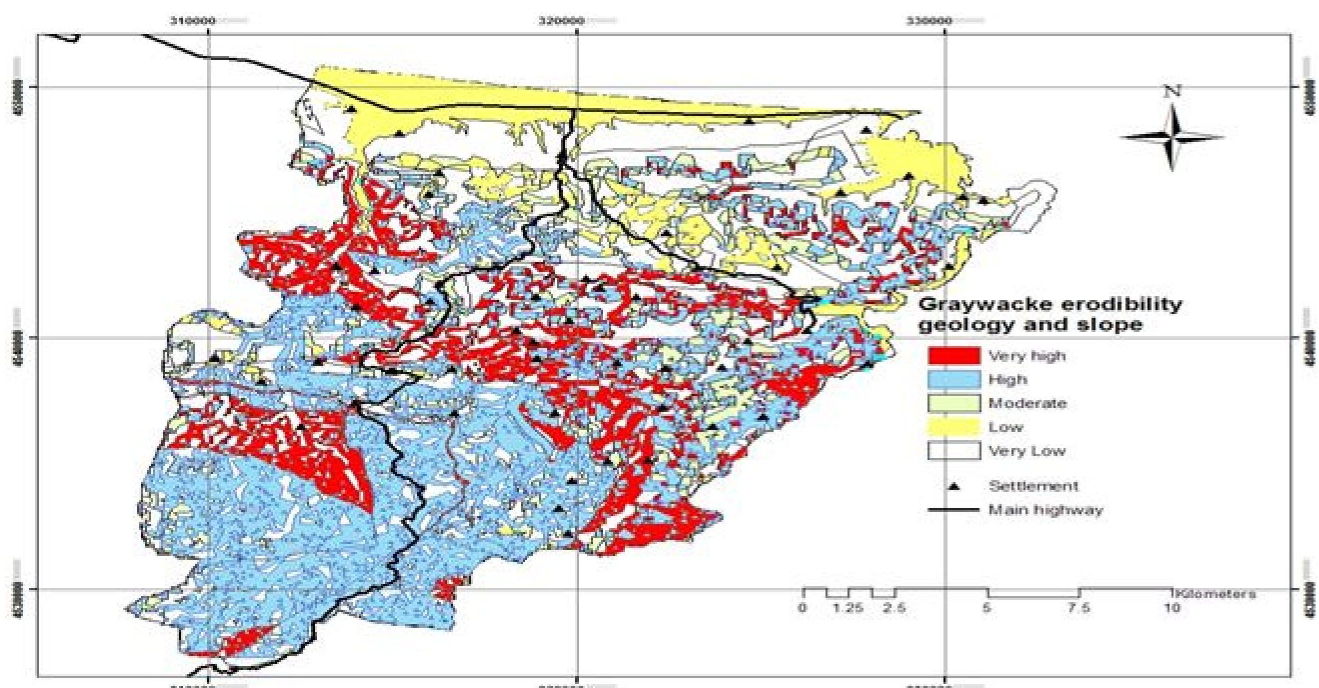

Figure 9. Erodibility map.

Table 11.

Within the concept of patch density, size and variability metrics, number of patches and mean patch size values have been assessed by taking fragmentation process as

Table 5. Rock erodibility classification according to rock types.

Class	Rocks
Well cemented calcareous rocks	Clayey lime stone, Shale Lime stone, Sand stone-mud stone- Lime stone,
Compacted calcareous rocks	Sand stone-mud stone Sand stone, Gravel stone- Sand stone Gravel stone- sand stone-mud stone
Aluvial deposits	Alluvium

Table 6. Comparison between rock erodibility and slope (Adopted from Mapa/Icona, 1983, 1991; Atucha et al., 1993; Gardi et al., 1996; Şahin and Kurum, 2002; Dilek et.al., 2008).

Rock erodibility	Slope %					
Geology erodibility degree	0-2	2-6	6-12	12-20	20-30	>30
Well cemented calcareous rocks	VL	VL	VL	L	M	H
Compacted calcareous rocks	VL	VL	L	M	H	VH
Aluvial deposits	L	L	M	H	VH	VH

VH: Very high, H: High, M: Moderate, L: Low, VL: Very low.

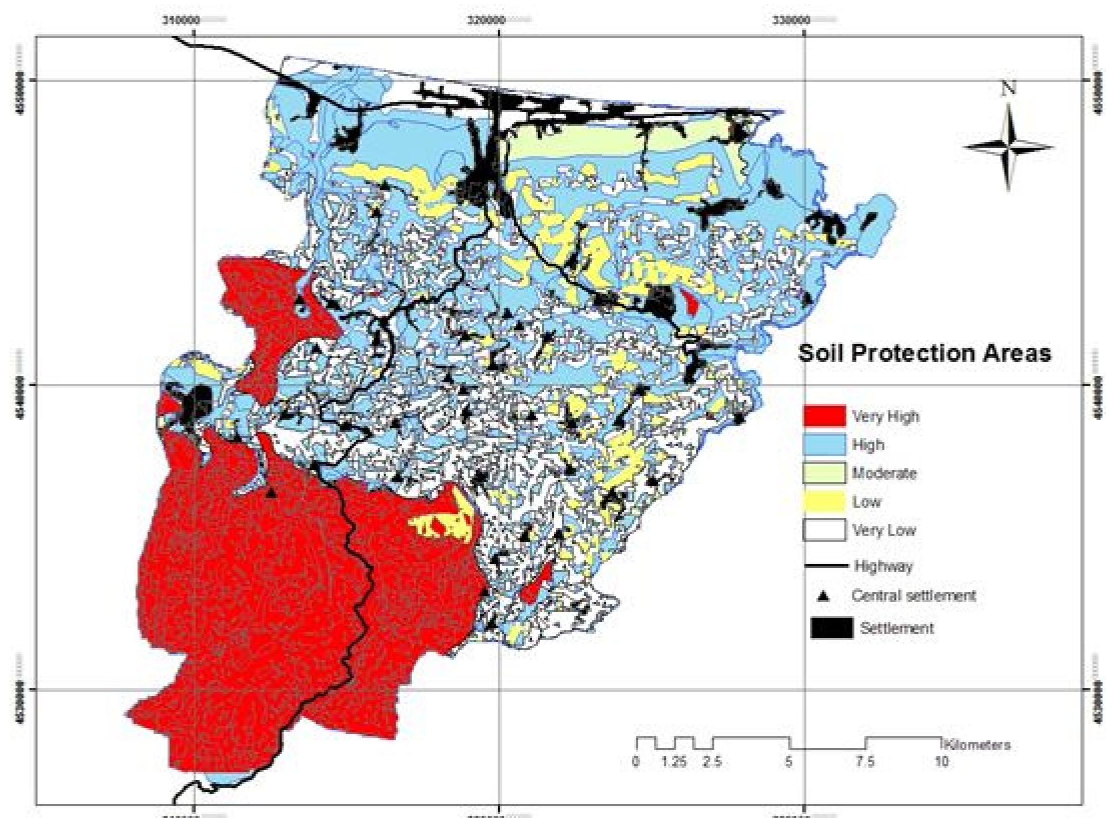

Figure 10. Soil conservation state of the project area.

Table 7. Soil protection indices by vegetation cover by IFIE (Mapa/Icona, 1983).

Vegetation type	Statement	Slope	Protection index
Forest	Dense woodland cover (0.7 density)	For any slope gradient	1.0
	Woodland cover with less than 0.7 density and non-degraded bushes and herbaceus plant cover.	For any slope gradient	1.0
	Woodland cover with less than 0.7 density and degraded bushes and herbaceus plant cover.	3	0.4
		2	0.8
		1	1.0
	Non-degraded bushes cover.	for any slope gradient	1.0
	degraded bushes cover	3	0.2
		2	0.6
		1	0.8
	well-conserved pasture	<30%	0.9
		>30%	0.6
	degraded pasture	For any slope gradient	0.3
Agriculture	agriculture without conservation practices	3	0.0
		2	0.5
		1	0.9
	agriculture with conservation practices	1 and 2	1.0
		3	0.3
Bare-Land		3	0.0
		2	0.5
		1	0.9

1. slope inferior than the gradient of erosion initiation, 2. slope between the gradient of erosion initiation and total dragging,3. slope superior than the gradient of total dragging.

Table 8. Adopted soil protection indices and soil protection grades (Adopted from Mapa/Icona 1983, 1991; Şahin and Kurum 2002).

Type of vegetation cover	Slope					
	0-2	2-6	6-12	12-20	20-30	>30
Dense woodland	1.0	1.0	1.0	1.0	1.0	1.0
	VH	VH	VH	VH	VH	VH
Loose woodland	1.0	0.8	0.6	0.6	0.4	0.4
	VH	H	M	M	L	L
Degraded bushes areas	0.8	0.6	0.4	0.4	0.2	0.2
	H	M	L	L	VL	VL
Degraded pasture	0.8	0.8	0.6	0.6	0.2	0.2
	H	H	M	M	VL	VL
Agricultural areas	0.8	0.8	0.6	0.4	0.2	0. 2
	H	H	M	L	VL	VL
Bare-Lands	0.0	0.0	0.0	0.0	0.0	0.0
	VL	VL	VL	VL	VL	VL

Soil protection grades: VH: Very high (1.0), H: High (0.9-0.8), M: Moderate, (0.7-0.6) L: Low,(0.4-0.3) VL: Very Low (0.2-0).

Table 9. Comparison between erodibility in terms of potential erosion and soil conservation state, erosion risk situation.

Potential erosion	**Soil protection degree**				
Erodibility degree	VH	H	M	L	VL
VH	L	M	H	VH	VH
H	L	M	M	VH	VH
M	VL	L	M	H	H
L	VL	VL	L	M	L
VL	VL	VL	VL	L	L

VH: Very high, H: High, M: Moderate, L: Low, VL: Very low.

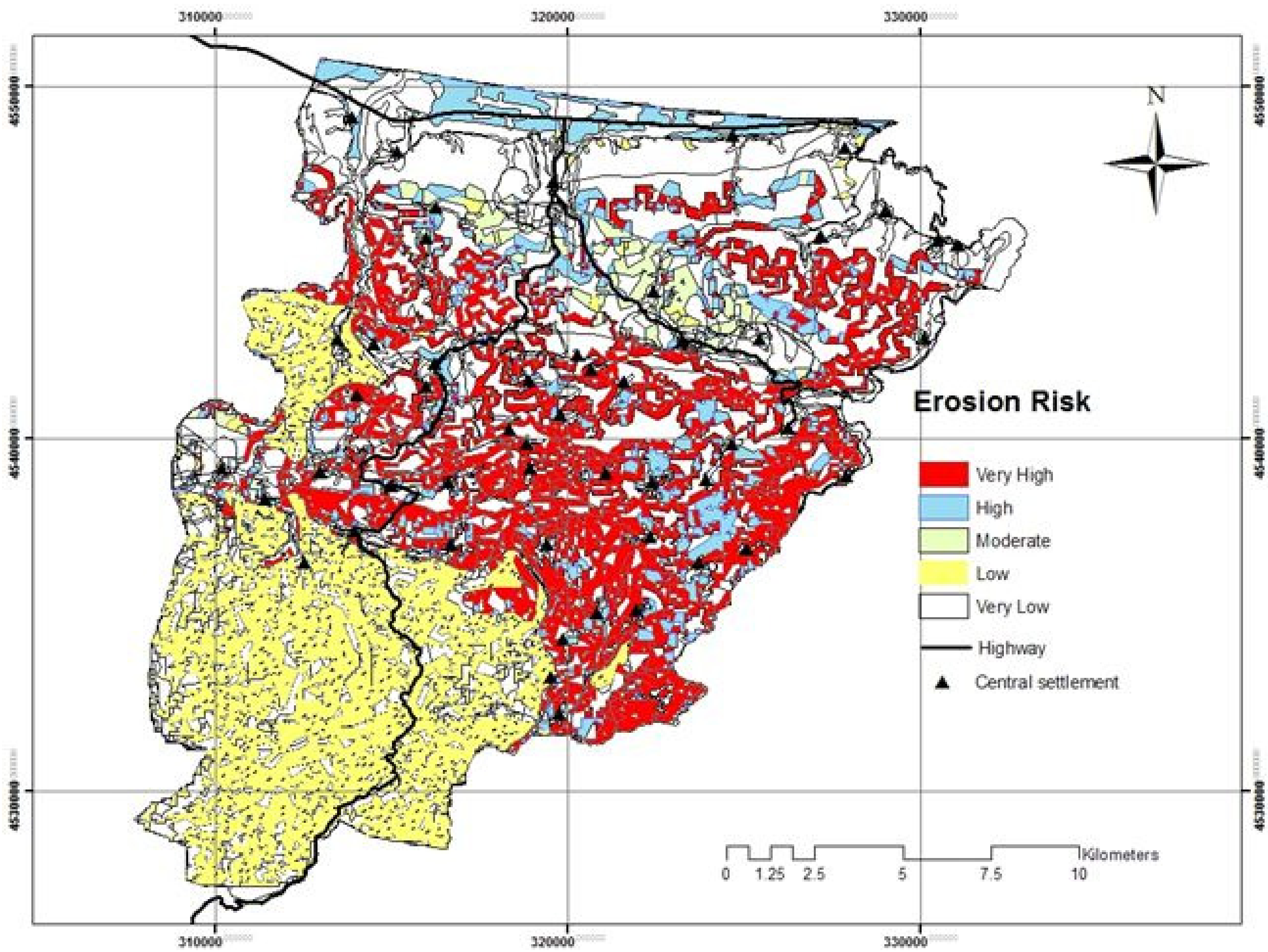

Figure 11. Erosion risk map.

base. A landscape that has high patch density in terms of patch type is more fragmented than a landscape that has low patch density. A patch type that has low averagepatch metric in one single landscape is more fragmented than the other patch type (McGarigal and Marks, 1994). When the patch classes are examined in terms of fragmentation in the research area, the landscape function of patch classes are arranged from the highest one to the lowest one respectively as follow; mixed forest, permanent crops and shrub, sandy seashore, agriculture and grassland (Table 11) (McGarigal and Marks, 1994; Forman, 1995; Dramstad et al., 1996; Olson and Andow, 2008; McGarigal et al., 2009).

Total edge, edge density and mean patch edge values have been measured in terms of edge metrics. It has been concluded that the more density a patch class has, the more fragmented that patch class is. When the

Table 10. Research area, patch-corridor-matrix model, patch analysis results.

Landscape metrics		Patch classes				
		Mixed forest	Permanent crops and shrub	Sandy seashore	Grassland	Agriculture
Class area	CA (ha)	9005.3	19077.79	788.35	76.75	3064.15
Total landscape area	TLA (ha)	34451.56	34451.56	34451.56	34451.56	34451.56
Number of patches	NumP	129	1716	240	30	520
Mean patch size	MPS	69.80	11.11	3.28	2.55	5.89
Median patch size	MedPS	0.02	0.07	0.12	0.09	0.26
Patch size coefficient of variance	PSCov	426.16	372.14	382.16	226.24	406.44
Patch size standard deviation	PSSD	297.50	41.37	12.55	5.78	23.95
Total edge	TE	509214.91	2182054.90	178836.54	17698.42	1.29
Edge density	ED	14.78	63.33	5.19	0.51	14.78
Mean patch Edge	MPE	3947.40	1271.59	745.15	589.94	979.22
Mean shape index	MSI	3.90	2.52	2.21	1.90	2.27
Area weighted mean shape index	AWMSI	2.88	2.00	2.47	1.60	2.13
Mean perimeter AREA ratio	MPAR	517538.57	40716.33	5656.80	3138.49	86948.57
Mean patch fractal dimension	MPFD	1.55	1.57	1.58	1.55	1.52
Area weighted mean patch fractal dimension	AWMPFD	1.28	1.27	1.32	1.29	1.29

Table 11. The evaluation of patch classes in terms of habitat function.

Assesment criterion	Patch classes				
	Mixed forest	Permanent crops and shrub	Sandy seashore	Agriculture	Grassland
a. Patch size and number	5	4	3	2	1
b.Patch form	1	3	4	2	5
c. Patch edge	3	1	4	2	5
Total	9	8	11	6	11

1: Habitat function has very low value. 2: Habitat function has low value. 3: Habitat function has medium value. 4: Habitat function has high value. 5: Habitat function has very high value.

related metric values are examined, the arrangement of patch classes according to edge density from the least fragmented ones to the most fragmented ones is as follows grassland, sandy seashore, mixed forest, agriculture and permanent crops and shrub respectively. The most fragmented patch class is permanent crops and shrub (Table 11) (McGarigal and Marks, 1994; Forman, 1995; Dramstad et al., 1996; Olson and Andow, 2008; McGarigal et al., 2009).

Mean perimeter area ratio has been assessed in terms of edge metric. The fact that MPAR has

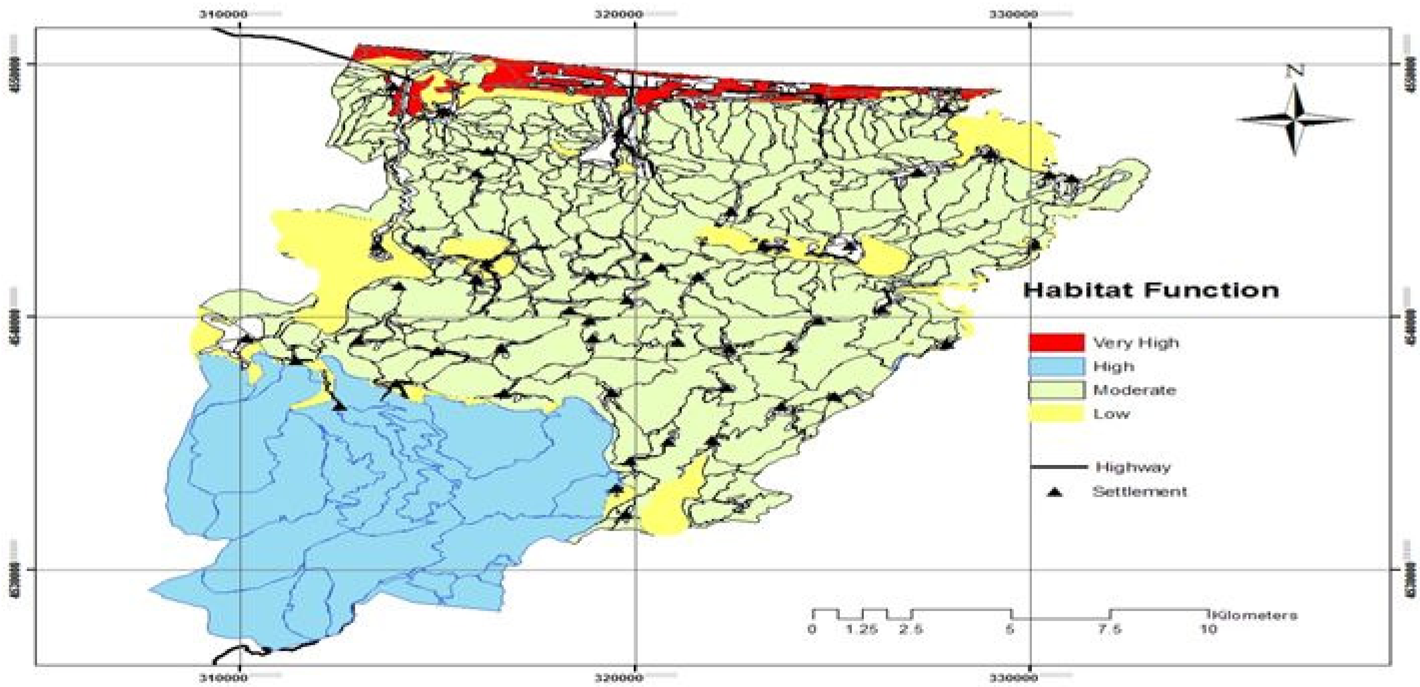

Figure 12. Habitat function of the research area according to landscape metrics.

Table 12. Comparison between potential erosion and permeability state (Uzun et al. 2010).

Landscape soil protection function	Infiltration degree				
Potantial erosion degree	VL	H	M	L	VL
VH	VH	VH	H	M	L
H	VH	H	M	L	VL
M	H	H	M	L	VL
L	H	M	L	VL	VL
VL	H	M	L	VL	VL

VH: Very high protection areas, H: High protection areas, M: Moderate protection areas, L: Low protection areas, VL: Very low protection areas.

low value and MPFD value is close to 1 shows that the patches have a more pressed structure. Round patched have been considered to have the optimum shape ecologically. Also, when the interior areas in the patch are increased, there will be more species than the amount of increased edge area (Forman, 1995). Within this context, when the patch classes in the research area have been assessed, the arrangement below has been presented concerning the fact that pressed patch classes support habitat function much more; grassland, sandy seashore, permanent crops and shrub, agriculture, mixed forest (Table 11) (McGarigal and Marks, 1994; Forman, 1995; Dramstad et al., 1996; Olson and Andow, 2008; McGarigal et al., 2009). As a result of the assessment of patch classes according to habitat function, Figure 12 has been formed according to Table 11.

Overlay analysis

The potential erosion map that has been obtained in provision of the sustainability of landscape in terms of soil conservation function, permeability map and habitat function of patch classes that has been formed with patch-corridor-matrix model have been overlaid in this stage of the research. In this way, functional areas that should be protected for wildlife and human life have been pointed. Firstly, the maps that include erosion risk and permeability values have been overlaid according to Table 12 (Figure 13).

Total landscape function map, in which infiltration, erosion and habitat functions of landscape in the research area has been assessed by overlaying research site, protected areas and degrees maps and habitat

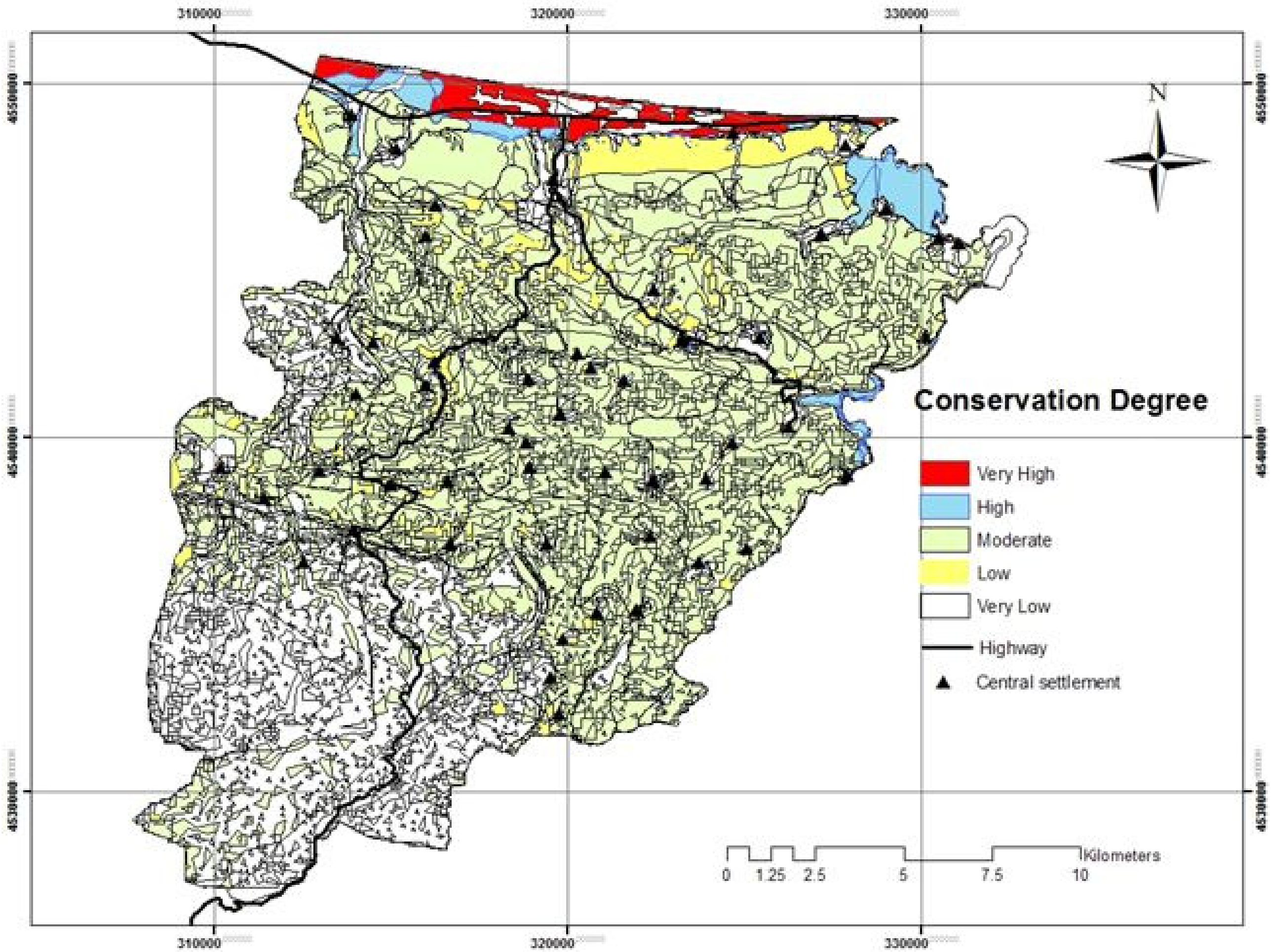

Figure 13. Protected areas and degrees in the research area (according to erosion map and infiltration zones).

Table 13. Overlaying of habitat and protection functions criteria.

Total landscape function	Habitat			
Protection	**VH**	**H**	**M**	**L**
VH	VH	VH	H	H
H	VH	H	H	M
M	H	H	M	L
L	M	M	M	L
VL	M	M	L	VL

VH: Very high protection areas, H: High protection areas, M: Moderate protection areas, L: Low protection areas, VL: Very low protection areas.

function maps according to Table 13, has been obtained (Figure 14).

DISCUSSION

Landscape ecology based landscape planning approaches in which landscape habitat, function and change are explained have been practiced frequently in recent years. In this way, planning decisions that are taken according to the processes that take place inside landscape provide sustainable management of natural resources (McGarigal and Marks, 1994; Forman, 1995; Dramstad et al., 1996; Hobbs, 1997; Opdam et al., 2002; Leitao and Ahern, 2002; Uzun, 2003).

The processes that take place in the landscape can be named as water process, soil process, soil conservation function, habitat function, biodiversity function and bio-comfort function in relation with the conducted landscape (Uzun et al., 2010). Water process function, erosion process function (soil conservation function) and habitat function of landscape have been focused in the research.

Finding infiltration amount in an area too high or too low requires some geologic and soil analysis and taking some examples by carrying out a probe performance in different parts of the area. A special field of expertise is required to measure infiltration amount depending on local conditions and the research area. Permeability analysis of the area has been carried out according to soil, geology and topography maps data to provide information for upper-scaled plan decisions. This situations supports that more proper decisions should be taken in time and sub-region scale. This approach shows parallelism with the findings of Buuren (1994), Şahin (1996), Şahin ve Kurum (2002), Uzun (2003), Dilek et al. (2008).

There are some methods that are relation to the erosion process, prediction of erosion risking and mapping such as ICONA (Bermúdez et al., 1998; Dilek et al., 2008; Mapa/Icona, 1983, 1991; Atucha et al., 1993; Gardi et al., 1996; Şahin and Kurum, 2002), CORINE (Dengiz and Akgül, 2005), USLE (Desmet and Govers, 1996; Fistikoglu and Harmancioglu, 2003). The methodology approach that has been formed by combining guidelines for Erosion/Desertification Control Management prepared by Unep/Map/Pap (2010) and Icona method by Şahin and Kurum (2002) has been used in the research. Icona method provides a quick assessment of potential erosion risk in big areas (Dilek et.al. 2008; Mapa/Icona, 1983, 1991; Atucha et al., 1993; Gardi et al., 1996, Şahin and Kurum, 2002). However, it can only be used in following studies.

A landscape ecology based approach that has been adopted in different stages of landscape planning since 1990s has been used to assess habitat function of landscape in the research. Landscape ecology based approaches provide quick and scientific based opportunities in the landscape structure assessments and analyses. This approach has supported the research findings of Forman and Godron (1986), McGarigal and Marks (1994), Forman (1995), Hobbs (1997), Uzun (2003), Opdam et al. (2002), Leitao and Ahern (2002), Rempel (2010).

The site that has high infiltration zones is situated on the beach which is located on the north of Kocaali. Another important zone is the irrigated farming area by Big Melen Stream in the northeast. Infiltration values decrease according to closeness of the area to the south. Hazelnut farming is done in the areas that have high infiltration values and it is quite possible that the chemicals and fertilizers that are used for hazelnuts interfuse the underground water from permeable grounds (Figure 8).

The area that has the highest erosion risk is the middle part in which hazelnut farming is done. Forested lands in the southwest have the lowest erosion risk owing to its vegetation. The beach part has high erosion risk value. The plants that grow up above the sand in this area play active roles to prevent erosion. However, it has been observed that this forest cover has been destroyed by human pressure in some parts of the area, so the erosion process has begun (Figure 11).

The sites that have few land uses in the research area have very high habitat function in terms of habitat function. Destruction of these sites will be a great loss for the species that live in these sites. Within this context, the beach part and the pasture area in the northwest of the area should be considered as two places that should not be lost (Figure 12).

The areas that have high values and should be protected have been stated to be the ones in the north of the area according to data formed by overlaying infiltration maps and potential erosion maps. This part faces important human interventions (use of the beach and settlements). Similarly, the cultivated areas and posture areas near the beach have been stated to be the areas that should be protected. The area of hazelnut-groves in the middle part needs medium level protection (Figure 13).

By overlaying all of the maps related with the research area, it has been revealed that the north part of the area should be protected in terms of the aforementioned three functions. The forested land in the south of the area should also be protected in terms of three functions. In the same time, this area has a function in that it provides potable water supply for the settlements around it (Figure 14).

The beach that is situated on the shore edge has been considered to be the first degree protected area according to the map that is formed by overlaying water, soil conservation and habitat function of landscape. In a study that has been carried out in this area Demir et al. (2010), it has been emphasized that the beach part that has *P. maritimum* L. plant should be protected. This shows that the site that emerges as a result of the overlay method shows parallelism with the results of the analysis that has been conducted in the area. Settlement is an important pressure in the seaboard in which there are *P. maritimum* plants, for this reason, development side of the settlements should be directed to the south instead of the north.

A barrage construction within the scope of Big Melen drinking water project in Ortaköy site in the southeast of the area has become a current issue. According to three examined analyses, this area has been considered to be medium level protected area. However, it should be noted that landscape restoration works are performed around the near neighborhood of pipelines that have been constructed for water transmission to Istanbul.

There are hazelnut-groves that have quite fragmented

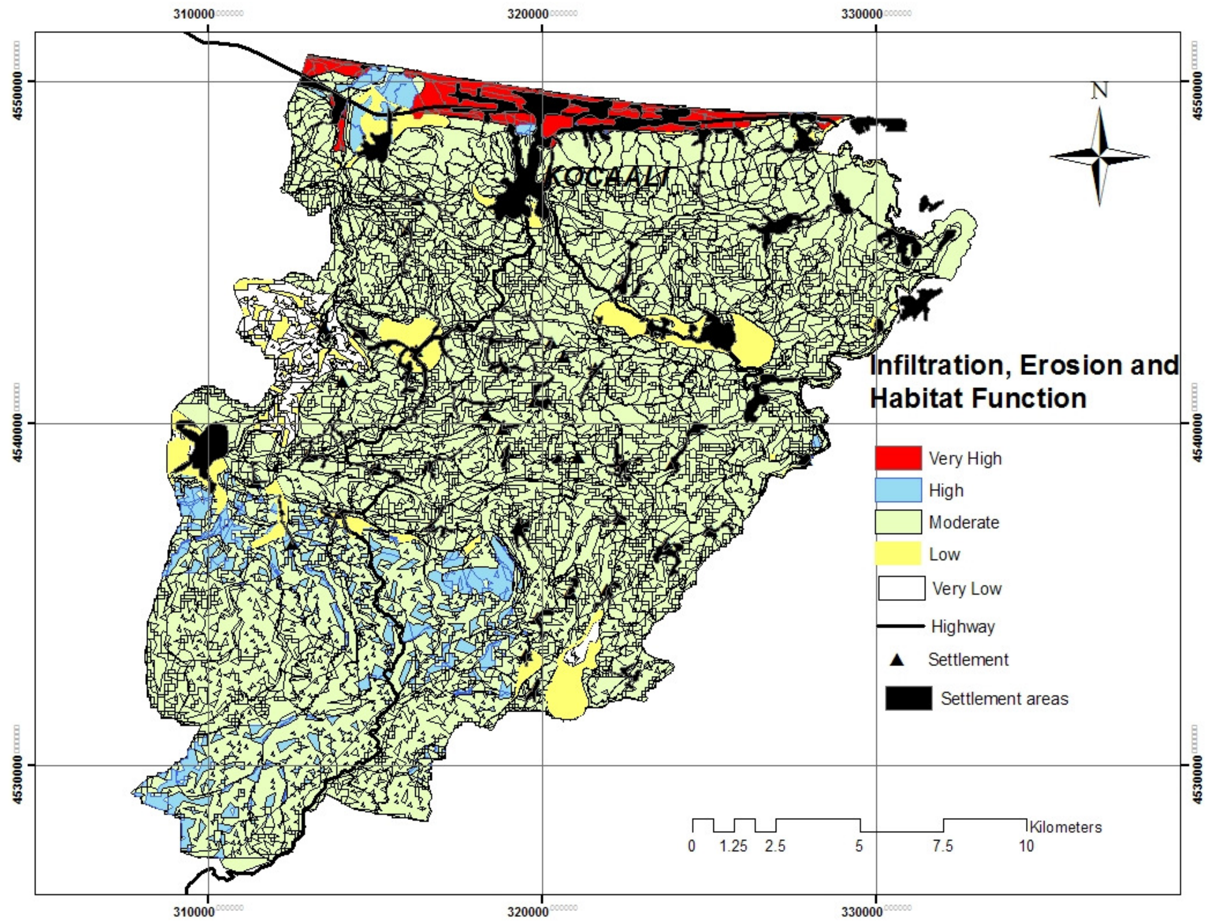

Figure 14. Total landscape function map.

structure in the large part of the area that has medium protection level. As a result of extensive human pressure, there are so much intervention and pressure. The forested land in the southwest of the area is an important area for the habitat function and vertebrates. The hazelnut-grove areas are important habitats for edge species.

Conclusions

As a conclusion, the use of landscape function in landscape planning has been one of the important approaches in recent years. Within the scope of the research, water process, soil conservation function and habitat function analyses have been carried out. The related analyses can be used in some sectors such as agriculture, forestry and settlement separately. Additionally gathering all of the function levels together in region or sub-region scale will be a guideline for the planning decisions. Just as water process, erosion process and habitat process assessed in the research can be used separately in plan decisions regarding different sectors such as agriculture, settlement, forestry and industry, they can also be used in plan decisions about the area in region or sub-region scale by combining the whole process with overlay analyses. Using different functions of landscape by the help of overlay analyses particularly supports the planner for planning decisions in advance of important decisions (Uzun et al., 2010). In addition to the conducted analyses, landscape character type can be stated and all the analyses will be made in the context of landscape character type by the help of the data available (Swanwick, 2002; Washer, 2005). Further studies for this point should be carried out.

The analyses used in the research have been made by the help of GIS program. GIS program provides convenience in collecting, storing, processing and analyzing of the data.

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