Chapter 5

Use of Watersheds Boundariesin the Landscape Planning

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Additional information is available at the end of the chapter

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1. Introduction

Interactions between human society, biosphere, atmosphere, and hydrosphere have increased extensively, sometimes for the welfare of mankind and environment, but frequently for their man. These interactions are characterized by increasing complexity, diversity, use, and misuse of natural resources, the latter permanently decreasing. And this holds true for any scale in space and time, from global to local and from long-term to short term.On the regional and local scale the interactions between society, hydrosphere, and biosphere are relevant (Kaden, 2003) and these interactions determine the future of the landscape.

Landscape is complex and far-reaching. People have strong ties to landscapes and use them in various ways. Thus landscape is interweaves with climate change and ecology, development, economics, politics, and culture (Bastian *et al.*, 2006; Jones, *et al.*, 2007). Landscape changes as a result of these relationships that human-nature interaction. The changes in landscape were brought up idea of planning for sustainable use, conservation and management. But landscape character and structure make difficult landscape planning decisions. Therefore it must be understood primarily "landscape" to successful landscape planning.

Two different approaches have emerged to defining landscape, when the definitions of landscape are evaluated. According to the first approach, landscape is ecological units. In this context Forman (1995) defined landscape as a mosaic where the mix of local ecosystems or land uses is repeated in similar form over a kilometers-wide area. A landscape manifests an ecological unity thought its area. Within a landscape several attributes tend to be similar and repeated across the whole area, including geologic land forms, soil types, vegetation types, local faunas, natural disturbance regimes, land uses, and human aggregation pattern. Thus a repeated cluster of spatial elements characterizes a landscape. Burel and Baudry

(2003) argue that landscape is a level of organization of ecological systems that is higher than the ecosystem level (Farina *et al.*, 2005). It is characterized essentially by its heterogeneity and its dynamics, partly governed by human activities. It exists independently of perception. Landscape is considered mainly a mosaic of geographical entities in which organisms deal with the spatial arrangement of these entities determined by complex dynamics (Farina *et al.*, 2005). Landscape is geographic unit at second approach. Geography, where the landscape plays a central role and may be considered a fundamental unit, is of particular importance in the attempt to delineate a clear, scientifically useful concept of landscape. The definitions in geography essentially focus on the dynamic relationship between natural landforms or physiographic and human cultural groups (Forman and Godron, 1986). Landscape refers to a common perceivable part of the earth's surface. Landscape became a core topic of geography, in particular regional geography. It was seen as a unique synthesis between the natural and cultural characteristics of a region (Mander and Antrop, 2003). As Zonneveld (1979) stated, landscape is part of the spaces on the earth's surface, consisting of a complex of systems, formed by the activity of rock, water, air, plants, animals and man, and that by its physiognomy forms a recognizable entity (Forman and Godron, 1986). The European Landscape Convention defines landscape as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (Anonymous, 2000). In this context Turner *et al.*(2002) indicated landscape as an area that is spatially heterogeneous in at least one factor of interest. Opdam *et al.* (2006) defined landscape as a "geographical unit characterized by a specific pattern of ecosystem types, formed by interaction of geographical, ecological and human-induced forces."

Regardless of how landscape is defined, landscape can be characterized by *structure, function, and change* (Kurum and Şahin, 2000). *Structure,* the spatial relationships among the distinctive ecosystems or elements present-more specifically, the distribution of energy, materials, and species in relation to the sizes, shapes, numbers, kinds, and configurations of the ecosystems. Landscape structure is generally defined in terms of "composition" and "configuration". Dunning *et al.* (1992), these are, respectively, the kinds of patches present in the landscape and the amount of each, and the spatial relationships among them as indices of landscape structure, landscape metrics can be used to describe the composition and spatial arrangement of a landscape (Forman and Godron, 1986). They can be applied at different levels to describe single landscape elements by such features as size, shape, number or for whole landscapes by describing the arrangement of landscape elements and the diversity of landscape (Forman and Godron, 1986; Waltz, 2011). Forman and Godron (1986) defined *landscape function* from a systems-theoretical point of view as "the interactions among the spatial elements, that is, the flows of energy, materials, and species among the component ecosystems". Leser (1997) emphasized that it is necessary to analyze functions and functional interactions between landscape factors and landscape components in order to understand the relationships within the system (Bastian, *et al.* 2006). *Change,* the alteration in the structure and function of the ecological mosaic over time (Baker, 1989).

Landscape change, because they are the perceivable expression of dynamic interactions between the physical and material environment and natural and cultural forces. In addition, Consequently, landscapes differ from place to place and different landscape types can be recognized as well as different landscape regions (Mander and Antrop, 2003). In this context three main factors can be identified in determining landscape: physical, biological and anthropic. Their interaction are continuously composing the landscape in such a way that we can distinguish between a spatial and a temporal aspect of this composition. The spatial landscape variety consists in the present interrelation of these three factors in a certain place (Kerkstra *et al.*, as cited in Makhzoumi, 1973 and Pungetti, 1999). In addition history and ecology are essential factors in the structuring and understanding of landscapes. No reference is made to "special" landscapes such as "spectacular" or "ordinary" ones, to rural, industrial or urban ones; all landscapes should be considered equally (Antrop, 2005).

Landscape ecology provides understanding of change of landscapes. In addition landscape ecology provides a strong conceptual and theoretical basis for management and planning at the landscape level by contributing to a better understanding of the structure and function (Uzun, 2003; Ivits *et al*., 2005). Landscape ecology, a subdiscipline of ecology, is the study of how landscape structure affects the abundance and distribution of organisms. Landscape ecology is the study of the pattern[1] and interaction between ecosystems within a region of interest, and the way the interactions affect ecological processes, especially the unique effects of spatial heterogeneity on these interactions (Clark, 2010). Landscape pattern consists of three elements: patches[2], corridors[3] and a matrix[4]. In addition, landscape ecology involves the application of these principles in the formulation and solving of real-world problems (Forman, 1995).

Landscape planning has come up in the process of understanding, maintainable usage and preservation of the landscape that changed as a result of the relationship and interaction between the man and the nature (Bastian *et al.*, 2006; Jones, *et al.*, 2007). Landscape planning is the key planning instrument for nature conservation. The basis for the concept of planning is formed by the idea of ''balancing the needs and the sources by complying with rational priorities in the long term to reach certain goals with scarce resources'' (Keleş, 2004). From upper scale to subscale, the planning includes physical environment, socio-cultural life, history on economic and political issues, decisions concerning today and future (Uzun, *et al.*, 2012). Also, social and physical are grouped as executive and object planning (Zaimoğlu, 2003). At that point, landscape planning is evaluated as the subtopic of physical planning (Köseoğlu, 1982) and accepted as the basis for it (Zaimoğlu, 2003).

The European Landscape Convention defines landscape planning as "strong forward-looking action to enhance, restore or create landscape" (Anonymous, 2000). Landscape planning is an activity that analyses, plans and localises landscape and environmental characteristics, resources and values (Dökmeci, 1996). Steiner (1999) used the term of

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[1] Pattern refers to its spatial arranges of ecosystems and their type, number, size, shape, and relative relationship over the landscape (Forman, 1995).

[2]Patch is a wide relatively homogeneous area that differs from its surroundings. Patches have familiar attributes, such as large or small, rounded or elongated, and straight or convoluted boundaries (Forman, 1995).

[3]Corridors, as strips that differ from their surroundings, permeate the land (Forman, 1995).

[4] Matrix is the background ecological system of a landscape (Forman, 1995).

landscape plan to emphasize that such as plans should incorporate natural and social consideration. Uzun *et al.,* (2012) stated that landscape planning had two basic approaches which were ''depending on a certain territory'' and ''directed to problem solving''. The landscape planning studies that depend on a certain territory are examples of the planning studies concerning an area having a developmental potential. It contains the approaches concerning the formation of criteria about determining the territorial usage (agriculture, recreation, etc.) in the process of development of a newly developing region or a sub-region. The landscape planning studies directed to problem solving have the aim of solving the present problems in the landscape planning and the problems concerning the planned usage. Choosing places for industry, settlement, highway route, etc. and landscape renovations are examples for these planning. In addition Uzun and Gültekin (2012) emphasized 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.

L. McHarg (1920-2000), the pioneer of the environmental movement, revealed that natural sciences should be evaluated in solving the problems, by focusing on the natural life processes and their determinative effects on area usage plans (Şahin, 2009a). In this context, putting preservation and usage balance forward, examining the ecological features, analysing the usages and accordingly the ecological relationships, and after these examinations, defining the actions and forming an environment which people will take the most benefit of, but will be less threat for other animals are emphasised in the landscape planning (Uzun *et al.,* 2012). At the same time landscape planning provides a coordinated information basis for all natural resources, which enables us to rapidly obtain an overview of the nature and landscape situation within the planning areas; fragmented changes to individual parts of nature and the landscape can be assessed with respect to their effect on the whole existing condition; planning and nature conservation experts in the administration can use this as basis for quick and uncomplicated comments. The complex interaction of all the factors affecting the balance of nature such as soil, water, air and climate, plants, and animals, as well as diversity, characteristic features and beauty and the recreational value of nature and landscape as well as the effects of existing and foreseeable land usages, are analysed and assessed within the landscape planning. As a result, extensive basic information about nature and the landscape is available for the whole area. The spatial objectives, measures and requirements developed in the landscape on the protection, maintenance and development of nature and the landscape (Anonymous, 2008).

In the basis of a successful landscape planning lies understanding and knowing the landscape. In this context, landscape structure, landscape processes and the changes in landscape were effective items. Uzun *et al*. (2012) states that the structure and functions of landscape are evaluated, landscape processes are analysed and landscape ecology based approaches are put forward in the recent landscape planning studies. In this context landscape ecology have also attached great significance to the issue of scale, and the "landscape units" is more widely canvassed as a framework for analyzing inter-relationship and delivering joined-up policy within a comprehensible and identifiable space (Selman, 2006).

In this study, the concept of boundary in landscape planning is emphasized. Additionally, the use of the ArcHydro Model was described to delineate watershed boundaries.

2. Exploring the boundaries in landscape planning

Natural systems are usually considered parts of hierarchies—an ordering from biggest to smallest (or vice-versa). For our purposes (planning, management, etc.), ecological hierarchy will be discussed from the largest to the smallest scale.

Scale is the dimension of an object or process. It can be described as resolution and range, which indicate in how much detail the object or process has been understood (Du-ning and Xiu-Zhen, 1999). Scale is a key issue in planning. Due to the interdependencies of ecosystems, a planning approach is need that examines a site in its broader context. Scale is related to three dimensions (Selman, 2006).

- A spatial dimension: -the mostly cited component of landscape scale, based on both a rational and intuitive recognitions of distinct physical units.
- A temporal dimension: -implying a continuum from the earliest human use of a landscape into the sustainable use by future generation.
- A modification dimension: -from intensely urbanized areas, through farmland and other types of natural use, to pristine or wilderness areas, with some areas processing such intense degrees of alteration that the landscape requires human assistance to accelerate the recovery of its "regenerative" properties.

The concept of scale can allow to the analysis on the level of different hierarchal system that can be related to each other and it can be related to the hierarchy theory. Allen and Star (1982) stated that the hierarchy theory was developed as a study outline for analysis of complex systems or situations which became organized in certain types. The systems that become organised hierarchically can be divided into functional components. These elements' structure, function and characteristics related to time and space can be formed in scale or on different levels. There is no basic hierarchy in the hierarchy theory. Its focus level can change according to considered events (Hersperger, 1994 as cited in Uzun, 2009). The hierarchical theory is a useful instrument for exploring numerous patterns and processes through various scales in space and time. Considering complexity as an attribute that is intrinsic to a landscape, the hierarchy paradigm explains how the various components located on certain scales enter into contact with other ones that are visible on different scales of resolution. The hierarchical theory views a system as a component in a larger system that consists of subsystems (Allen and Starr, 1982; O'Neill *et al.*, 1986; Allen and Hoekstra, 1992 as cited in Farina, 2001).

The concept of boundary is a spatial expression of the scale and it can be expressed in different ways with hierarchy theory. Such as the biosphere or planet is boundary and is subdivided into continents (and oceans) within hierarchical theory. Continents are subdivided into regions, region into landscapes, and landscapes into local ecosystems or land uses. Region is a broad geographical area with a common macroclimate and sphere of human activity and interest. This concept links the physical environment of macroclimate, major soil groups, and biomes, with the human dimensions of politics, social structure, culture, and consciousness, expressed in the idea of regionalism (Forman, 1995). A region therefore almost always contains a number of landscapes (Forman and Godron, 1986; Duning and Xiu-Zhen, 1999). In addition the region is composed of patches, corridors and a matrix that vary widely in size and shape. In this case the spatial elements are whole landscapes. Unlike the recurring landscape elements in a landscape, a region does not exhibit a pattern of repeated landscape. Usually the distribution of landscape simply mirrors the typically coarse-grained, geomorphic land surface. Thus, most regions are coarse grained or variable-grained with group of small landscapes. In short, the spatial pattern or arrangement of landscape in a region is just as important functionally as the pattern of continents on the globe, local ecosystems in a landscape (Forman, 1995).

Landscape is a dynamic and hierarchical setting. Landscape comprises so many hierarchically constructed ecosystems from a single molecule to the whole Earth and even the limitless emptiness called the space (Selman, 2006). Considering complexity as an attribute that is intrinsic to a landscape, the hierarchy paradigm explains how the various components located on certain scales enter into contact with other ones that are visible on different scales of resolution (Farina, 2001). Every ecosystem has its own boundaries yet is in relation with other ecosystems through the flow of energy and data which ensure the continuity of the system. A system is theoretically in balance when the inputs and outputs required for its functions within its natural boundaries are equal. Therefore, the assessments in defining the capability, capacity and sensitivity of the area for any human activity should be performed within the natural boundaries (Şahin, 2009b). For instance, bioregionalists have argued that "nature" defines its own integral systems and that, historically, sustainability in human systems has been a consequence of close alignment between socio-economic practices and environmental capacity. This leads to arguments, discussed more fully below, that natural, rather than political, boundaries could form the basis of many planning and management choices (Selman, 2006).

A landscape can vary in size from a few centimeters to tens of kilometers. The heterogeneity might be expressed as physically identifiable structures. At any rate, the degree of heterogeneity varies according to the spatial arrangement of the single component parts. Landscapes do not exist in isolation. Landscapes are nested within larger landscapes that are nested within larger landscapes, and so on. In other words, each landscape has a context or regional setting, regardless of scale and how the landscape is defined. The landscape context may constrain processes operating within the landscape. Landscapes are "open" systems; energy, materials, and organisms move into and out of the landscape. This is especially true in practice, where landscapes are often somewhat arbitrarily delineated. That broad-scale processes act to constrain or influence finer-scale phenomena is one of the key principles of hierarchy theory and “supply-side” ecology. The importance of the landscape context is dependent on the phenomenon of interest, but typically varies as a function of the “openness” of the landscape. The “openness” of the landscape depends not only on the phenomenon under consideration, but on the basis used for delineating the landscape boundary. For example, from a geomorphological or hydrological perspective, the watershed forms a natural landscape, and a landscape defined in this manner might be considered relatively "closed". Of course, energy and materials flow out of this landscape and the landscape context influences the input of energy and materials by affecting climate and so forth, but the system is nevertheless relatively closed. Conversely, from the perspective of a bird population, topographic boundaries may have little ecological relevance, and the landscape defined on the basis of watershed boundaries might be considered a relatively “open” system (Farina, 2001).

Landscape has different hierarchical systems. The classification of a landscape as one goes from lower to increasingly higher levels in the hierarchy: ecotope (the basic unit in a landscape consisting of biotic and abiotic elements); microchore (the spatial distribution of ecotopes); mesochore (the environmental system composed of a group of microchores); macrochore (a mosaic of landscapes); and megachore (a group of geographical elements covering several kilometers). A system exists independently of its components and is generally able to organize itself and to transmit information; in other words, it is able to exist as a cybernetic system. A landscape exhibits its own type of complexity, and in order to understand it fully it is necessary to focus on a certain organizational level. There are innumerable hierarchical levels and thus an equal number of systems that are nested inside them in one way or another. The behavior of a given subsystem conditions nearby systems both above and below it. The speed with which the processes unfold and thus the scales in time are specific to each level. When going from one level to another, it is therefore necessary to adjust the resolution (Farina, 2001). In the most variants of the landscape, researchers refer to something framed at the human scale. However, this is revised upwards to reveal patterns from satellites, and downwards to reveal mosaics related to the life-spaces of meso- and micro- organism. McPherson and DeStefano (2003), writing from an ecological perspective, identify landscape studies as being those undertaken at quite an extensive spatial scale: less extensive than the “biome” or biosphere”, but larger than the ecosystem, community, population, organism or cell (Selman, 2006).

Landscape ecological concepts and applied metric are likely to be useful to addresses the spatial dimension of sustainable planning. The landscape ecological aspect of spatial scale has received so much attention in the literature. Landscape ecology is the study of the interactions between the temporal and spatial aspects of a landscape and its flora, fauna, and cultural components in so far as this impact on ecosystem properties. However, the subject also incorporates the study of water movements, particularly insofar as these impact on ecosystem properties. An understanding of ecological and hydrological pattern and processes not only reveals the complex web of natural interdependencies, but also enroll economic and social systems at these strongly modify the energy and materials inputs into landscape (Selman, 2006). In this context, watershed boundaries, for having well-defined edges make up a fundamental unit for landscape planning (Makhdoum, 2008).

A widely advocated approach to landscape planning is to steward resources on the basis of biogeographic units: that is, segments of the earth's surface defined, not on the basis of traditional political and administrative boundaries. Selman (2006) stated that landscape planning has three main reasons for the popularity of biogeographic units. First, natural systems, as watershed, often form logical units for many resources management decisions, and focusing on an integrative landscape unit may help reduce fragmentation of environmental processes and of policy delivery. Second, neither wildlife species nor hydrological systems recognize administrative boundaries, and their natural geographical range and extend must be taken into account in spatial planning, or even serve as its framework. Finally, people develop particular attachments to landscape on the basis of both physical and cultural factors, and so may possibly identify with distinctive biogeographic space more than with, say, local government districts (Selman, 2006).

Graff, 1993; Metzger and Muller, 1996; Şahin, 1996; Tangtham, 1996; Farrina 2006; Uzun, 2003; Selman, 2006; Bulley *et al.*, 2007; Karadağ, 2007; Şahin, 2007; Makhdoum, 2008; Şahin, 2009b; Uzun, 2003 and Uzun *et al.*, 2012 have drawn attention to the information of watershed in landscape planning. Watersheds can be considered as landscapes. It seems useful to study landscapes by applying the scale of watersheds, which can be considered as multifunctional units in which flows of water and the transfer of nutrients are distinctive processes (Farina, 2001).

3. Watershed

Water effects on the environmental and on life in all forms in distribution and circulation of waters (O'Callaghan, 1996). Surface flow, travel of water which is called hydrological circuit and feeding of ground waters, form the basis for ecological processes. The flow of water not only provides a unique ecological feature, but also forms geographically unique areas/spaces.

Surface flow, travel of water which is called hydrological circuit and feeding of ground waters affect landscape from different aspects. Surface flow of water and feeding of the ground waters are related to water period of landscape. Water period depends on permeability values (Uzun and Gültekin, 2013). Hydrological circuit is the process of evaporation and condensation of surface waters with the effects of climactic factors (Karadağ, 2007).

A watershed is the area drained by a river or stream and its tributaries. Generally many watersheds are included in a landscape, and a landscape boundary may or not correspond to the boundaries of watershed (Forman and Godron, 1986). A watershed is a landscape surface area that surrounds and drains into a common waterbody such as a lake, small stream or river basin system (Anonymous, 2012a). Davenport, *et al*. (2012) defined as watershed is an area of land that drains into a lake or river. As rainwater and melting snow run downhill, they carry sediment and other materials into streams, lakes, wetlands and groundwater. According to United States Environmental Protection Agency (EPA), watershed is the area of land where all of the water that is under it or drains off of it goes into the same place (Anonymous, 2012b). A watershed is a catchment basin that is bound by topographic features, such as ridge tops (Anonymous, 2012c). In addition watershed defined as a physiographic landscape (Şahin, 2007) and units of hydrologically independent areas (McHarg, 1991). In addition a functioning natural unit with interacting biotic and abiotic components in a system whose boundaries is determined by the cycles and flux of energy, materials and organisms. It is valid to describe different ecosystems with different, overlapping sets of boundaries in the same geographic area (e.g. forest ecosystems, watershed ecosystems and wetland ecosystems). A watershed is one of many types of ecosystems (O' Keefe *et al.,* 2012).

A large numbers of terms are very frequently and loosely used to classify watershed in different sizes (micro, small, and large). "Small watersheds are those where the overland flow is the main contributor to peak runoff / flow and channel characteristic do not affect the overland flow". "Large watersheds are those give peak flows are greatly influenced by channel characteristics and basin storage". Watershed classified according to drainage systems; main river watersheds, watersheds and sub-watersheds (micro watersheds). River watersheds are the areas which all the flows on the ground (river, lake, etc.) flow into the sea through a single river mouth, an estuary or delta from a certain point on the water route. Watersheds are defined as multiple territorial areas which feed a certain water resource (river watershed). However, sub-watersheds (micro watersheds) are defined as catchment areas concerning drainage lines in various sizes which feed watersheds and river watersheds (Karadağ, 2007).

Hydrological systems have along with ecological units, long been viewed as a natural basis for division of the earth's surface. Thus the "watershed" or "catchment" has often been proposed as the most appropriate division for landscape planning. Key reasons have been: its relative self-containment in terms of flows of water, other materials and energy; its relationship to geomorphic processes and the consequent recognisability of landform characterizing individual catchments; and the importance of water, often in short or excess supply, to human settlements. Increasingly, landscape ecologists also recognize the importance of water catchments in influencing the nature and functionality of ecosystem, through their role not only in supplying moisture but also moving chemical nutrients along rivers and though ground and soil water (Selman, 2006).

Watershed classification provides a means for generalizing or grouping watersheds by characteristics such as ecological properties, or land use patterns, so that they can be managed, treated, or compared efficiently. Classification can be based on a number of attributes related to natural or anthropogenic differences in watersheds. Natural features include climate, physiography, soils, nutrient productivity, watershed size and connectivity to other aquatic ecosystems. Anthropogenic features are primarily related to land use and include land-use types (urban, agriculture, forest), the degree of hydrologic disturbance and imperviousness, water withdrawals, water quality, in stream habitat conditions, and riparian integrity (Page, *et al.,* 1999).

Climate, hydrology, and geomorphology are physical template to shape forces of ecosystems. The three elements of the physical template and other factors also interact significantly in determining the structure and composition of a watershed and its biotic communities. As a result of different combinations of these formative processes, different types of watersheds are created (O' Keefe *et al.,* 2012). Besides watersheds are continually changing and evolving. Some changes are natural, or are accelerated by human activities. A watershed contains information about all the things happening and lands use history within it (Anonymous, 2012d). Because of that watersheds are frequently used to study and manage environmental resources because hydrologic boundaries define the flow of contaminants and other stressors (O' Keefe *et al.*, 2012).

Each part of a watershed is unique, even though the characteristics of any watershed are similar. All watersheds flow from headwaters to outlets, eventually ending in an ocean. As the water flows, it passes through many parts. And like the parts of a puzzle, if one happens to be damaged, the result affects the whole picture (Anonymous, 2012d). The watersheds are complex ecosystems in which land use, surficial geology, climate, and topography are interrelated with biological components such as vegetation communities (Page, *et al.,* 1999). Weekes (2009) believe that headwater stream flow patterns are homogenous when they have similar climate, bedrock type and hardness, topographical range, drainage area, soils and vegetation). In addition his investigations strongly support that meso-scale geomorphic processes and structures are first order drivers of hydrologic regimes. Geomorphic processes are a part of landscape function. Landscape ecology and catchment hydrology, both disciplines deal with patterns and processes as well as their interactions and functional implications (Schroder, 2006).

A watershed has three primary functions. First, it captures water from the atmosphere. Ideally, all moisture received from the atmosphere, whether in liquid or solid form, has the maximum opportunity to enter the ground where it falls. The water infiltrates the soil and percolates downward. Several factors affect the infiltration rate, including soil type, topography, climate, and vegetative cover. Percolation is also aided by the activity of burrowing animals, insects, and earthworms. Second, a watershed stores rainwater once it filters through the soil. Once the watershed's soils are saturated, water will either percolate deeper, or runoff the surface. This can result in freshwater aquifers and springs. The type and amount of vegetation, and the plant community structure, can greatly affect the storage capacity in any one watershed. The root mass associated with healthy vegetative cover keeps soil more permeable and allows the moisture to percolate deep into the soil for storage. Vegetation in the riparian zone affects both the quantity and quality of water moving through the soil. Water moves through the soil to seeps and springs, and is ultimately released into streams, rivers, and the ocean. Slow release rates are preferable to rapid release rates, which result in short and severe peaks in stream flow. Storm events which generate large amounts of run-off can lead to flooding, soil erosion and siltation of streams (Anonymous, 2012b). This situation, as Schroder (2006) stated, forms the interaction between the landscape and watershed.

Implementing a watershed approach has environmental, financial, social and administrative benefits. As well as its potential for considerable impact on the environment, this type of approach can result in cost savings by building upon the financial resources, knowledge and the willingness of interested people in the watershed to take action. An action plan that focuses on solutions evolves from those knowing the local issues and opportunities. This can help to enhance local and regional economic viability in ways that are environmentally sound and consistent with defined watershed objectives (Anonymous, 2012b).

4. How to delineate watershed using the archydro model

The advantage of Geographic Information Systems (GIS) technology lies in its data synthesis, the geography simulation, and spatial analysis ability. Spatial analytical techniques, geographical analysis and modeling methods are therefore required to analyses data and to facilitate the decision process at all levels within an urban regional context. GIS approach is very efficient as a tool to facilitate the decision-making process (Laurini, 2001). GIS has emerged as a significant support tool for managingand analyzing water resources using digital elevation models (DEM) of land surface terrain.

Various methods are used in determining the river basin boundaries. The traditional methods are determining and drawing the boundaries of drainage divides, peaks, stream beds on the topographical maps by hand. However, the modern methods are determining the boundaries by digitising and analysing the contour lines developed by GIS.

Arc Hydro is a geospatial and temporal data model for water resources designed to operate within ArcGIS (Maidment, 2003). Arc Hydro is a geographical data model that describes hydrological systems. A data model is a set of conceptsexpressed in a data structure; the data model describes a simplification of reality using tables and relationships within a database. Geographic data models use database structures to describe the world or part of it usingGIS technology. The ArcHydro data model is a conceptualization of surface water systems and describes features such as river networks, watersheds and channels. The data model can be the basis for a "hydrologic information system" which is a synthesis of geospatial and temporal data supporting hydrologic analysis and modeling. Arc Hydro integrates geospatial and temporal information into a defined structure. Based on this structure analysis and modeling tools can be applied. The data model provides a common characterization and understanding of the hydrological system and this description canbe utilized by multiple models, analysis tools and decision support systems all referring to the same common structure (Kovar and Nachtnebel, 1996; Strassberg *et al.*,2011).

This study is going to demonstrate the use of the ArcHydroModel to determine watershed boundaries of a small stream (Köprü stream) in the Central Mediterranean Basin. The hydrologic modeling involves delineating streams network and watersheds, and getting some basic watershed properties such as area, flow length, stream network density, etc. Traditionally this was (and still is!) being done manually by using topographic/contour maps. But in ArcHydro Model analysis is performed by using DEM (Ayhan *et al*., 2012). DEM generation from topographic maps that derived from a 10 meter DEM from the General Command of Mapping (Turkey).

Watershed and drainage systems can define generally with 4 stages and 11 analysis in ArcHydro module. At the first stage of the analysis, ''DEM reconditioning'' and ''fill sink'' analysis, which are confirmation and preparation processes for the given analysis, are carried out. At the second stage, ''Flow direction, Flow Accumulation, Stream Definition'' and ''Stream Segmentation'' analysis, by which evaluations concerning surface flow are made, are carried out. At the third stage, ''Catchment Grid Delineation'' and ''Catchment Polygon Processing'' analysis, by which catchment areas are determined, are carried out. At the last stage, "Drainage Line Processing", "Drainage Point Processing" and "Batch Watershed Delineation" analysis, by which watershed boundaries are defined by evaluating drainage systems according to surface flow and catchment areas, are carried out. But first of all, Archydro tools must be downloaded to the computer to start the analysis. Archydro tool 1.3 is downloaded because of ArcMap 9.3 is used in this study.

First stage of Archydro Model is Terrain Preprocessing. Arc Hydro Terrain Preprocessing should be performed in sequential order. All of the preprocessing must be completed before Watershed Processing functions can be used. DEM reconditioning and filling sinks might not be required depending on the quality of the initial DEM. DEM reconditioning involves modifying the elevation data to be more consistent with the input vector stream network. This implies an assumption that the stream network data are more reliable than the DEM data, so you need to use knowledge of the accuracy and reliability of the data sources when deciding whether to do DEM reconditioning. By doing the DEM reconditioning you can increase the degree of agreement between stream networks delineated from the DEM and the input vector stream networks (Mervade *et al.,* 2009; Ayhan *et al*., 2012; Mervade, 2012).

DEM Reconditioning: This function modifies a DEM by imposing linear features onto it (burning/fencing). The function needs as input a raw dem and a linear feature class (like the river network) that both have to be present in the map document (Mervade *et al.,* 2009; Ayhan *et al*., 2012; Mervade, 2012). This function is located on Terrain Preprocessing on the ArcHydro Toolbar (*Terrain Preprocessing*→DEM Manipulation→DEM Reconditioning) (Mervade *et al.,* 2009; Ayhan *et al*., 2012; Mervade, 2012).

Select the appropriate Raw DEM (köprü_dem) and AGREE stream feature (köprü_str). Set the Agree parameters as shown. You should reduce the Sharp drop/raise parameter to 10 from its default 1000. The output is a reconditioned Agree DEM (default name Agree DEM). A personal geodatabase with the same name as your ArcMap document has also been created as shown in the following ArcCatalog view (Figure 1.)(Mervade *et al.,* 2009; Ayhan *et al*., 2012; Mervade, 2012).

Fill Sinks: This function fills the sinks in a grid. If cells with higher elevation surround a cell, the water is trapped in that cell and cannot flow. The Fill Sinks function modifies the elevation value to eliminate these problems.The model readjusts the height value with this stage to solve the problem. Therefore, the drainage networks' being asunder is prevented. This function is located on Terrain Preprocessing on the ArcHydrotoolbar (Terrain Preprocessing→DataManipulation→Fill Sinks) (Mervade *et al.,* 2009; Ayhan *et al*., 2012; Mervade, 2012).

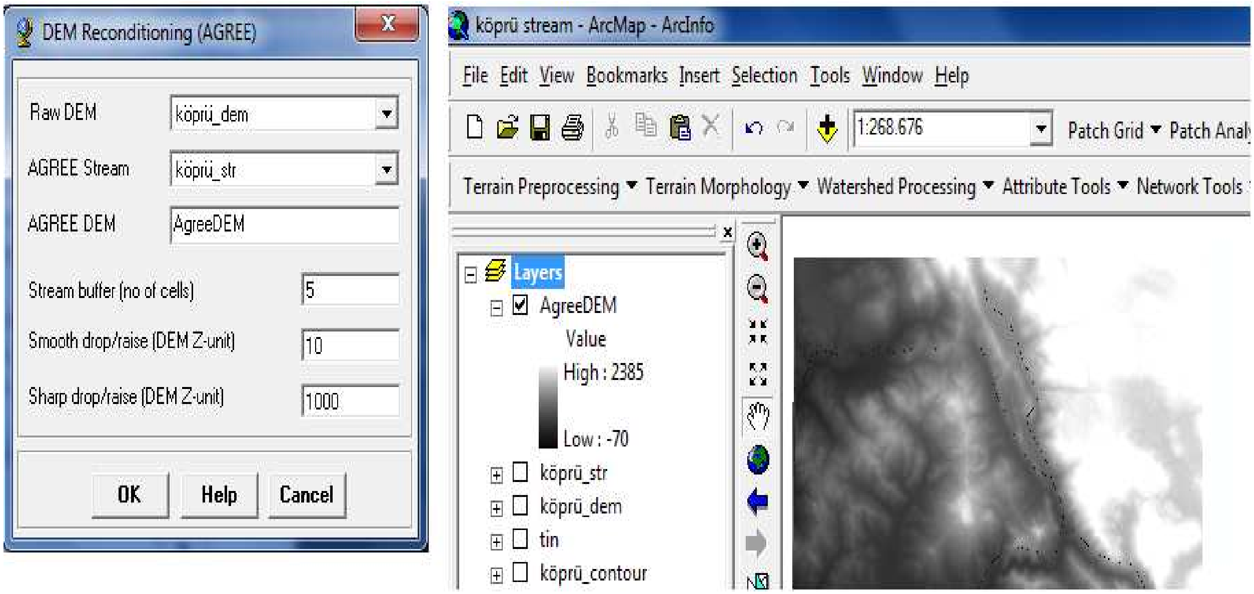

Figure 1. DEM Reconditioning menu and AgreeDEMlayer.

Confirm that the input for DEM is AgreeDEM. The output is the Hydro DEM layer, named by default Fil. This default name can be overwritten. Leave the other options unchanged. The Fil layer is added to the map, when the process completed (Figure 2.) (Mervade *et al.*, 2009; Ayha n*et al*., 2012; Mervade, 2012).

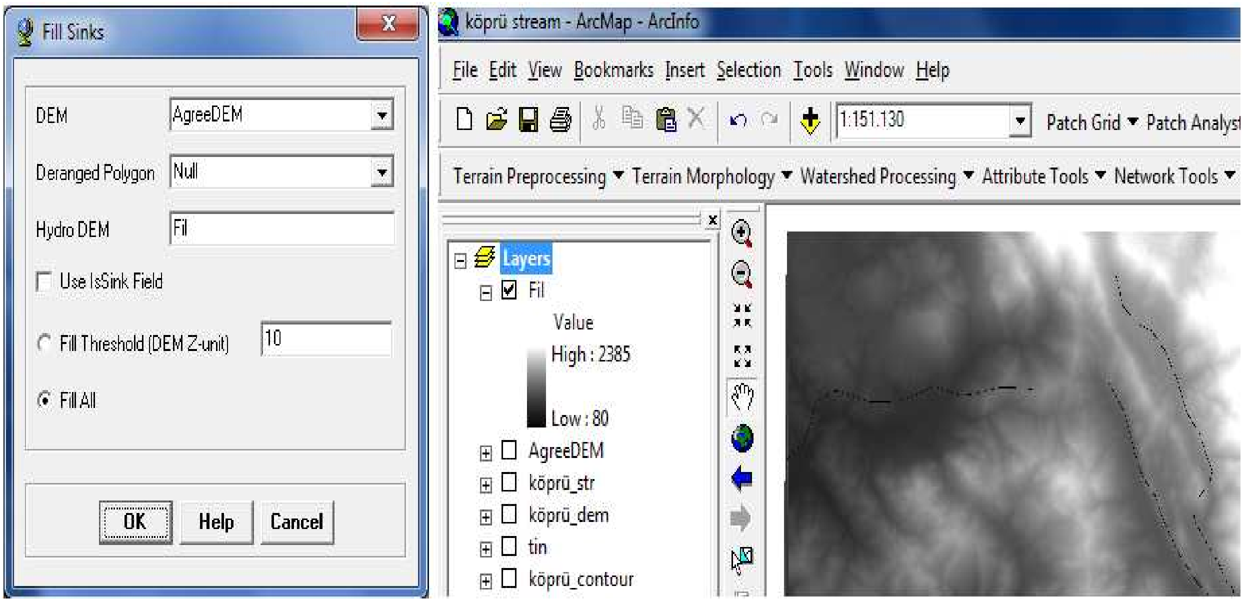

Figure 2. Fill Sinks menuand Fillayer.

Flow direction: This function computes the flow direction for a given grid. Each grid has a value of height and water flow will be towards the lowest one, by comparing the height values of 8 grids. The flow direction is defined as ''8 directional flow model'' in the computer environment. Digital values, which are developed depending on the directions, are used to show the flow direction of the grid in the module. This function is located on

Terrain Preprocessing on the ArcHydro toolbar (Djokic 2008, Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

Confirm that the input for Hydro DEM is Fil. The output is the Flow Direction Grid, named by default Fdr. This default name can be overwritten. The flow direction grid Fdr is added to the map, when the process completed (Figure 3.) (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

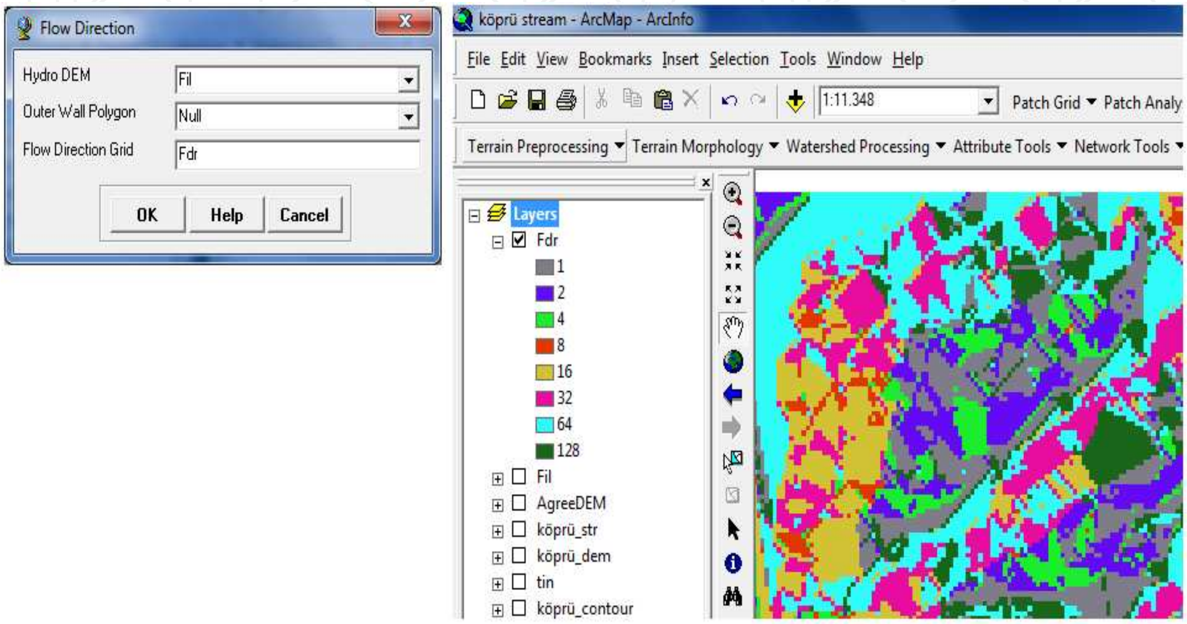

Figure 3. Flow direction menu and Fdrlayer.

Flow Accumulation: This is the stage in which the cells taking place in the catchment area of each cell are calculated. The water gathered in the lowest grade is calculated, by assuming that each cell has 1 unit of water. The system defines the value of the cells having no flow as zero, and cells in which water gathers are defined in the number of cells having flow. The flow calculation is carried out by taking 8 cells as basis. This function is located on Terrain Preprocessing on the ArcHydrotoolbar (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

Confirm that the input of the Flow Direction Grid is Fdr. The output is the Flow Accumulation Grid having a default name of Fac that can be overwritten. The flow direction grid Fac is added to the map, when the process completed. Adjust the symbology of the Flow Accumulation layer Fac to a multiplicatively increasing scale to illustrate the increase of flow accumulation as one descends into the grid flow network (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

Zoom-in to a stream network junction to see how the symbology changes from light to dark color as the number of upstream cells draining to a stream increase from upstream to downstream. If you click at any point along the stream network on Fac grid using the identify button you can find the area draining to that point by multiplying the Fac number by the area of each cell (cell size x cell size which is 30.89 x 30.89 in this case) (Figure 4.) (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

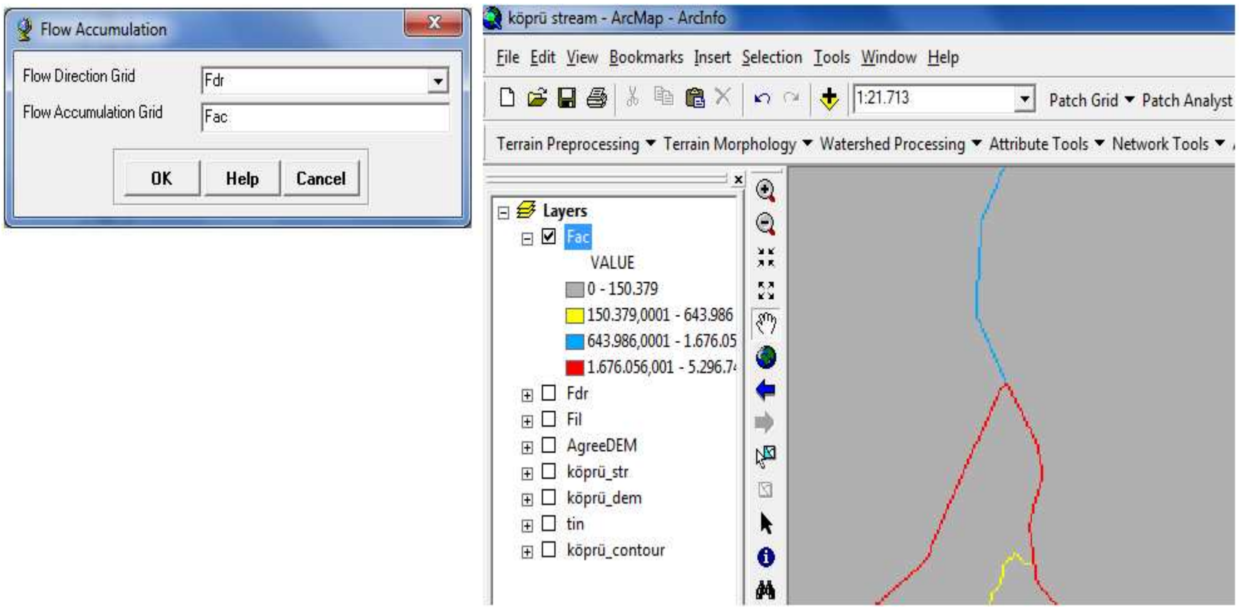

Figure 4. Flow Accumulation menu and Faclayer.

Stream Definition: This function computes a stream grid which contains a value of "1" for all the cells in the input flow accumulation grid that have a value greater than the given threshold. All other cells in the Stream Grid contain no data. This function is located on Terrain Preprocessing on the ArcHydro toolbar (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

Confirm that the input for the Flow Accumulation Grid is “Fac”. The output is the Stream Grid. “Str” is its default name that can be overwritten. The stream grid Str is added to the map, when the process completed (Figure 5.) (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

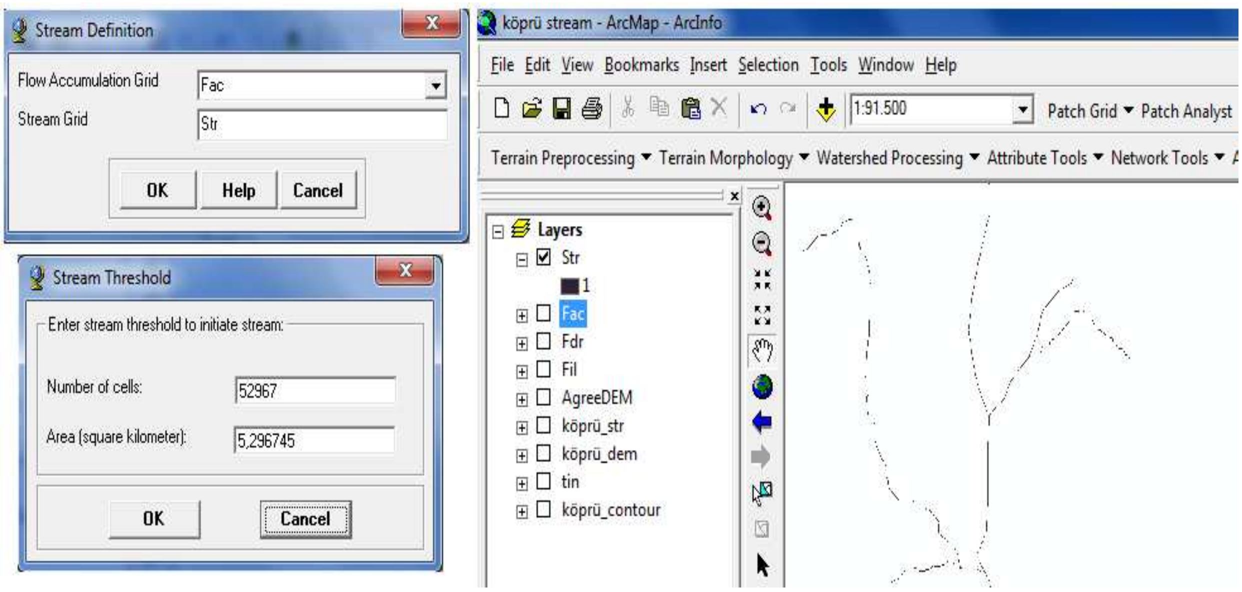

Figure 5. Stream Defination menu and Str layer.

Stream Segmentation: This function creates a grid of stream segments that have a unique identification. Either a segment may be a head segment, or it may be defined as a segment between two segment junctions. All the cells in a particular segment have the same grid code that is specific to that segment. This function is located on Terrain Preprocessing on the ArcHydro toolbar (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

Confirm that Fdr and Str are the inputs for the Flow Direction Grid and the Stream Grid respectively. Unless you are using your sinks for inclusion in the stream network delineation, the sink watershed grid and sink link grid inputs are Null. The output is the stream link grid, with the default name StrLnk that can be overwritten. The link grid StrLnk is added to the map, when the process completed (Figure 6.) (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

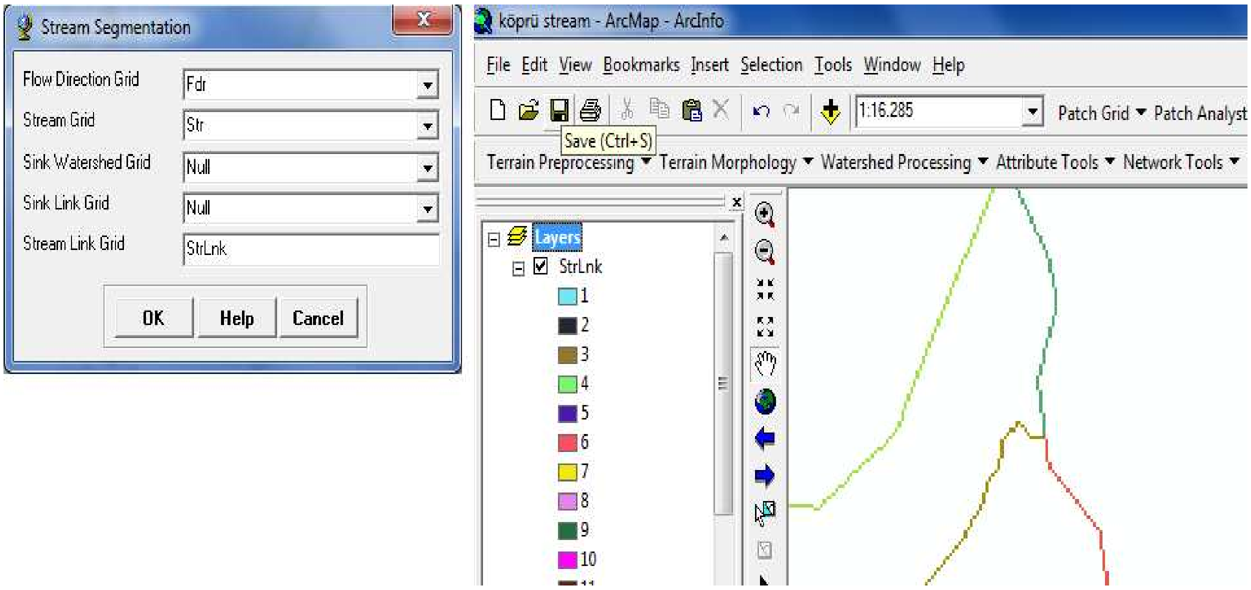

Figure 6. Stream Segmentation menu and StrLnk layer.

Catchment Grid Delination: This function creates a grid in which each cell carries a value (grid code) indicating to which catchment the cell belongs. The value corresponds to the value carried by the stream segment that drains that area, defined in the stream segment link grid. This function is located on Terrain Preprocessing on the ArcHydro toolbar (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

Confirm that the input to the Flow Direction Grid and Link Grid are Fdr and Lnk respectively. The output is the Catchment Grid layer. Cat is its default name that can be overwritten by the user. The link grid StrLnk is added to the map, when the process completed. The Catchment grid Cat is added to the map, when the process completed. In addition study case will have 70 catchment (Figure 7.) (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

Catchment Polygon Processing: This function converts a catchment grid into a catchment polygon feature. This function is located on Terrain Preprocessing on the ArcHydro toolbar (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

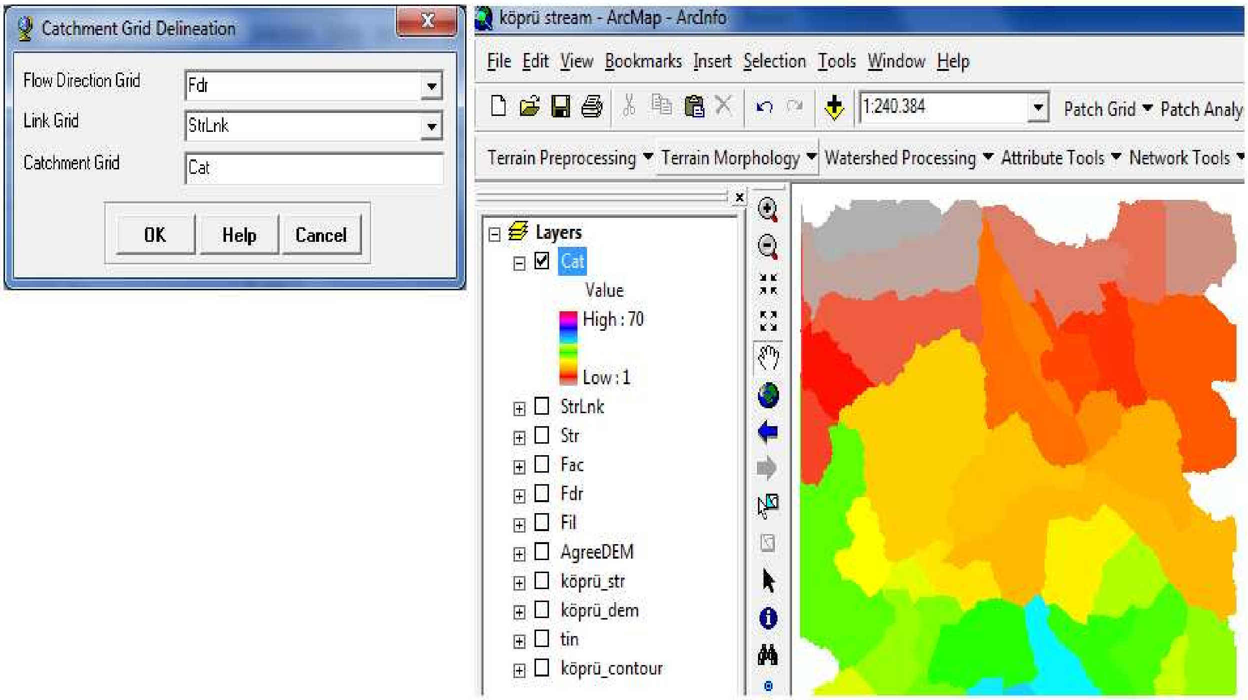

Figure 7. Catchment grid menu and Cat layer.

Confirm that the input to the CatchmentGrid is Cat. The output is the Catchment polygon feature class, having the default name Catchment that can be overwritten. The polygon feature class Catchment is added to the map, when the process completed. In addition there are important information (HydroID assigned, Length and Area attributes of catchment) in attribute table of Catchment (Figure 8.) (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

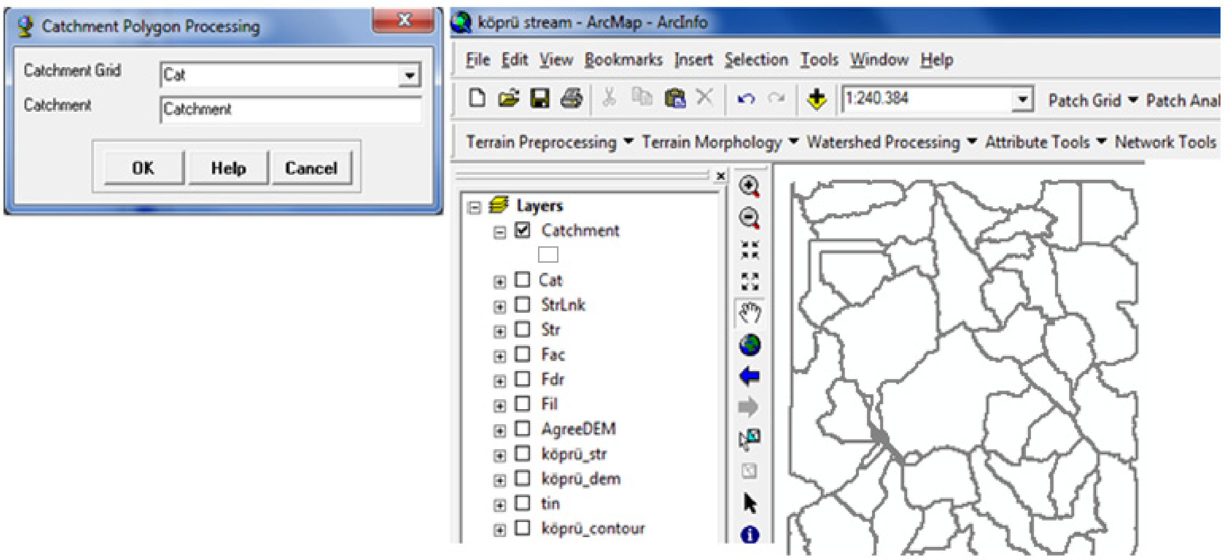

Figure 8. Catchment polygon processing menu and Catchment layer.

Drainage Line Processing: This function converts the input Stream Link grid into a Drainage Line feature class. Each line in the feature class carries the identifier of the catchment in which it resides. This function is located on Terrain Preprocessing on the ArcHydro toolbar (Mervade *et al*., 2009; Ayhan *et al*., 2012; Mervade, 2012).

Confirm that the input to Link Grid is Lnk and to Flow Direction Grid Fdr. The output Drainage Line has the default name DrainageLine that can be overwritten.The linear feature class DrainageLine is added to the map, when the process completed (Figure 9.) (Mervade *et al*., 2009; Ayhan *et al*., 2012; Mervade, 2012).

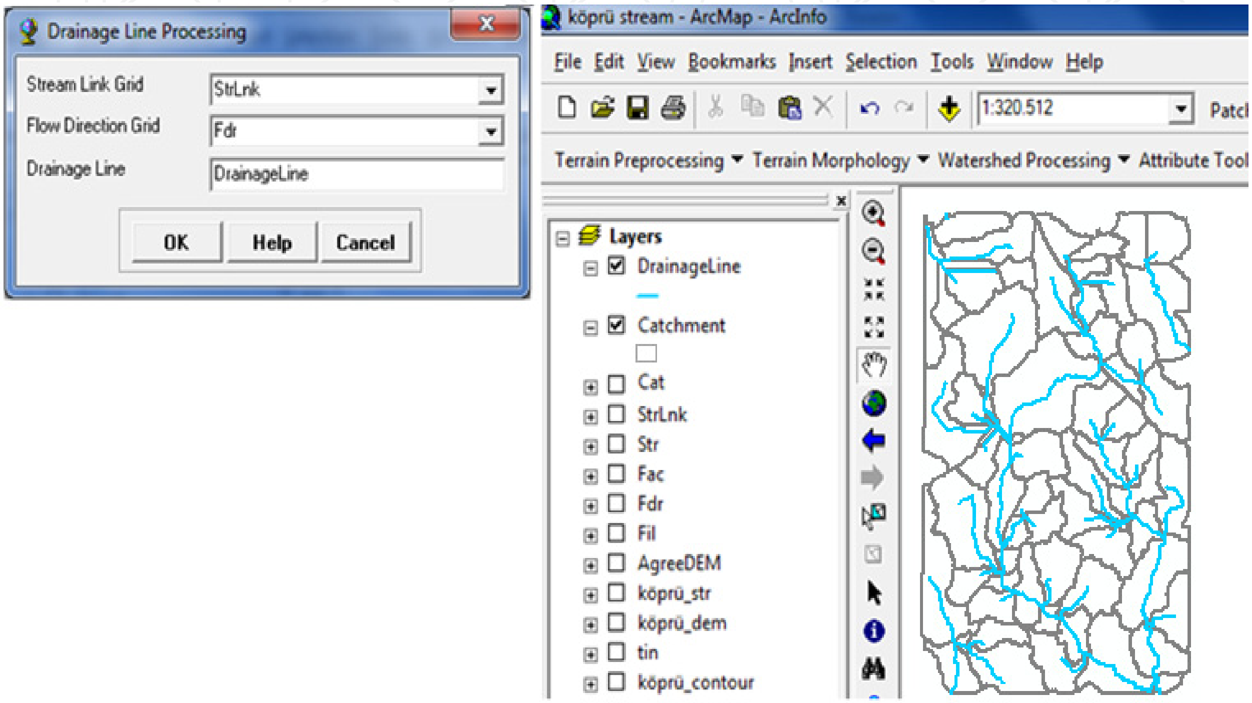

Figure 9. Drainage line processing menu and Drainageline layer.

Drainage Point Processing: This function allows generating the drainage points associated to the catchments. This function is located on Terrain Preprocessing on the ArcHydro tools(Mervade *et al*., 2009; Ayhan *et al*., 2012; Mervade, 2012).

Confirm that the inputs are as below. The output is Drainage Point with the default name DrainagePoint that can be overwritten. Upon completion of the process, the point feature class "DrainagePoint" is added to the map (Figure 10.) (Mervade *et al*., 2009; Ayhan *et al*., 2012; Mervade, 2012).

Watershed Processing: Arc Hydro toolbar also provides an extensive set of tools for delineating watersheds and subwatersheds. These tools rely on the datasets derived during terrain processing.

Batch watershed delineation function delineates the watershed upstream of each point in an input Batch Point feature class. Batch Point Generation can be used to determine the outlet of the watershed. Arrange your display so that Fac, Catchment and DrainageLine datasets are visible. Zoom-in near the outlet of the Köprü stream watershed (Figure 11.). The display should look similar to the figure shown below and be zoomed in sufficiently so you can see and click on individual grid cells. Our goal is to create an outlet point on the flow accumulation path indicated by Fac grid where the flow leaves the Köprü stream watershed (Mervade, 2012).

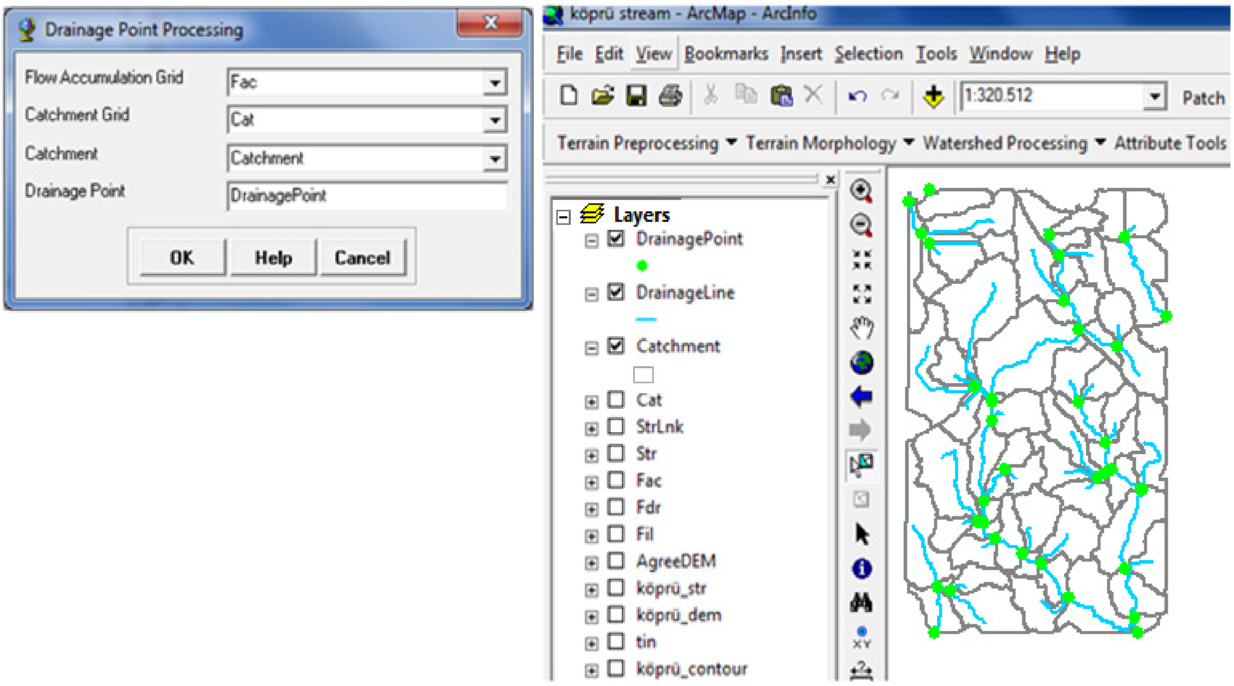

Figure 10. Point processing menu and Drainage point layer.

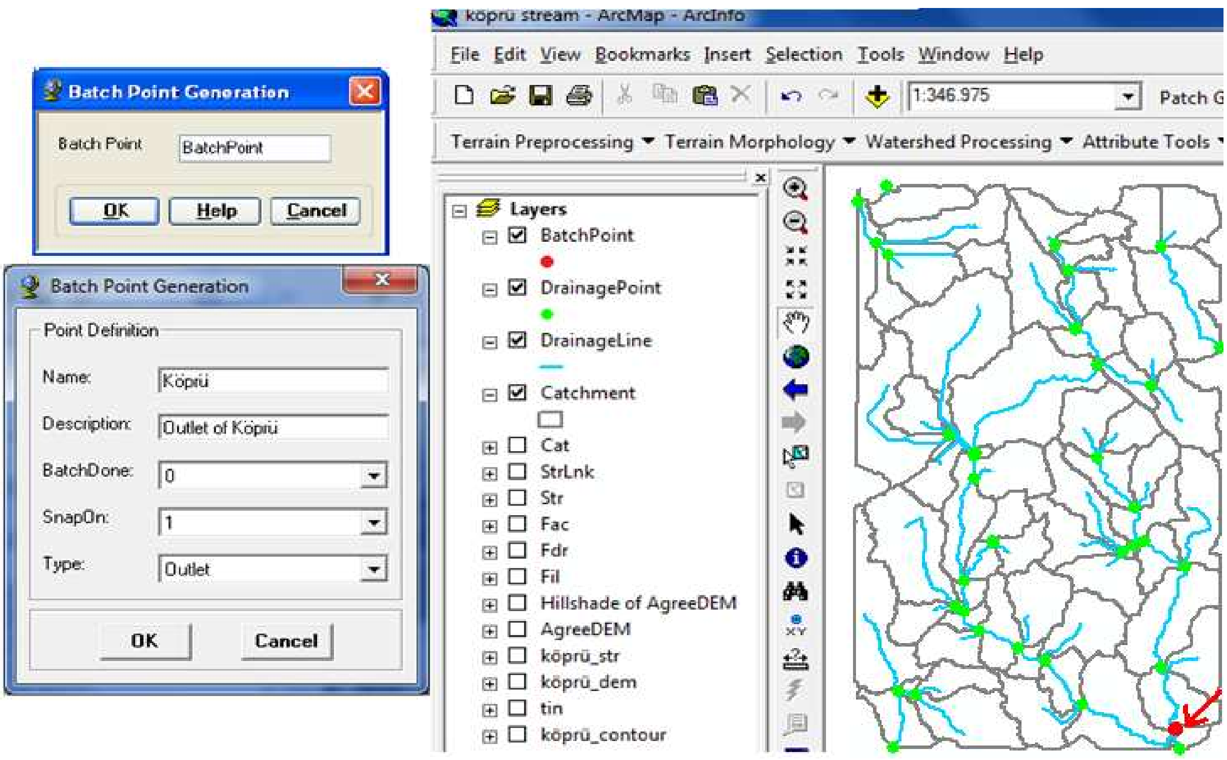

Figure 11. Batch Point generation

Batch watershed delineation function delineates the watershed. This function is located on Watershed Processing on the ArcHydro Toolbar. Confirm that Fdr is the input to Flow Direction Grid, Str to Stream Grid, Catchment to Catchment, AdjointCatchment to AdjointCatchment, and BatchPoint to Batch Point. For output, the Watershed Point is WatershedPoint, and Watershed is Watershed (Figure 12.). WatershedPoint and Watershed are default names that can be overwritten (Mervade *et al.*, 2009; Ayhan *et al.*, 2012; Mervade, 2012).

You can see that area and length, if you open the attribute table of Köprü_watershed. In addition you will see that these two are related through HydroID–the DrainID of WatershedPoint is equal to the HydroID of the watershed, when you open the attribute table of catchment and DranaigePoint. At the same time you can learn length of drainage line from attributes table of DranaigeLine (Mervade *et al.*, 2009; Mervade, 2012).

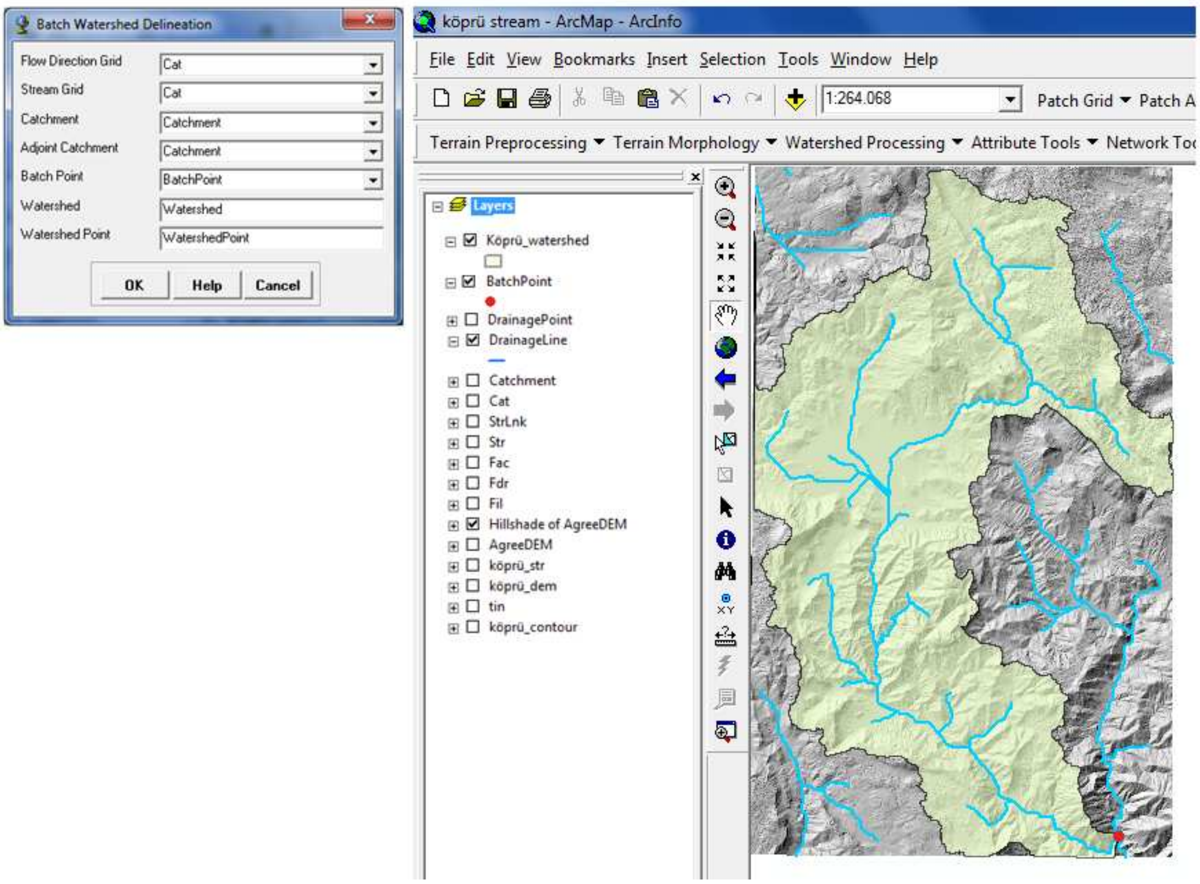

Figure 12. Batch watershed delineation and Köprü stream watershed

5. Conclusion

The future of our present societies is determined by environmental, social, economic and political situations and the problems and the solutions concerning these issues. Landscape, which can be defined as the interaction space or product of natural and cultural processes, puts its relation with future at this point. The concept of future brought about the concept of planning, which is evaluated in different topics, and transformed landscape planning into a part of the future. Therefore, ecological, aesthetic and economic importance of landscape has become a topic for many researchers and the need for landscape planning is emphasised. At last, vital importance of landscape and need for its being planned were transferred to a legal text when European Landscape Convention was signed in 20 October 2000.

The aims of European Landscape Convention are to promote landscape protection, management and planning, and to organise European co-operation on landscape issues. The Convention applies to the entire territory of the Parties and covers natural, rural, urban and peri-urban areas. It includes land, inland water and marine areas. It concerns landscapes that might be considered outstanding as well as every day or degraded landscapes. Landscape planning means strong forward-looking action to enhance, restore or create landscapes in the Convention (Anonymous, 2000). The convention intended to plan landscape with a "comprehensive, pedant, holistic, coordinated, participant, rationalist" approach. Also, with the expression "transboundary landscape", which took place in 9th clause of the convention and which emphasised local and regional cooperation, brought about the concept of "planning boundary".

The planning, which is defined as balancing the needs and the resources in the long run by complying with the reasonable priorities to reach certain aims with limited resources (Keleş, 2004), is a versatile activity from upper scale to subscale and a body of decisions related to past, present and future integrating social, economic, political, physical, anthropogenic and technical elements, as Alipour (1996) stated (Uzun *et. al.* 2012). This general definition of planning requires landscape planning to be made in different scales and accordingly in certain boundaries. Also, as Uzun *et. al.* (2012) stated, the boundaries of the study area are the first stage of planning and are very important in clarifying the goal. The data gathering, which enables the planning to be carried out systematically and defines success (Mcharg, 1967), depends on the boundaries of the planning area. Ultimately, the management process of realising the plan will be integrated with the administrative structuring within the boundaries. All these put the importance of the question ''What should be the boundary of landscape planning?'' forward.

When determining the boundaries of landscape, the fact that landscape is "a space in which natural, socio-cultural and economical life come together" should not be ignored. This situation emphasises that the boundary of landscape shouldn't just describe the natural areas (eco-zone, ecoregion, habitat, etc.) or administrative spaces. Therefore, the boundary will be integrated with the body of the landscape. Within this context of approach, there are various consistent points of view about the boundary of landscape. Meijerink (1985) considered that watersheds were the best units in which the interactions of human and natural resources, and the geographical distribution of their consequences could be observed and modeled (Metzger and Muller, 1996). Gregersen *et al.* (1987), said watersheds can use as a physical-biological and a socioeconomic-political units for planning of natural resources (Graff, 1993). According to Farrina (2006) watersheds are examples of the hierarchical organization of the landscape. River watershed is composed of sub-watershed, each of which is composed of smaller-order watershed. The upper and lower limits of this hierarchy are not definitive but it is possible to move in both directions, including smaller and larger basins. Tangtham (1996) and Karadağ (2007) lay stress on watershed classification is thus anticipated as a useful tool for management and planning of natural resources. Selman (2006) emphasized the importance of watershed boundaries in landscape ecology. Makhdoum (2008) indicated that the mapping unite (or land unit) is freely derived from watershed, land system, land form units and ecosystems, at different scale level. He accepted watershed as one of mapping units in land ecology. Bulley *et al.* (2007) point out that watershed provides an important spatial framework to develop a classification system. Şahin (2007) and Şahin (2009) suggests that watershed can be descriptive and administrative units for landscape planning. According to EPA watershed is an example of hierarchical system in nature (Anonymous 2012a). Efe and Aydın (2009), indicated that the provincial boundaries which constitute the framework of the administrative organization where planning is currently authorized do not coincide with the natural boundaries. They suggest redefining the provincial boundaries compatible with watershed for the protection of the nature.

Actually watershed clarifies the complexity of boundary in the landscape. When we consider the importance of water in life of living things, its effect on establishing, developing and even collapsing civilisations, it is clear that watershed will be effective boundaries in landscape planning; because water turns into the interaction space of natural and cultural life while forming socio-cultural and economical life by its presence. This situation enables a watershed to turn into not only a natural boundary, but also a boundary that effects a human's life. Also, the landscape changes as nature reshapes with human life. The changing landscape gains a new character. This character is not only a product of the change of the natural structure caused by the human presence, but also can be expressed with a hierarchal system from a local scale to upper scales. Thus, the watershed supports the scale approach in the planning with its hierarchal structure (main river basin, basin, subbasin, microbasin). Along with that, the main river basins that go beyond the national boundaries will be able to easily define its collaborators in the transnational landscapes.

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