Effects of Land Use on Biodiversity in the Eastern Black Sea Region of Turkey

Tüfekçioğlu, A[1]., Terzioğlu, S.[2] and Tilki, F[1]

[1] Kafkas University, Faculty of Forestry, 08000-Artvin, Turkey.
[2] Karadeniz Technical University, Faculty of Forestry, 61080-Trabzon, Turkey.

Abstract

The biodiversity of Turkey is deteriorating due to rapid human population growth and associated intensive or unwise utilization of natural resources and habitats. Cultivation, forestry practices and heavy grazing are some of the main reasons of decreasing biodiversity in the East Black Sea Region of Turkey. Endemism is high in this region and 386 plants are endemic to the region. Eight of the endemics are in critically endangered list of IUCN while 55 are in endangered list. Most of these critically endangered and endangered species were found in grasslands and forest openings. Also, influence of land use on biodiversity was evaluated in the region, and possible effects of conversion of the forests into cultivation on biodiversity were discussed in this paper.

Introduction

Biological diversity or biodiversity refers to the variety of life and its processing in a given area. This variety encompasses the richness, relative abundances, and distribution of biological variation from individual gene systems through populations of species, communities, ecosystems, and ultimate of life in the biosphere (Williams, 1988). The variety of life and its processing in a given area are constantly changing. These changes have occurred since life began and they will continue, with or without the presence of humans.

The extinction rates of species have never been so high since the disappearance of the last dinosaurs, about 60 million years ago. According to a UN study, in the next 30 years 25% of the mammals and 12% of the birds of the planet will go extinct. Some scientists hold that several tens of thousands of tropical rain forest species disappear each year or are condemned to die in the near future because of the destruction of those forests (Centre Naturopa, 1996).

Preventing extinction and preserving species' ecological roles requires protection of their natural habitats. The most significant threat to biodiversity now lies in the loss, degradation and fragmentation of the habitats in which animals and plants need to survive. According the Natural Resources Conservation Service's Natural Resources Inventory, an estimated 2.2 million acres of land are lost to development in the United States each year. The Department of the Interior reports that more than half the nation's wetlands have been filled since the American Revolution. In the Tucson area of Arizona alone, an estimated 6,400 acres of Sonoran Desert are now being converted to human use annually. A 1995 analysis by Defenders of Wildlife identified 69 ecosystems in the United States that had lost 85 percent or more of their acreage to development over the last three centuries. Other studies indicate that only 42 percent of U.S. lands remain covered with natural vegetation (Anonymous, 2004).

Parks and preserves help protect natural habitats, but they are scattered throughout the country with few natural landscape linkages between them. Most protected areas are also found at high elevations, or on biologically unproductive lands that tend to harbor fewer species than those at lower elevations. These low-elevation, biologically diverse areas are also attractive for development.

Turkey contains a great variety of natural habitats, ranging from Mediterranean, Aegean, and Black Sea beaches to towering coastal and interior mountains, from deeply incised valleys to expensive steppes, from fertile alluvial plains to arid, rocky hillslopes (Kaya

and Raynal, 2001). The components of biodiversity are important to maintain for the welfare and sustainable development of Turkey. Turkey contains the wild relatives of many domesticated plants, which have economic importance for the world, thus forming one of the eight major gene centers on earth (Harlan, 1995). For example, wild progenitors of such cultivated plants as chickpea, wheat, peach, lentil, almond and pistachio are native to Turkey. Civilizations have exploited the natural resources of Turkey over many millennia. Today, because of rapid human population growth (about 2.5% per year) and associated intensive or unwise utilization of natural resources and habitats the biodiversity of Turkey is deteriorating. Diverse ecological conditions (e.g. great variation in topography and land-forms) are responsible for the growth of more than 9.500 plant species and hundreds of plant communities in Turkey (Alptekin et al., 2003).

Eastern Black Sea Region of Turkey is rich in biodiversity compared to other regions. The east-west oriented, parallel ranges of the Northern Anatolian Mountains run in the southern part of the Eastern Black Sea. These coastal mountain ranges are the broadest and the highest in their eastern section, attaining elevations of over 3000 m (the highest peak Kaçkar Mountain is 3937 m). Northern Anatolian mountains form a barrier between the Black Sea and inland part of Central Anatolia. The north-facing slopes of these mountains receive abundant precipitation. For this reason, the broad-leaved deciduous forests and coniferous forests composed of *Fagus orientalis, Picea orientalis, Castanea sativa, Alnus glutinosa* and *Tilia rubra* species are found on the north-facing slopes of the northern Anatolian mountains. But tectonic depressions produce semi-arid climatic conditions due to lee of the mountains. These areas are covered by generally xerophytic plant communities composed of some Mediterranean plant elements.

In the northern part of Turkey, there are significant differences in the amount of precipitation between the bottomland of river valley and the higher parts of the mountains. For example, the mean precipitation in Çoruh valley in the vicinity of Artvin is about 300 mm, whereas mean precipitation of slopes facing north of the eastern Black Sea Mountains is above 2000 mm. The winds bearing abundant moisture penetrate towards the inland section through the river valleys and tectonic depressions.

Main objective of this study was to investigate effects of land use on biodiversity in the region based on existing literature. We tried to evaluate current status of biodiversity in the region and to figure out possible reasons causing significant decreases in biodiversity.

Materials and Methods

We used existing literature related to flora of the region and field observations done in the different times to assess biodiversity.

Main Factors of Decreasing Biodiversity in the Region

Major factors that influence biotic change in the Eastern Black Sea region of Turkey: 1) conversion of wild areas to agriculture; 2) fragmentation of habitats and populations due to the rapid population increase, which results in small and often isolated demes which suffer local extirpation; 3) over-exploitation of plant species, which exceeds the ability of species and recovery; 4) pollution of soil, water and atmosphere, which either kill individuals outright or impair their natural functioning, 5) industrial forestry and industrial agriculture which alters in the structure and function of ecosystems; and 6) introduced or naturalized species. Some of these factors result from intentional actions taken to meet the needs of a growing human population. Often, however, the changes are undesired results of human actions.

One of the main factors that may cause the loss and/or decline of biodiversity at local, regional, national and/or global scales is the "introduced or naturalized species" (WRI, IUCN & UNEP, 1992). A total of 32 flowering plant taxa naturalized in the Eastern Black Sea

Region of Turkey (Terzioğlu and Anşin, 2001). Because of the favorable climatic conditions of the region, diaspores of these naturalized taxa can easily germinate in the area and become new individuals. Especially some of these individuals, which has established groups such as *Robinia pseudoacacia, Ailanthus altissima, Sicyos angulatus, Conyza canadensis, Paspalum dilatatum, Commelina communis*, have local detrimental effect for the native species.

Current Status of Conservation in the Region:

Most of the protected areas established in the higher mountain areas in the region (Table 1). Whereas, major disturbance on biodiversity has been seen in coastal and lowland areas. Small estuaries and alluvial plains around rivers has been heavily occupied and converted into either settlement area or agricultural land.

Table 1. Some conservation areas in the Black Sea Region and in Turkey (Anonymous, 2000; Konukcu, 2001).

Conservation program types	Numbers	Area (ha)	% Conserv. area of Turkey	Numbers in Turkey	Area (ha) in Turkey	% Area of Turkey
National parks	4	77 100	11.2	33	686 631	0.9
Nature Conservation Areas	4	2 386	2.8	35	83 524	0.1
Nature Parks	2	7 484	10.8	16	69 137	0.07
Nature Monuments	4	0.9	0.2	56	333	0.0003
Seed stands	39	5 484	11.8	345	46 266	0.05
Gene conservation forests	2	190	1.2	115	16 210	0.01

There are 386 endemic plant taxa in the Eastern Black Sea Region. From these, 8 taxa are in critically endangered category, 55 taxa are in endangered category, 46 taxa are in vulnerable and 246 taxa are in lower risk category (Ekim et al., 2000).

Major land use types in the region and their biodiversity:

Major land uses in the region are: forest lands, croplands, grasslands, wetlands and developed lands (settlement areas). Forests cover around 36% of the region, grasslands and croplands cover around 20% and 23% of the region, respectively. The region has 23% of total forest of Country.

Croplands:

Major crops of the region are tea and hazelnut. However, there are small vegetable gardens, olive and other fruit orchards, small corn fields in the region. In this paper we will focus on tea and hazelnut gardens:

Tea areas:

Tea gardens are located at Trabzon, Rize, Giresun and Artvin cities. Tea gardens are the poorest in terms of biodiversity compared to other crop areas. Most of the herbs don't have chance to grow in tea gardens due to intense shading by tea. This shade also result in very humid conditions on the soil surfaces which is another negative effect. Edges of tea gardens are the only places, some grasses and herbs can have chances to grow. We have observed total of 18 species in tea gardens, 51 species in adjacent forests and 11 of these species were exist in both vegetation type. This results indicated that conversion of forests into tea gardens reduced number of existing species from 51 to 18.

Hazel nut areas:

Hazel nut gardens are rich in biodiversity compared to adjacent tea gardens and forests. Openings in canopy and falling of leaves allow light to penetrate into ground and most grass and herb species to grow. In Değirmendere Watershed of Trabzon, 56 species was

observed in pseudo-maquis areas while 69 observed in hazel nut gardens. This result implies that conversion of forests into hazel nut gardens have no negative effect on plant diversity in the region. But similar argument cannot be made for animal diversity. Conversion of forests into hazel nut gardens could greatly reduce some bird and mammal diversity in the region.

Other crop areas:

These areas are better in biodiversity compared to tea gardens. Tilling allows most of the annual grass and herb species to grow on plowed soils. These species are mainly weeds. In a study done by Terzioğlu (1998) in Solaklı Watershed of Trabzon, 39 species observed in croplands and 61 species in adjacent forests. Twelve of these 39 species were introduced crop species such as *Phaseolus vulgaris, Solanum tuberosum, Solanum esculentum, Zea mays.* This shows that conversion of forests into croplands greatly reduces the plant diversity of the area.

Forests:

Around 36% of the area covered by the forests. Coniferous forests cover 36.5% while broad leaves and mixed forests cover 16% and 15.1% of the total forest area, respectively. Conservation forests cover 26.4% of the area and regeneration areas and the other areas cover the remaining 4.8% (Baskent et al., 2002). Kose (1994) reported that canopy coverage was less than 10% in 52% of forests in the region. He also stated that 25% of forests are under heavy social pressure. The total forest area lost into cultivation and other activities in the region was 9947 ha in the last fifteen year. Major forest zones and their diversity are presented in the following paragraphs according to Anşin (1979).

Pseuodo-maquis areas:

Most of these areas converted into croplands especially hazel nut gardens. These areas are under heavy human pressure. Only those areas with very high slope, little soil or parent material in the surface has this vegetation type left. Areas covered by this vegetation type are rich in biodiversity compared to chestnut, beech and spruce forest areas. In Değirmendere Watershed of Trabzon, 56 species was observed in pseudo-maquis areas while 69 observed in hazel nut gardens. In a study done at Meryemana Watershed of Trabzon, Ansin (1979) listed name of species representing each vegetation zone of study area. According to this study there were 70 species representative to pseudo-maquis zone. Among these species 26 were woody and 44 were herbaceous species. This zone is less diverse in terms of mammals compared to other zones. In terms of bird diversity this zone is richer than the other zones.

Chestnut-Oak forests:

These forests generally have less diversity compared to pseudo-maquis areas. Main tree species of this vegetation type are *Quercus petraea, Acer cappadocicum, Carpinus betulus, Corylus avellena* etc. In a study done at Melet Watershed in Ordu by Tüfekçioğlu (1995), 23 woody and 77 herbaceous species were reported in this vegetation type. In the same study, the number of representative species were 18 woody and 22 herbaceous. In a similar study done by Anşin (1979) the number of representative species for this vegetation type were 25 woody and 23 herbaceous. Terzioğlu (1998) observed 61 species in forests and 55 species in adjacent croplands at Solakli Watershed in Trabzon.

Beech Forests:

These forests generally have less diversity compared to pseudo-maquis areas and chestnut forests. Main tree species of this vegetation type are *Fagus orientalis, Acer trautvetteri and Picea orientalis.* In a study done at Melet Watershed in Ordu by Tüfekçioğlu (1995, 2003), 24 woody and 69 herbaceous species were reported in this vegetation type. In the same study, the number of representative species were 12 woody and 13 herbaceous. In a similar study done by Anşin (1979) the number of representative species for this vegetation type were 23 woody and 23 herbaceous.

Spruce forests and clearcutting areas:

These forests generally have more plant species diversity compared to chestnut forests and beech forests. Main tree species of this vegetation type are *Abies nordmanniana, Acer trautvetteri* and *Picea orientalis.* In a study done in Ordu by Tüfekçioğlu (1995), 19 woody and 118 herbaceous species were reported in this vegetation type. In the same study, the number of representative species were 16 woody and 22 herbaceous. In a similar study done by Ansin (1979) the number of representative species for this vegetation type were 24 woody and 34 herbaceous. This vegetation zone also rich in mammal's diversity. Terzioğlu (1998) compared spruce forests with adjacent clear cutting areas in terms of their plant diversity. He reported 96 plant species for pure spruce forests and 72 for clear cutting areas. Low plant diversity in clear cutting areas compared to spruce forests was result of intense competition and dominance of species ecologically adapted to local conditions. He reported that species like *Rubus spp., Rhododendron ponticum* and *Pteridium aquilinum* grew well and dominated others in clear cutting areas.

Alder forests:

These forests generally occur in Rize, especially East part of Trabzon and some part of Artvin (Hopa and Arhavi) where annual precipitation is higher than 1500 mm. There are no literatures about plant diversity in these forests. They have either grass or *Rubus spp.* as understory species.

Grasslands:

Most of the grassland areas are located in the upper mountains or alpine zones in the region. Heavy grazing and erosion are the main reasons for the decrease in biodiversity in these areas in the region. We divided grasslands into three subcategories as below:

Lower grasslands

These grasslands are mainly owned by people and fertilized to feed animals. Fertilizer or manure use in these grasslands gave advantage to some species to dominate and remove other species from area. They have less plant species diversity compared to alpine grasslands. In some areas, some of these grasslands are owned by public and open to common use. These types of grasslands are not fertilized and they are under heavy grazing. They are generally subject to very strong erosion and their compositions are rich in terms of undesirable species compared to fertilized grasslands.

Grasslands in forest openings

These are grasslands that located inside the forests as large openings. Their species composition depends on which vegetation type they occur. Most of these grasslands were found in mid elevations. These grasslands are generally subject to heavy grazing in early summer when the people migrating their animals into higher plateaus and in early fall when they returning to low elevation areas.

Alpine and subalpine grasslands

These grasslands are located at above the tree-line in the region. They are under heavy grazing pressure and subject to erosion in most places. Undesired species like *Nardus stricta* has become dominant species in areas under heavy grazing pressure. Terzioğlu (1998) observed nearly 550 plant taxa in the alpine and subalpine grasslands of Soğanlı Watershed of Trabzon.

Wetlands:

Wetlands are located around lakes and riparian areas in the region. One of the major wetland area in the region is Uzungöl (Öztürk and Leblebici, 1997). The other important wetland areas located in the region are Trabzon-Sera Lake and Artvin-Karagöl Lake. In a flora survey study, Terzioğlu (1998) observed 41 plant species in wetland area of Uzungöl Lake. Dominant found in this lake were *Lythrum salicaria* and *Equisetum fluviatile.* Sediment removal studies in the lake causes destruction of growing area of these species. Species like *Potamogeton spp.* and *Polygonum amphibium* observed only in Artvin-Karagöl

but not in Uzungöl Lake. But the lake faces a major threat by the amount of sediment carried by the river. Because of large amount of sediment deposition, the area of lake has been reduced significantly.

Effects of some ecological factors on biodiversity in the region:

According to Tüfekçioğlu (1995) factors such as canopy coverage, slope position, slope and aspect had effect on plant diversity in Melet Watershed of Ordu. In his study, average numbers of species in a 20x20 m area were 26 for 11-40% canopy covered, 22 for 41-70% canopy covered and 15 for 71-100% canopy covered forests. For the same area, he found almost similar number of plant species in southern and northern slopes (21 for southern, 20 for northern). Similarly, effect of slope on the number of plant species was small (18 for 17-36% slope, 22 for 36-58% slope and 19 for 58-100% slope). In the same study, numbers of plant species were 22 for lower slope, 20 for mid slope and 18 for upper slope position. There are no other studies done in the region comparing number of plant species change with these ecological factors.

Endemism in the Region:

There are 386 endemic plant species in the region. High mountain areas in Artvin, Rize and Trabzon are the places rich in endemism. Eight of the endemics are in critically endangered list of IUCN while 55 are in endangered list in the region. The number of total species in each cities are 1219 for Artvin, 747 for Rize, 894 for Trabzon, 457 for Giresun and 301 for Ordu. Number of endemic species in each city are 119 for Artvin, 74 for Rize, 70 for Trabzon, 54 for Giresun and 19 for Ordu. Most of the critically endangered and endangered species were found in grasslands and forest openings. Distribution of threatened species according to cities are listed below (Ekim et al., 2000) (CR: critically endangered; EN: endangered; DD: data deficient):

1. **Artvin:** *Anthemis calcarea* var. *calcarea* (CR), *Centaurea leptophylla* (CR), *Hypericum fissurale* (CR), *Lathyrus woronowii* (CR), *Onosma circinnatum* (EN), *Symphytum savvalense* (EN), *Campanula choruhensis* (EN), *Campanula troegerae* (EN), *Silene scythicina* (EN), *Rhodothamnus sessilifolius* (EN), *Helichrysum artvinense* (EN), *Hieracium diaphanoidiceps* (EN), *Hieracum foliosissimum* (EN), *Hieracium radiatellum* (EN), *Clypeola raddeana* (EN), *Hypericum marginatum* (EN), *Crocus biflorus* subsp. *artvinensis* (EN), *Crocus biflorus* subsp. *fibroannulatus* (EN), *Stachys choruhensis* (EN), *Lilium carniolicum* subsp. *ponticum* var. *artvinense* (EN), *Ornithogalum byzantinum* var. *proliferum* (EN), *Orobanche armena* (EN), *Heracleum sphondylium* subsp. *artvinense* (EN), *Hieracum artvinense* (DD), *Hieracium cinereostriatum* (DD), *Hieracium debilescens* (DD), *Hieracium floccicomatum* (DD), *Hieracium subartvinense* (DD), *Hieracium subhastulatum* (DD), *Hieracium virosiforme* (DD), *Astragalus imbricatus* (DD), *Allium koenigianum* (DD), *Gagea tenuissima* (DD), *Verbascum artvinense* (DD), *Ferulago latiloba* (DD),

2. **Rize:** *Campanula latiloba* subsp. *rizeensis* (EN), *Silene scythicina* (EN), *Senecio ovatifolius* (EN), *Blysmus compressus* subsp. *subulifolia* (EN), *Onobrychis lasistanica* (EN), *Geranium davisianum* (EN), *Sorbus caucasica* var *yaltirikii* (EN), *Alchemilla ancerensis* (EN), *Alchemilla cimilensis* (EN), *Alchemilla ciminensis* (EN), *Alchemilla hemsinica* (EN), *Alchemilla ikizdereensis* (EN), *Alchemilla kackarensis* (EN), *Salix rizeensis* (EN), *Angelica sylvestris* var. *stenoptera* (EN), *Symphyandra lazica* (DD), *Hieracium amblylepis* (DD), *Festuca paphlagonica* subsp. *villosula* (DD), *Ranunculus dissectus* subsp. *rigidulus* (DD), *Ornithogalum balansae* (DD),

3. **Gümüşhane**: *Paracaryum erysimifolium* (EN), *Paracaryum leptophyllum* (EN), *Barbarea integrifolia* (EN), *Aethionema sintenisii* (EN), *Hesperis stellata* (EN), *Thlaspi*

sintenisii (EN), *Vicia quadrijuga* (EN), *Elymus longearistatus* subsp. *sintenisii* (EN), *Erodium hendrikii* (EN), *Arenaria scariosa* (EN), *Onosma obtusifolium* (EN), *Galanthus koenianus* (EN), *Centaurea rhizocalathium* (DD), *Echinops sintenisii* (DD*), Hieracium mannagattae* (DD), *Hieracium subrosulatum* (DD), *Taraxacum bassarabicum* subsp. *gumusanicum* (DD),

4. **Trabzon**: *Symphytum sylvaticum* subsp. *sepulcrale* var. *hordorkopii* (EN), *Symphytum sylvaticum* subsp. *sylvaticum* (EN), *Sempervivum furseorum* (EN), *Erysimum deflexum* (EN), *Rhododdendron ponticum* subsp. *ponticum* var. *heterophyllum* (EN), *Erodium absinthoides* subsp. *latifolium* (EN), *Festuca pontica* (EN), *Astragalus arakliensis* (EN), *Alchemilla trabzonica* (EN), *Salix rizeensis* (EN), *Salix trabzonica* (EN), *Verbascum varians* var. *trapezunticum* (EN), *Zelkova carpinifolia* subsp. *yomraensis* (EN), *Angelica sylvestris* var. *stenoptera* (EN), *Elymus longearistatus* subsp. s*intenisii* (EN),

5. **Giresun:** *Micromeria fruticosa* subsp. *giresunica* (CR), *Doronicum tobeyi* (CR), *Hieracium tamderense* (EN), *Hieracium giresunense* (EN)

Conclusions

Major threats to biological diversity in the region are: heavy grazing pressure in grasslands, conversion of forests into croplands in low and mid elevations, construction of buildings and roads and other human activities in coastal and riparian areas. Conversion of forests or grasslands into tea gardens resulted in most dramatic degradation in biodiversity. Conversion to hazelnut gardens did not change the biodiversity in large extent in terms of number of species, but it changed the floristic composition.

Artvin is the richest city in the region in terms of biodiversity. But on the other hand it has the highest number of critically endangered (CR) and endangered (EN) species. Construction of dams on Çoruh River will create major threat for some of these endangered species. Species grown in dam areas need to be *ex-situ* conservation measures. They need to be propagated and planted in such areas as arboretum and botanical gardens to eliminate their disappearance. In forestry practices, distribution of Critically Endangered and Endangered species should be mapped by using Geographic Information System not to damage their habitat. Forest management plans must dictate the core areas to conserve biodiversity. In alpine pastures, grazing has to be prevented in the areas rich in endemic species. In the one hand, corms and bulbs of the geophytes have never been picked up from the nature, but from the mass produced gardens, on the other hand, whole part of herbaceous medicinal plants, which are not endemic or rare, and any part of endemic and rare species too.

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