A REVIEW OF THE FOREST VEGETATION OF TURKEY: ITS STATUS PAST AND PRESENT AND ITS FUTURE CONSERVATION

Alper H. Çolak and Ian D. Rotherham

ABSTRACT

This paper reviews the history and development of forests in Turkey. It considers the published literature and summarises extensive fieldwork in order to present an overview of the forest resource. The issues of landscape change and the associated historic drivers are addressed and the threats to these important and biodiverse landscapes, both now and in the past, are considered.

The findings are placed in a wider context, and comparisons with wooded or forest landscapes elsewhere are drawn. It notes the impacts and influences of the transfer of perceptions, management cultures and priorities in approaches and actions from elsewhere. In particular, the contrasting situation in the United Kingdom is discussed with its implications for strategic developments. Suggestions for future priorities and for conservation action are put forward.

Alper H. Çolak (corresponding author; e-mail: alpere@istanbul.edu.tr), Istanbul University, Faculty of Forestry, Department of Silviculture, TR-34473 Bahceköy, Istanbul, Turkey; Ian D. Rotherham, Tourism Leisure and Environmental Change Research Unit, Sheffield Hallam University, Sheffield, United Kingdom.

INTRODUCTION

Turkey consists of European Turkey and Anatolia, i.e. that part of the country in Asia. The country is the meeting place of three phyto-geographical regions: Euro-Siberian, Mediterranean and Irano-Turanian. Their distinctive vegetation reflects differences in climate, geology, topography, soils and floristic diversity, including endemism. Scientific and historical research indicates that 4,000 years ago the Anatolian landscape was 60%–70% forest and 10%–15% steppe (Davis 1965–1988; Fig. 1). However, over-grazing, over-cutting, fires, clearance for agriculture, wars and general misuse of the land have caused a decrease in forest area to 26%, and an increase in steppe area to 24% (Mayer and Aksoy 1986; Fig. 1). Ninety percent of the forest in Turkey is 'natural' in origin and contains over 450 species of trees and shrubs. These are adapted to a diversity of site conditions and provide a rich biological resource that still remains reasonably intact.

Forestry in Turkey has been strongly influenced by that practised in Germany, Austria, France and the United Kingdom. These influences, which encouraged a move away from traditional forest use and management towards intensive forestry, guided practise in many regions during the second half of the twentieth century. It is fortunate that Turkey lagged behind in the implementation of these approaches, given their long-term and increasingly recognised consequences, including ecological simplification, replacement of native forests by exotic species and massive soil erosion. These consequences need to be addressed by conservation management.

Authors such as Malcolm (1976) have noted the poor state of Turkish forestry with, in in Malcom's view, many areas seriously degraded. He suggested that around 25% (around twenty million hectares) of the country was covered with forest, with around half being coppice, although the true figure for coppice is probably closer to a quarter. Coppice in Turkey is simple coppice with no overstorey (unlike coppice-with-standards found in the United Kingdom) and most of this was considered to be degraded. A shortfall in Turkish domestic timber supply was predicted, and a vigorous programme of rehabilitation and conversion of 'degraded' forest to more productive species was strongly advocated (Ürgenc 2004). A programme of planting was drawn up with 18,000ha of plantations annually in degraded forests and 5500ha annually of new forest. These included exotic species such as poplar (e.g. *Populus* x *euramericana* and *Eucalyptus* species. Old coppice was to be clear-cut and replaced by what Malcolm described as 'industrial plantations'. The steep slopes were to be terraced by bulldozer. In these early days, with labour still cheap and imported herbicides expensive, weed control was by hand. By the 1990s, the broad-scale spraying of 'weedy' areas by chemical herbicides was being advocated (Çolak 1996; 2001).

This situation parallels what happened in the United Kingdom during the twentieth century, but

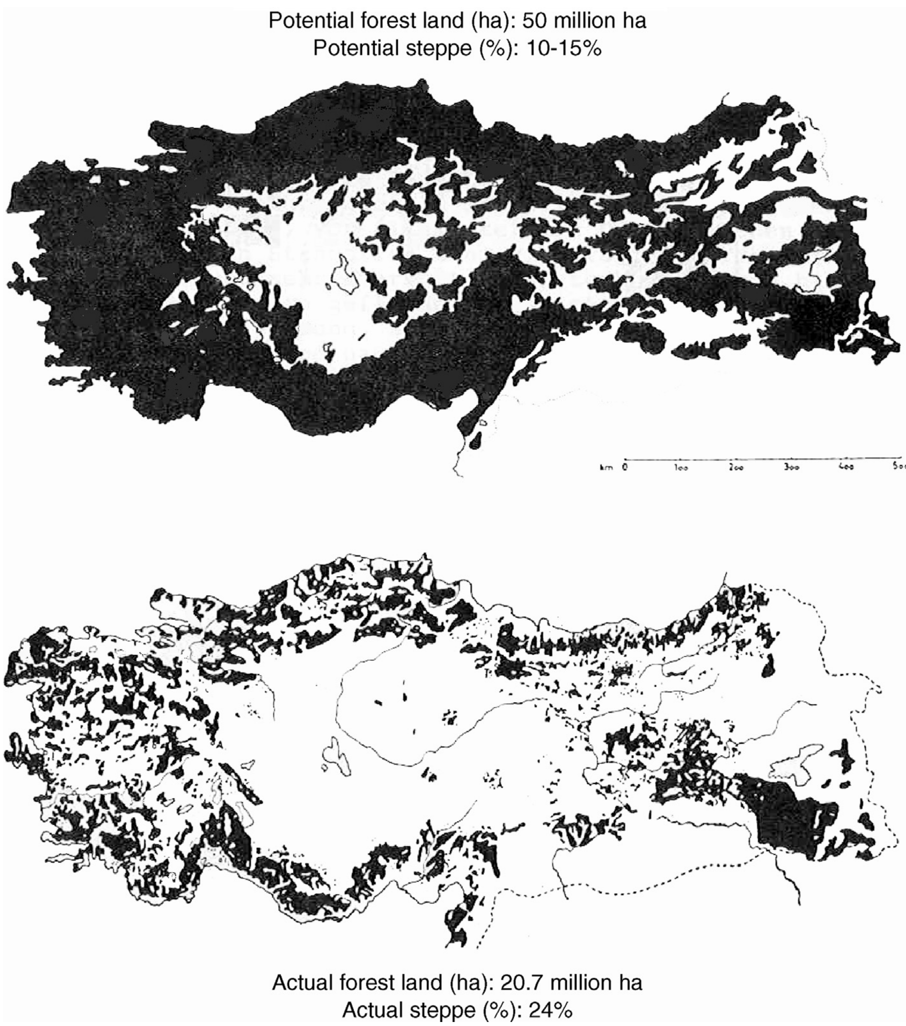

Fig. 1 — Potential and actual cover of forest in Anatolia (after Schiechtl *et al.* 1965; Mayer and Aksoy 1986; Ürgenc 2004).

lags some decades behind. Plantations of generally exotic species replaced traditional coppice woods and blanket afforestation was rolled out across former heaths, moors and commons. This was particularly the case following the establishment of the Forestry Commission in the United Kingdom after the First World War and again between *c.* 1950 and 1980 in the push to improve 'derelict, unproductive, and marginal lands'.

Key differences between the United Kingdom and Turkey are the large economic resources available to bring about such change in the former and the much more extreme physical conditions in the montane forests in Turkey. There are, however, other important differences — firstly the sheer biological richness of the Turkish flora in comparison with the United Kingdom. Secondly, there is the absence until very recently of an established academic discipline of forest ecology in Turkey, combined with a lack of a conservation lobby. Most of the work and strategy has been led and implemented by commercial forestry.

Turkish forests also have a global relevance. This rich and extensive resource, combined with a unique geographical location, means that with global climate change, Turkey may have an important phytogeographical role, e.g. as a reservoir for species transfer both within Turkey, and from Turkey to Europe. Their importance was recognised in the Helsinki Resolution (Ministerial Conference on the Protection of Forest in Europe 1993; Geburek 1998), which encourages research in forest genetics related to adaptational processes under a global climate change scenario. This suggests that it is important to select and protect key gene-pool reserves. We argue that Turkish forests should be a priority for such action, as is provided for under the Global Plan of Action (FAO 1996; Schachl 1998), which includes the improvement of both *in situ* and *ex situ* conservation and promotes the use of plant genetic resources.

This paper is based on an extensive review of the literature relating to the history of forestry and landscape in Turkey and the biodiversity of the region. The importance of the biodiversity of Turkish montane forests and the major threats to their genetic diversity associated with over-exploitation, forest fragmentation, air pollution and global climatic change are described. Parallels are drawn with the situation in the United Kingdom, where there is increasing awareness of the importance of ancient woods and wood pastures and associated changes in policy. Despite superficial dissimilarities, there are in fact remarkable parallels in cultural impacts and an emerging awareness of the importance of sustainable development across Europe.

Nomenclature for Turkish species follows Davis (1965)–1988). For exotic species, we use CABI (2005) and Elicin (1980).

THE FORMER FOREST VEGETATION OF ANATOLIA: THE CULTURE AND HISTORY OF THE REGION

Turkey and other Mediterranean countries contain ancient cultural landscapes with a rich biodiversity and distinctive vegetation. They are strongly influenced by human activity reaching back far into history and often resulting in degradation (Thirgood 1987; Perlin 1989; Kehl 1995; Rackham and Moody 1996). This is very obvious in Anatolia, a region where eastern and western civilizations meet and which is one of the oldest continually inhabited regions in the world. It has been repeatedly a battleground for foreign powers, being noted as a melting pot of cultures. From the first known urban city (Catalhöyük *c*. 7500 BC) to the historically famous Troy, and from the Ionians to the great empires of the world (e.g. Roman, Byzantine, and Ottoman), many cultures (e.g. Sumers, Cimmerians, Hurries, Cilicans, Phoenicians, Lydian, Carians, Persians, Hellenes, etc.) were established. The earliest major empire of the region (the Hittite Empire) derived its name from the dominant prehistoric culture of Anatolia (Hatti, Khetas or Hetas).

Palaeoecological studies have greatly increased our knowledge of Late Quaternary environmental changes in Turkey and the eastern Mediterranean arising from both climate change and human impact (e.g. Bottema *et al*. 1993a, 1993b; Eastwood *et al*. 1998; 1999). However, in Turkey many palynological studies are spatially very limited (e.g. Aytug 1970; Aytug *et al*. 1975; Aytug and Görcelioglu 1987; 1993; 1994; Bottema *et al*. 1993a, 1993b) and correlation of sediment profiles from different regions is often impossible, because of the very distinct local differences in deposition rates. Furthermore, there are chronological problems, particularly for the mid-Holocene onwards, in relation to vegetation development in different regions of the Near East. Pollen diagrams show that, following the end of the Ice Age, a wetter and warmer climate led to the spread of forest into the steppes of central Anatolia and other large landmasses. Over the last 2,000 years, anthropogenic impacts have significantly reduced forest areas, most markedly in the last five centuries.

All these civilizations and especially their cities required wood, timber and grazing land. Their cumulative impacts caused the destruction of forest vegetation. Mayer and Aksoy (1986) drew attention to periods of deforestation and degradation during the prehistoric period (*c*. 1850–1180 BC) and again during the rise and fall of the Ottoman Empire (1299–1922 AD). Anatolia was a centre for the production of both big timber and secondary forest products for the great Mediterranean and near-east civilizations, e.g. Egyptians, Mesopotamians, Phoenicians and Romans. High quality logs were transported to construct temples, houses, and ships. King Solomon, for example, is reputed to have sent 30,000 workers from Israel to the Taurus Mountains of southern Turkey, to cut trees of about 30m in height for the construction of his temple in Jerusalem. Furthermore, once the cedar forests (*Cedrus libani*) in Lebanon were almost destroyed, the timber needs of countries in the eastern Mediterranean were provided from the Taurus Mountains (Senitza 1989). Mayer and Aksoy (1986), referring to Evliya Çelebi (a famous seventeenth century traveller and writer), note that thousands of timber producers lived in northwest Anatolia in 1648 AD.

The importance of anthropogenic impacts, however, is still debated. According to Hempel (1981, 1983) people played a far less important role in the origins of present-day vegetation and the current eroded landscapes than was previously assumed. Human activities certainly reduced forest areas and caused soil erosion, although significant soil erosion is also shown to have occurred in the Sub-boreal (4680–2890 BC) to early Atlantic Periods (2890–1690 BC). Historical records and contemporary research suggest Anatolia had 60-70% forest cover and 10-15% steppe around 2000 BC (Walter 1956). The forest area has declined to 26% as a result of over-grazing, over-cutting, fires, spread of agricultural lands, wars, etc, and steppe has increased to 24% in the intervening 4,000 years (Louis 1939; Walter 1956; Fig. 1). Despite these changes it is generally agreed that relative to the vegetation of Central Europe (Mayer 1984; Ozenda 1988; Ellenberg 1996; Bundesamt für Naturschutz

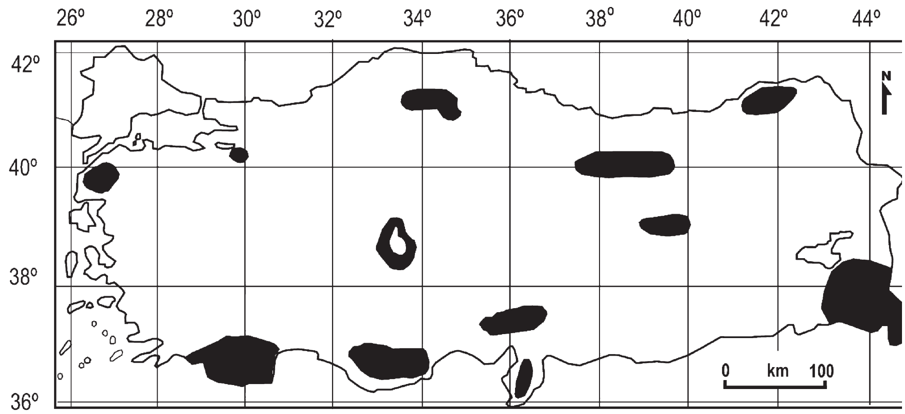

Fig. 2 — The important areas for endemic plants in Turkey (after Ekim *et al.* 2000).

2004), Turkish vegetation is still more 'original' or 'natural' in its composition (Schwarz 1936; Walter 1968; Schmidt 1969; Zohary 1973). Furthermore, many of the elements of the vegetation types are felt to have a high ecological resistance and an ability to regenerate (Kehl 1995). Authors such as Thirgood (1987) have highlighted not only the destructive power of human impacts, but also the potential of the vegetation to recover.

A paradox running through all civilizations is that while they utilize natural resources they also destroy the living systems on which they depend. Thus, whilst the civilizations in Anatolia were destroying forests on the one hand, on the other they used the flora for a variety of purposes. The peoples of Anatolia have benefited from a diversity of botanical riches. They have cultivated soil and domesticated animals but also used wild plants for food, spices, dyes and medicines. During the Mesopotamian Civilization some 250 wild plant species were used as drugs; today over 2000 are used (Baytop 1984) and most people in Anatolia still live close to nature and maintain a deep interest in wild plants.

THE FLORA OF TURKEY: THE PHYTO-GEOGRAPHICAL REGIONS AND THEIR BOTANICAL RICHNESS

The vascular flora of Turkey contains *c*. 9,000 species and is the richest of the Near East and Middle East regions (Çolak 2001). It includes, for example, 670 species of Leguminosae, 700 species of Compositae, 450 species of Labiatae and 250 species of Gramininеae. Its richness is of interest for both the total number of species and especially the number of endemics, of which there are *c*. 3,000 (Ekim 1995; Ekim *et al*. 2000; Fig. 2). (This compares with a total of *c*. 12,000 species of vascular plants and *c*. 1,750 endemic species in Europe despite having a land area fifteen times larger). Many endemic species (*c*. 3000 species) are peculiar to the transitional belt in Turkey between Europe and Asia.

There are several reasons for Turkey's particularly interesting flora (Davis 1965–1988). irstly, it is the meeting place of three phyto-geographical regions: Euro-Siberian, Medite-rranean and Irano-Turanian regions (Fig. 3). Secondly, Anatolia forms a bridge between southern Europe and southwest Asia and has apparently served as a migration route (Davis 1965–1988) facilitating the penetration of Asiatic floral elements into southern Europe. Thirdly, many genera and sections have their centre of diversity in Anatolia and species endemism, at *c*. 30-35%, is high. This is probably connected with the climatic and topographical diversity of the county and the limited extent of Pleistocene glaciations, allowing species survival. Finally, many cultivated plants (crop plants, fruit trees, ornamentals) and weed species in Europe originated in Anatolia and adjacent lands. The arid areas have numerous fodder plants of potential economic importance.

FACTORS RESPONSIBLE FOR THE HIGH BIODIVERSITY OF THE TURKISH FLORA

Important factors responsible for the biodiversity of the Turkish flora have been discussed by Davis (1965–1988), Mayer and Aksoy (1986) Çolak (2001), Çolak and Pitterle (1999) and Çolak and Sorger (2005). They are briefly considered below:

GEOGRAPHICAL LOCATION AND TOPOGRAPHY

Anatolia covers *c*. 75 million hectares, and European Turkey *c*. 2.4 million hectares. Most of the region consists of a plateau, rising steadily towards the east and bounded to the north and south by steep mountain ranges. In the west, this

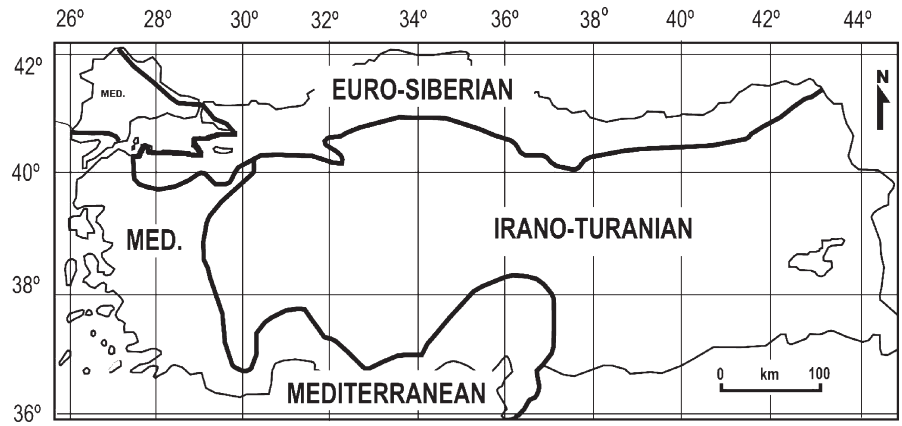

Fig. 3 — The three phyto-geographical regions in Turkey: Euro-Siberian, Mediterranean, and Irano-Turanian (after Davis *et al.* 1971).

plateau falls gradually to sea level, terminating in a series of promontories. Half the land is above 1000m and 10% is over 2000m. The northern Anatolian mountains are the continuation of the Carpathian–Balkan mountain chains while the Taurus Mountains in the south are eastern extensions of the Alps. These mountains provide physical links with Mesopotamia (comprising parts of Turkey, Iraq and Syria between the Tigris and Euphrates Rivers) and the Syrian Desert to the southeast and the Caucasus to the north-east (Davis 1965).

CLIMATIC DIVERSITY

Within the study region there are many variations in climatic conditions. Simplified these can be placed within the a) Euxinian, b) Forest-steppe transition and c) Mediterranean. The Euxinian region covers the whole of the Euro-Siberian phyto-geographical region and is best referred to the *Euxinian province*, an area that covers much of Georgia and the Caucasus, the Istiranca mountains of European Turkey and south-east Bulgaria. In contrast to the rest of Turkey, the most striking feature of this region is the very wet climate, particularly in the east, with heavy precipitation occurring all year and frequent mists. In the Mediterranean region, the precipitation has a distinct seasonality and varies considerably from year to year. Throughout much of the area snow lies in winter above 1000m. The low temperatures and dry air lead to the penetration of steppic elements from Inner Anatolia into the high mountains, where steppe-like vegetation usually predominates above the tree-line. In summer in Inner Anatolia, there is a marked diurnal temperature change. A major limiting factor for the vegetation is the very low summer humidity. This favours a predominantly herbaceous and suffruticose flora and (with the exception of some conifers) precludes the growth of evergreen trees and shrubs. On the lower, outer plateau of Mesopotamia, temperatures are higher than in the rest of Inner Anatolia. This accounts for the floristic affinities with the Syrian Desert, of which it is the northern extension (Davis 1965).

GEOLOGY

The geology is very varied and there is a great range of igneous, sedimentary and metamorphic rocks, including extensive areas of recent volcanic rock and numerous extinct volcanoes. These variations have a major impact on the soil, drainage, topography and vegetation and the volcanic areas display pronounced floristic differences. The mountainous topography results in pronounced vertical and horizontal climatic differences from semi-arid, steppic conditions, to humid, broad-leaved forest. For example, in the eastern Black Sea region *Fagus orientalis* occurs on north-facing slopes from the humid zone to the steppe transition zone. On south facing slopes, *Abies bornmülleriana* and *Pinus sylvestris* occur with *Pinus nigra* close to the steppes (Mayer and Aksoy 1986; Çolak and Pitterle 1999).

THE FLORA OF THE PHYTO-GEOGRAPHICAL REGIONS

EURO-SIBERIAN REGION

This region extends along most of north Anatolia and a narrow strip along the Black Sea coast of European Turkey. The relatively humid climate is reflected in the predominantly mesophytic vegetation. Deciduous forest is the usual climax in the middle and lower zones with phanerophytes and hemicryptophytes occurring in abundance. However, there is a broken chain of Mediterranean enclaves extending along much of the

Black Sea coast but poorly developed in northeast Anatolia. Most of the Euxinian climatic province below the tree-line is covered with forest or, where the forest has been destroyed, by scrub. At lower levels, the forest is mainly deciduous, often associated with evergreen shrubs, but at higher levels conifers increase or become dominant. The flora of these montane coniferous forests and the alpine zones are similar to those in the Caucasus, and even the mountains of Central Europe (Davis 1965–1988).

MEDITERRANEAN REGION

In Turkey all the Mediterranean vegetation can be placed within the communities of the East Mediterranean province. This is treated here as extending from the eastern half of Italy to the Lebanon. Large numbers of geophytes, therophytes and suffrutescent chamaephytes are characteristic of the region; though sclerophyllous vegetation dominates the landscape. Maquis, dominated by evergreen shrubs, covers much of the land below 1000m or 1200m. Forest communities prevail on deeper soils or where there has been less interference with the natural climax vegetation. Above 1000m or 1200m (corresponding to a sporadic winter snowline), the Mediterranean region is largely dominated by conifers (Davis 1965–1988).

IRANO-TURANIAN REGION

This is by far the largest of the three regions in Turkey and, apart from a few enclaves is confined to Central and East Anatolia. Although it is a large area rich in herbaceous and suffruticose species, it is far less well understood than the Mediterranean and Euro-Siberian regions. This is largely due to the difficulties of identification in several genera that play an important role in the vegetation. Where the broad zone of *Pinus nigra* subsp. *pallasiana* forest which borders Central Anatolia in the north, west and south meets the oak scrub, the most abundant type of vegetation on the periphery of the central Anatolian steppes, it is usually associated with a largely Irano-Turanian ground-flora. This Irano-Turanian scrub is best developed in the north and west. The Irano-Turanian flora in Turkey is closely related to that of Transcaucasia, northwest and west Iran, and north Iraq (Davis 1965–1988).

FOREST VEGETATION IN CONTEMPORARY TURKEY

Turkey has 21.18 million ha of forest, covering 26% of the land surface of the country. High forest covers *c*. 8.94 million ha, active coppices *c*. 1.68 million ha, degraded high forest *c*. 6.50 million ha and degraded coppices *c*. 4.06 million ha (Ministry of Environment and Forestry Turkey: www.ogm.gov.tr). Most of these forests occur in the mountains. According to Sag (2002), there are 3.15 million ha of forest found in the zones 1500–2500m, and 15.77 million hectares of open land.

42% of the forests in Turkey are composed of coniferous species (30% Pinus spp., 4.6% Juniperus spp., 0.9% Abies sp, 0.7% Picea orientalis, 0.5% Cedrus libani, and 5.5% mixed coniferous forests), 53.3% of broad-leaved species (22.7% Quercus spp., 3.3% Fagus orientalis, 0.2% Alnus spp., 0.1% Castanea sativa, 0.1% other broad-leaved species, 18.5% mixed broad-leaved forests and 8.4% maquis) and 4.5% mixed coniferous and broad-leaved forests (Mayer and Aksoy 1986) (see Tables 1 and 2). Table 1 shows how the distinctive forest communities are adapted to the different climatic conditions. These forest communities havemore than 450 native species of trees and shrubs, the most important listed in Table 2.

Despite centuries of human activity, much of the forest in Anatolia is still *relatively* natural compared with those of Western Europe such as in the UK. In particular, until very recently they have escaped many of the impacts of modern forestry management methods that have impacted negatively on forests in Western Europe. However, Turkish forests are typically mosaics, and include clear-felled or highly altered areas. These forests may be classified as near-natural, semi-natural and partly altered or as oligohemerobic, meso-hemerobic and partly euhemerobic (Çolak *et al*. 2003). There are still some residual virgin forest areas, but much has been degraded from near-natural to semi-natural and altered. Where natural forests have been completely cleared they are classified as artificial / polyhemerob with some afforestation (Çolak 2000). Remnants of Mediterranean shrub formations can often be identified in the immediate vicinity of settlements. Seriously damaged maquis formations with mantle communities and forb fringes, subjected to high grazing pressure, are able to spread and regenerate rapidly if protected (Greuter 1975; Amir and Sarig 1976; Godron *et al*. 1981). This highlights issues about relationships between human influences and the dynamics of semi-natural and anthropogenically influenced flora and vegetation (Kehl 1995).

THREATS TO THE FLORA AND FOREST VEGETATION OF TURKEY

The most important threats to the forests and flora of Turkey are noted by Çolak (2001) and Ekim *et al*. (2000). They include the following:

AGRICULTURE

In recent decades an extension of agriculture into former forest areas and inappropriate and unsustainable agricultural practices by forest villagers has placed intense social and economic pressure on the forest resource. Poor land-use practices in the Mediterranean regionhave transformed regional landscapes, putting intense pressure on native plant species and often removing most of the pre-existing vegetation. Uncultivated land is often used as natural pasture and, with mild winters in the lower Mediterranean region, grazing is possible throughout the year (Efe 2004). There has been an increased use of agro-chemicals, particularly herbicides, associated with more intensive farming. A consequence has been widespread soil erosion. Uncontrolled and damaging use of wild plants (e.g. inappropriate and unsustainable collecting and overuse) by villagers and commercial collectors has also caused problems.

FOREST MANAGEMENT

Excessive harvesting and unplanned exploitation past and present have destroyed, and still are destroying, the structure of these highly specialized systems. The potential timberline has descended by between 50m and 400m due to human impacts. This varies with different impacts affecting high mountain forestry at the timberline. Over the last 200 years timber production, clear cutting for pasture and direct impacts of grazing stock have destroyed many areas and the forest has retreated. This is similar to elsewhere in Europe (see Kral 1973). Afforestation with monocultures and a tendency towards the planting of barren areas within the forest zone has compounded the damage. This has changed species composition and structure away from natural forests, resulting in a characteristic mosaic of degraded maquis around many rural settlements. The maquis is species-rich with fringe forbs, heliophilous plants, species of extensive pastures and clearings and ruderal and segetal species close to settlements. There are often intimate mosaics of shrub complexes but such land use does not necessarily lead to an increase in biomass suitable for grazing. The migration of species more ecologically resistant to extreme habitats (such as *Evax erisophaera*) into extensive pastures has been accompanied by a process of negative selection (Kehl 1995).

URBANISATION AND INDUSTRIALISATION

There has been an expansion of industrial and urban areas into the mountain zone. Fires and air pollution have massive, if very localised, impacts (e.g. at Murgul, Karabük and Yatagan).

TOURISM

There is an increasing threat from uncontrolled and unsustainable tourism development. This is

Table 1 — The forest regions of Turkey (after Mayer and Aksoy (1986) from Çolak and Odabasi (2004)).

	Euxin-Subeuxin Forest Regions of North Anatolia
	(cool winters, humid to sub-humid summers)
a	North-west Euxin-Subeuxin Forests
b	Middle Euxin-Subeuxin Forests
c	East Euxin-Subeuxin Forests
	Steppe Forest Region
	(cold winters, dry summers)
a	East Thrace Lowland Steppe Forests
b	Central Anatolia Sub-Mediterranean Steppe Forests between Lowland and Highland
c	East Anatolia Highland Steppe Forests
d	Southeast Anatolia Mountain Steppe Forest
e	Mesopotamia Steppe Forests
	South and East Anatolia Mediterranean / Sub-Mediterranean Forest Regions
	(very hot summers, mild winters)
a	South Anatolia Mediterranean Forest Regions
b	Mediterranean West Aegean Forest Regions
c	Sub-Mediterranean East Aegean Forest Regions

presently associated with dense housing along the coastal zones.

The consequence of these pressures is damage to high quality forests and ecosystems in mountain areas and declining local economies. In all forest zones, from sea level to the timberline, even-aged stands have become standard over large areas and in some regions there has been extensive clear-felling. Natural regeneration has been used at high altitudes and to a limited extent for some tree species at all altitudes. However, there has often been inadequate protection from over-grazing. As a consequence

Table 2—The forest tree species found in the different forest regions.

	Euxin-Subeuxin Forest Regions of North Anatolia	
Abies bornmülleriana	*Picea orientalis*	*Taxus baccata*
Abies nordmanniana	*Pinus nigra*	*Ulmus glabra*
Acer trautvetteri	*P. sylvestris*	*U. minor*
Alnus glutinosa ssp *barbata*	*Platanus orientalis*	*Tilia platyphyllos*
Betula pendula	*Prunus spinosa*	*T. argentea*
Buxus sempervirens	*Pterocarya fraxinifolia*	*Zelkova carpinifolia (Relict: Arbutus andrachne*
Carpinus betulus	*Quercus cerris*	*Juniperus excelsa*
Castanea sativa	*Q. hartwissiana*	*Juniperus foetidissima*
Corylus avellana	*Q. iberica*	*Juniperus oxycedrus*
Crataegus orientalis	*Q. macranthera* ssp *syspirensis*	*Laurus nobilis*
Fagus orientalis	*Q. petraea* ssp *iberica*	*Myrtus communis*
Fraxinus angustifolia ssp *oxycarpa*	*Q. petraea* ssp *petraea*	*Olea europea*
Fraxinus excelsior	*Q. robur* ssp *robur*	*Phillyrea latifolia*
Ilex colchica	*Q. pubescens*	*Pinus brutia*
Juglans regia	*Q. syspirensis*	*P. pinea*
Juniperus comminus ssp *nana*	*Rhododendron ponticum*	*Pistacia terebinthus*
Juniperus communis ssp *communis*	*Sophora jaubertii*	*Punica granatum*
Laurocerasus officinalis	*Sorbus aucuparia*	*Quercus coccifera*
Ostrya carpinifolia	*S. torminalis*	
	Steppe Forest Region	
Betula pendula	*P. sylvestris*	*Q. libani*
Juniperus excelsa	*Populus tremula*	*Q petraea* ssp *pinnatiloba*
J. oxycedrus	*Quercus branti*	*Q. pubescens*
J. foetidissima	*Q. cerris*	*Q. robur* ssp *pedunculiflora*
Paliuris spina-christi	*Q. coccifera*	*Q. robur* ssp *robur*
Pinus nigra	*Q. frainetto*	*Q. vulcanica.*
	South and East Anatolia Mediterranean/Submediterranean Forest Regions	
Abies cilicica	*J. foetidissima*	*Populus tremula*
Acer hyrcanum	*J. oxycedrus ssp oxycedrus*	*Prunus divaricata*
A. sempervirens	*J. phoenicea*	*Quercus aucheri*
Alnus orientalis,	*J. sabina*	*Q. calliprinos*
Arbutus andrachne	*Laurus nobilis*	*Q. cerris*
Arceutos drupacea	*Liquidambar orientalis*	*Q. coccifera*
Carpinus betulus	*Olea europaea*	*Q. frainetto*
C. orientalis	*Ostrya carpinifolia*	*Q. ilex*
Castanea sativa	*Phillyrea latifolia*	*Q. infectoria* ssp *infectoria*
Cedrus libani	*Pinus brutia*	*Q. ithaburensis* ssp *macrolepis*
Celtis australis	*P. halepensis*	*Q. pubescens*
Cercis siliquastrum	*P. nigra*	*Q. trojana*
Ceratonia siliqua	*P. pinea*	*Sorbus umbellata*
Cupressus sempervirens	*Pistacia terebinthus* ssp *palaestina*	*Styrax officinalis*
Fraxinus ornus	*Platanus orientalis*	*Tamarix smyrnensis*
Juniperus excelsa		

plantation forests have developed at the expense of more natural forest ecosystems.

DISCUSSION

There are many issues regarding the relationships between historical, anthropogenic and environmental factors that have influenced the nature of wooded landscapes. Critical evaluation is important in determining the degree to which more natural forest cover is indeed 'close-to-nature' in Turkey and elsewhere (Çolak *et al.* 2003). There are parallels in northern and Western Europe and in parts of the Mediterranean such as the Tuscany region of Italy. In these areas, semi-natural, ancient woods enclosed and managed for coppice since medieval times, grazed medieval forests, parks and chases and other wood pastures are considered to demonstrate varying degrees of naturalness (Peterken 1996; Vera 2000). However, the balances between the factors themselves and the perception of them vary dramatically across Europe, Turkey and elsewhere. If it is desired that a forest is to be managed according to 'close-to-nature' silvicultural principles, then maps of naturalness zones, biotopes and key sites will be central to the process. Parallel to this debate is the fact that, on the one hand, traditional forest management is often deeply embedded in regional culture and, on the other hand, wooded landscapes that we might regard as 'close-to-nature', are hugely important as reservoirs for biodiversity. Damage to these areas has led to significant declines in the resource.

It is useful here to make comparison with the United Kingdom, as the process of deforestation has gone much further than in Turkey. Many of the problems now faced by the Turkish montane forests are very similar in nature and cause to those experienced in the United Kingdom during the second half of the twentieth century. The United Kingdom has suffered longer and more intensive periods of agro-forestry, a large-scale collapse of traditional management and a consequent decline in species-richness. With the possible exception of the Scottish Caledonian Pine Forests the woodland resource of the United Kingdom is far more fragmented than that of Turkey. Furthermore, for higher plants at least, the woods of the United Kingdom are far less diverse than the forests of Turkey, although there are high levels of biodiversity in other taxa, such as lichens, bryophytes, myxomycetes, and saproxylic invertebrates, for example. This raises further issues for Turkish forests in that there may well be significant unrecorded and unrecognised biodiversity.

The consequences of land-use changes in Turkey have been very similar, with loss of biodiversity, decline in cultural distinctiveness of the landscape, soil erosion and water management problems, etc. The agri-forestry approach has diminished both the natural and the cultural forest resource, but has also eroded the areas of marginal and unproductive lands that are likely to have biodiversity conservation significance and probably also archaeological and cultural value. However, the implications of the continued decline in biodiversity and of the impacts of global climate change are different. For Turkey there are the twin issues of the inherent species diversity and loss. There is also the significance of its geographical location as a source of or corridor for species migration and genetic resource conservation. The United Kingdom, in contrast, is geographically isolated and for many species there may simply be nowhere else to go.

CONSERVATION OF TURKISH FORESTS

It is clear that effective conservation management of Turkish forests is an urgent necessity, and much can be transferred from experiences in the United Kingdom and elsewhere in Western Europe. It is suggested that new approaches and practical applications are needed. Forestry activities, such as silvicultural conversion, restoration and 'close-to-nature' silvicultural operations, can be organized effectively if guided by 'naturalness zone maps'. With naturalness maps prepared according to hemeroby classes for five- or ten-year periods, it is possible to predict human impacts on forest ecosystems and so influence the degree to which 'close-to-nature' silvicultural practices may meet targets set for forest management and conservation. Furthermore, the use of naturalness maps with biotope maps can assist in the prediction at a landscape scale of any likely variations, deviations or conservation risks.

In preparing naturalness maps, natural forest conditions and relevant natural life-stages and processes should be taken into account. Any zones in which management ceases, and for which only natural successional development is allowed, should be carefully monitored. Use of new technology, e.g. Geographic Information Systems, Geographic Location Systems, portable computers, will assist site management and monitoring. This approach should help to provide a useful and unifying framework for directing management and assist in setting realistic targets as well as for monitoring and evaluating progress (Çolak *et al*. 2003).

There are many potential approaches that can be considered in order to protect Turkish forests, e.g. preventing fragmentation, protecting meta-populations and valuable biotopes. Key strategic measures include the protection of species and genetic diversity. To ensure that this is successful there must be recognition of the underlying diversity of the resource, albeit blurred by agri-forestry, and of the embedded cultural landscape.

Protection of gene reserves and genetic diversity

Gene conservation is considered an integral part of sustainable forestry in Turkey. It is especially important for the maintenance of the adaptive capability of species and to maintain genetic diversity, which is a non-renewable resource. The fundamental basis for the conservation of forest genetic resources in Turkey is relatively positive compared with other countries because approximately 90% of the remaining forests are considered near-natural, semi-natural or only partly altered. *In situ* measures are favoured to preserve the genetically variable populations of all tree and shrubs species. To this end a network of gene conservation forest reserves has been established representing the natural forest communities of Turkey (e.g. Bonfils and Finkeldey 1998). However, they must not be isolated islands but embedded within managed forests and other vegetation subject to 'close-to-nature' management (Frank 1998).

The following criteria will be decisive for their success (Frank 1998): minimum size, number, distribution, and representativity. Wherever the transmission of the genetic material is impeded by restricted size, rarity of the species concerned, or other reasons, *ex situ* measures are also taken. These include the establishment of clonal archives, conservation seed orchards and/or long-term storage of seeds (Müller and Schultze 1998).

To date, active conservation measures have only been carried out with commercially important species, mostly as part of tree breeding programmes. Protection and conservation of genetic resources of rare or threatened species in Turkey is not yet seen as a high priority. This reflects the absence of ecological appreciation within mainstream forestry. According to the Turkish Forest Tree Seeds and Tree Breeding Research Institute, twenty-four species are protected in 188 gene protection stands covering an area of 25,704 ha. In addition, 166 seed orchards covering 1,140 ha have been established for nine species and 229 seed stands covering 42,085 ha have been selected for twenty-one species.

Furthermore, there are thirty-five National Parks (totalling 689,631 ha) and thirty-five Nature Protection Areas (totalling 84,230 ha). The total area under different categories of protection in Turkey is 2,693,000 ha, representing about 3% of the total land area. However, the area that is strictly protected is still low (about 1.06% of the total area of the country).

International collaboration on the conservation and sustainable use of forest genetic resources is increasingly significant. This is especially important in view of the similar problems faced in other countries. Common threats to the genetic diversity of forests include air pollution, global climate change, over-exploitation, forest fragmentation, etc. (Turok 1998). The Rio Convention (UNEP 1992), the Ministerial Conferences in Strasbourg (Ministerial Conference on the Protection of Forest in Europe 1990), the Helsinki Resolution (Ministerial Conference on the Protection of Forest in Europe 1993), The Global Plan of Action for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture (FAO 1996), have all called for the development of instruments of international collaboration in this area.

CONCLUSIONS

It is clear that a more sensitive and sustainable approach to Turkish forestry is required, and the consequences of failure to change current practice are very serious. Socio-economic and environmental problems arising from mismanagement of forests are not unique to Turkey but occur elsewhere, e.g. central Europe (Mayer and Ott 1991; Kral 1992; Çolak and Pitterle 1999). However, for a diversity of social and environmental reasons, the potential costs of further decline are particularly acute in Turkey.

There is a wealth of good practice and evidence from case studies in Europe that can help inform the future management of this unique resource. In the United Kingdom and Germany, and in mountain regions of Italy and Austria, for example, there are many situations where sustainable forest management is increasingly moving towards 'close-to-nature' silviculture. This is generally incorporated into development plans that help sustain local communities through jobs and economic regeneration; the forest seen as a key to success. In particular, the concept of multi-functional forest management, including timber and wood production, sustainable tourism and leisure, wildlife, heritage and forest culture (with local food and drink), begins to provide a potential framework for long-term remediation.

Vital elements are the local differences and distinctiveness of landscapes, forest produce and management. Application of 'close-to-nature' silviculture in Turkey could significantly reduce the problems facing Turkish forests today. However, it will take time and requires a change from current practices. The application of similar management regimes for all forest zones regardless of stand properties, is not sustainable.

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