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Forest diversity, climate change and forest fires in the Mediterranean region of Turkey

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Abstract: *This paper reviews the forest resources in Turkey in the light of published literature and summarises extensive fieldwork undertaken in the Mediterranean phytogeograhical region of Turkey. The issues of landscape change and the associated drivers are addressed and the threats to the forest diversity are considered. It notes the impacts of climate change and forest fires and attemepts have been made to put forth future options for sustainable forest development.*

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Introduction

Recently, the Millennium Ecosystem Assessment concluded that out of 24 major ecosystems, which make a direct contribution to the human well-being, 15 are in decline (Zakri, 2009). Coming generations will also see the widespread depletion and degradation of habitats, water resources and most probably significant climate change (Bruntland, 1987; Ahmad, 2008). The global coverage of forests is around 4 billion ha. These extensive areas have shrunk by some 40% since agriculture began 11000 yr ago. Three quarters of this loss has occurred during the last two hundred years through a land clearance for farms and to meet demand for wood. Over the last five years, the world has suffered a net loss of some 37 million ha of forest (FAO, 1989). We are using billions of hectares of our land area for cultivation and replacing a third of temperate and tropical forests through agricultural practices and urbanisation. Habitat loss from the conversion of natural ecosystems, in particular forests, is the main reason why species extinction is increasing (Ozturk *et al.,* 2002, IUCN, 2006, Kirnak, 2006). According to the decisions reached at Rio biodiversity conference chapter 11 of Agenda 21 concluded that "The impacts of loss of forests are in the form of soil erosion, loss of biological biodiversity, damage to wildlife habitats and degradation of watershed areas, deterioration of the quality of life and the reduction of options for development".

The situation in Turkey, which is a meeting place of two continents Asia and Europe and three phyto-geographical regions; Euro-Siberian, Mediterranean and Irano-Turanian (Fig. 1), is not different. It hosts a rich plant diversity with nearly 10000 taxa of higher plants out of which more than 3000 are endemics. It is a well known fact that 4,000 yr ago 60-70% of the Anatolian landscape was forest and 10-15% was steppe (Davis, 1965-1985; Ozturk *et al.,* 2004, 2008a,b). During the last 4 decades more than 2.5 million ha of habitats of the country have been destroyed. Though limited to about 27% of the total land area of the country,maintaining healthy forests is vital to support national objectives of sustainable development. Intense pressure on the natural resources of Turkey resulting from human exploitation necessitates new techniques for promoting sustainable resource use. This prompted us to prepare this overview on the forest, forest fires and climate change in the Mediterranean phytogeographical region which is confronted with a heavy land degredation.

Forest resources

Turkey is regarded as on of the richest countries in terms of plant diversity in the temperate climate zone. An important part of this wealth is found in forest areas. The data published in 2006 reveals that approximately 21.2 million ha of the total land area of Turkey is forest, 99% of the forests belong to the state and 19% (4.1 million ha) include conservation forests such as; national parks, protected areas and other protected forests, remainder (17.1 million ha) are commercial forests. About 10 million ha of these forests are productive, whereas nearly 11 million ha are unproductive (OGM, 2006). Up till now 1.9 million ha have been afforested through artificial regeneration. Ministry of environment and forests is mainly making efforts on the environmental protection and rehabilitation of forests, preservation and development of country's natural resources (flora-fauna), prevention of environmental pollution, developing and spreading forests, protect the forested areas and to take necessary measures in order to ensure the development of forests and provide economic support to the villagers living in and around forest areas, and ensure the claims against forest products to well as to develop industry of forest products.

Table - 1: Forest resources in Turkey (OGM, 2006), volume (* million m^3)

	Tall forests			Coppice			Total		
	Normal	Degraded	Total	Normal	Degraded	Total	Normal	Degraded	Total
Coniferous	7.083	5.689	12.772	-	-	-	7.083	5.689	12.772
Deciduous	1.857	0.810	2.667	1.681	4.068	5.749	3.538	4.878	8.416
Total	8.940	6.499	15.439	1.681	4.068	5.749	10.621	10.567	21.188

Most of the forest lands are located in the Black sea, the Mediterranean sea and Aegean geographical regions (Akman, 1995; Atalay, 1994; Kaya and Raynal, 2001; Colak and Rotherham, 2006; Ozturk *et al.,* 2008b; Ozkan *et al*., 2009). A comparison of forest cover in Turkey with its neighbouring countries shows that country stands number two after Iran (Fig. 2). Nearly 40% of these are composed 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 60% coniferous species (30% *Pinus spp*., 4.6% *Juniperus spp*., 0.9% *Abies spp*., 0.7% *Picea orientalis*, 0.5% *Cedrus libani* and 5.5% mixed coniferous forests). The broad leaved trees contribute to 32% and coniferous species to 68% of the timber resources. *Quercus* species occupy 6.4 million ha, *Pinus brutia* 5.4 million ha, *Pinus nigra* 4.2 million ha, *Fagus* 1.7 million ha, *Pinus sylvestris* 1.2 million ha, *Abies* 0.6 million ha, *Juniperus* 0.5 million ha, *Cedrus* 0.4 million ha and *Picea* 0.3 million ha of forest area (OGM, 2006). The area covered by the major taxa of forests in the Mediterranean region of Turkey is given in Fig. 3 a, b.

Forest ecosystems of the Mediterranean floristic region cover the coastal belt of the Marmara sea, the western part of the Anatolian and the Mediterranean geographical regions. The elevation of these forests ranges from sea level up to 4000 m. The primary vegetation formations are shrubs (maquis and garrigue), lower (Eu- or Thermo) Mediterranean belt forests, Aegean mountain (Oro-) forests and Mediterranean (Oro-) mountain forests (Atalay, 1994). Characteristic species being; *Abies cilicica*, *Acer campestre, Arbutus andrachne, Carpinus orientalis, Castanea sativa*, *Cedrus libani*, *Fagus orientalis, Fraxinus excelsior*, *Juniperus excelsa*, *Juniperus foetidissima*, *Laurus nobilis, Myrtus communis*, *Nerium oleander*, *Ostrya carpinifolia, Pinus brutia, Pinus nigra* subsp. *pallasiana, Pinus sylvestris, Quercus cerris*, *Quercus coccifera*, *Quercus frainetto*, *Quercus infectoria*, *Quercus libani*, *Quercus pubescens*, *Quercus vulcanica*, *Sorbus terminalis, Spartium junceum*, *Tilia rubra* and *Ulmus glabra* (Kaya and Raynal, 2001; Çolak and Rotherham, 2006).

Major threats facing the forests in Turkey are; over and illegal tree cuttings, fires, climate change, agricultural land development and clearance, over-grazing, harmful insects and fungi, wind, snow, unsuccessful regeneration attempts and infrastructure establishments. Expansion of agriculture, particularly into woodlands, coupled with use of different technologies is one of the most devastating causes for deforestation. Overgrazing results in the reduction of vegetation cover and occurs when livestock density becomes excessive and too many animals are grazed on the same area. The industrial activities and housing add to these destructive factors. All these factors lead to a decrease in forest area and an increase in steppe area (Mayer and Aksoy, 1986; Canakcioglu, 1993). Timber harvest ranges from 6 to 8 million m^3 annually, most of which is used in the construction, furniture, and paper industries. Although annual firewood production is high but half of it is harvested by illegal means. A widespread conversion of natural forests into monocultural plantations of commercial value reduces habitat diversity, especially in forest lands where micro-habitat differences are much needed for wildlife.

Climate change

Climate change is arguably the greatest challenge to humanity and one of the utmost international concerns emerging as a major problem for modern society (Niyazi, 2004; Ahmad, 2008, Kalem *et al.,* 2009). There is a perception among many that global climate change is simply global warming. In fact, global climate change is an integrated system of several atmospheric phenomena and their products.

Average global air temperature has increased by about 0.8°C above pre-industrial levels and expectations are that a rise will take place from 1.4 to 5.8°C by the year 2100 (Ahmad, 2008). However local climate in different geographical areas may become warmer and drier, cooler and wetter or remain unchanged. The world is warming and much of it is due to human emissions of greenhouse gases. It is the most important menace ever known to Earth´s biodiversity and other activities. The climate change is turning its attention to the predicted effects of temperature rise on individual plant species. The alteration of a species' environmental niche will in turn affect whole ecosystems; habitats will shift and their composition change. The humankind needs to make a great deal on the basis of equity, environmental integrity and openness to all different means to stop global warming and secure capacities to build resilience to the most probable climate scenarios in the near future. Agriculture is regarded as one of the main contributors to global climate change by its greenhouse gas emissions, fluctuating between 10 and 12% of the world avarage, and by the high deforestation rate (Tuik, 2006; Sorusbay and Ergeneman, 2006). The mediterranean region of Turkey experiences a typical Mediterranean climate with dry hot sumers and mild rainy winters. There are 9 types of climate observed in the country. These are; mediterranean climate, wet mediterranean climate, partially wet mediterranean climate, Black sea climate, Partially Wet marmara climate, Steppe climate, Partially dry central anatolian climate, Partially dry south east anatolian climate and continental east anatolian climate (Koçman ,1993; Akman, 1999). The most outstanding feature of the changes experienced in the climate of Turkey is increase in summer temperatures. Summer heats often

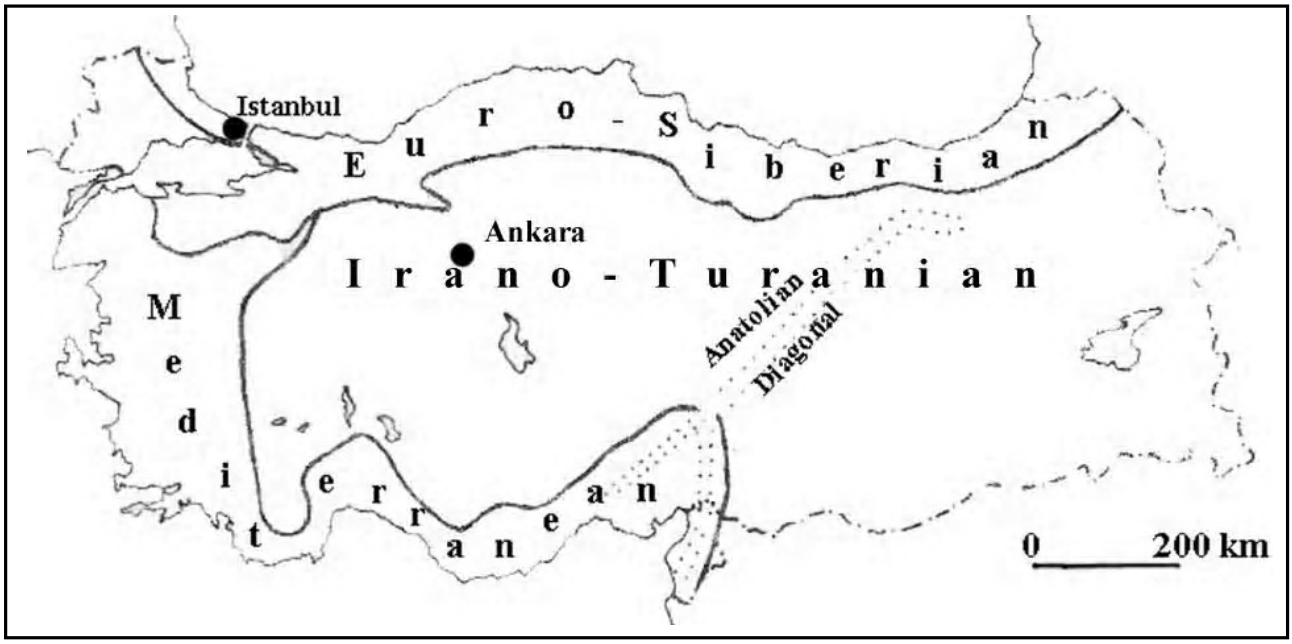

Fig. 1: Map showing the phytogeographical regions of Turkey

occur in the west and south western parts. The rainfall has decreased significantly during the last five decades in the western provinces in winter, but the most significant reduction has been recorded along the south-west coast. These climatic changes are expected to lead to a sea level rise resulting in serious damage in historical sites. Work on surface waters in the basin has revealed that by the year 2030 there will be nearly 20% loss and 35% in 2050 and 50% in 2100. In addition water loss through evaporation has been calculated to be 10% and 54% in 2030 and 2100 respectively. Thus the problems of water shortage, land use and land cover in the region will get seriously affected by climate change. The most important factors in this connection are greenhouse gases in particular carbon dioxide and methane emissions.

The data published in 2004 shows the total emissions of CO_2 in Turkey were 81.5%, whereas CH_4 emissions were around 15.6% followed by N_2O as 19% and fluorine gases as 1%. During the period between the years 1972-2004 the forested areas has increased by 5% while the annual growth rate has been 29% (Asan, 2006). Energy sector emissions in 2003 have been recorded as 32% but are expected to go up to 37% in 2020.CH_4 emissions have shown an increase of 58.5% between 1990 and 2004. These values are expected to increase by 2.4 times by 2020. These emissions from the industry are expected to go up by 6.5% in 2020. But it is hoped that these values will drop as the use of natural gas, electricity consumption increase and recycling facilities of wastes increases.

Forest fires

The forest fires are the most important elements threatening the forests in Turkey, in particular the forests in the Mediterranean region are under an intense threat in summer season (Avci *et al.,* 2009; Demirtas 2009). The coastal belt staring from Antakya up to Istanbul is regarded as the most risky region in terms of fires. Nearly 12 million ha of forests along this belt is very sensitive to fire. The main reasons for these are; air temperature rise and global warming, decrease in the level of moisture in the air (10%), high speed winds, agricultural activities in the rural areas followed by negligence among the agricultural practitioners, shepherds, beekeepers, hunters and finally touristic activities. Nearly 93% of these are accidental and carelessness. Despite all the technical and administrative measures taken, from time to time forest fires become a national disaster (Serez *et al.,* 1997; Özcan, 2009). People-caused fires account for 98% of all fires, while natural factors are responsible for the remaining 2%. Of the people-caused fires 23% was classified as arson, 27% as negligence and carelessness and 50% as unknown (Neyisci, 1985; Mol and Kucukosmanoglu, 1997; Mustafa 2009).

About 7.09 million people live in 21216 villages in or near forests. Some fires are set by people to create jobs or manipulate vegetation to improve and produce useful plants for their animals to graze (Anonymous, 1991). These people have a low income and lower life standards therefore they see the forest ground for their sustenance. Sometimes personal conflicts between people and forestry officials or between shepherds or different villagers have also been reported to have been a cause for fires.

The fire statistics starting from 1937 till 2007 reveals that on an average every year 2000 forest fires take place in Turkey and average damage is 15000 ha per annum. However, all these burned areas are afforested by the directorate of forests. There have been several casualties during these fires and up till now 97 people have been killed by fires. The data published in 2007 shows that nearly 150 million dollars have been spent in combating forest fires.The biggest forest fires recorded in Turkey are; 15,795 ha (Manavgat-Tasagil, 31.07.2008), 13260 ha (Mugla-Marmaris-Çetibeli, 23.03.1979), 7090 ha (Mugla-Marmaris-Çetibeli, 01.08.1996), 6000

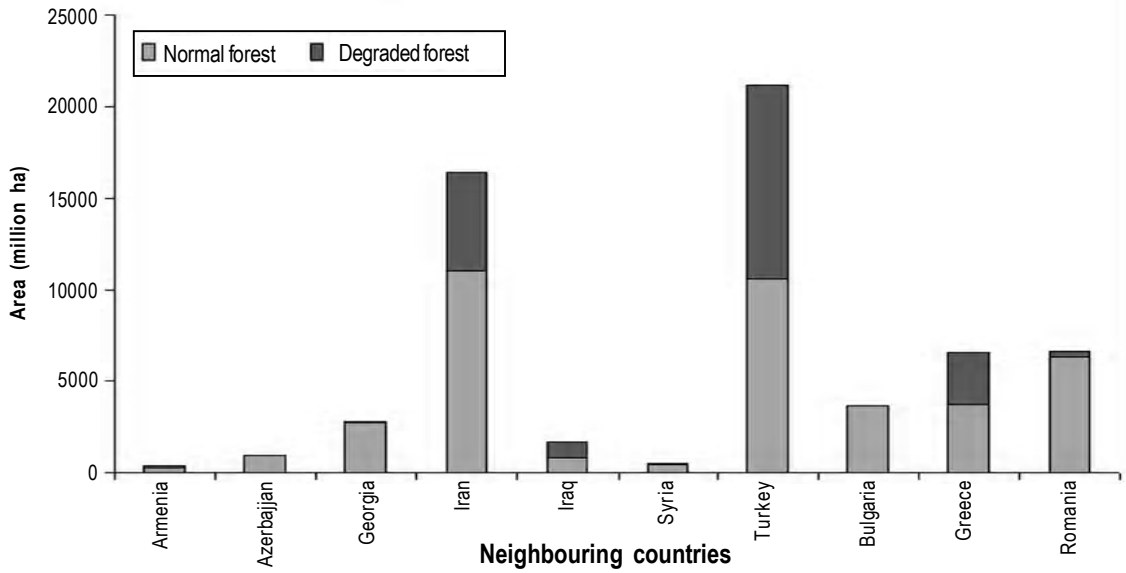

Fig. 2: A comparison of the area of normal and degraded forests of Turkey with neighbouring countries

ha (Canakkale-Intepe, 16.08.1985), 4049 ha (Canakkale-Eceabat, 27.07.1994), 3573 ha (Balikesir-Kepsut, 13.08.2002). A comparison of forest fire damage in 2007 with other Mediterranean countries reveals that the loss of forests in Turkey (11665 ha) is less than Greece (280000 ha) and Italy (55000 ha) (Kucukosmanoglu, 1987; Küçük, 2009). The burden on the country's economy and the biodiversity loss is very high. The fires also lead to erosion of fertile soils and a decrease in the balance of oxygen in the air. The functional value of an adult tree has been calculated as equivalent to 1500-3000 Euro per year.

Although presently 775 units of forest fire observation towers are existing and operating 24 hr without interruption, still some fires do take place. Turkey has been the most succesful country in the Mediterranean region to combat forest fires. Forest fires are a recurring phenomenon and has always had a pervasive influence on Turkish forests. In the period 1938-1998, a total of 63242 fires burned a total of 1487877 ha of forest land (Fig. 4). In recent years, there has been a gradual increase in the number of fires (Mol and Küçükosmanoglu 1997) (Fig. 4). The distribution of fires in different regions is as follows: 41% in the Aegean; 24% in the Mediterranean; 22% in Marmara and 13% in other regions (Anonymous, 1989). According to these figures the Mediterranean faces a total of 65% fires.

Quo vadimus

There is a great need to maintain ecosphere for its sustainable use, preserve plant genepool of all plant and animal taxa, study plant introductions and create a conservation conscious world. In spite of our need to manipulate nature we have to understand it in order to be on the proper junction within the ecosphere. A healthy ecosphere needs healthy trees and forests because these have many direct and indirect values to the people in the form of food resources; medicinal preparations and drugs for people and their livestock; fodder and browse, wood and fibres for building, making tool handles, means for earning cash, and provision of religious and other sacred needs; maintaining and improving the soil conditions and the hydrological systems; help in moderating climate by soaking up and storing CO_2; while assuring self renewal processes of the land base and its sustainability. Tree planting in various forms can constitute an affective means of combating desertification while providing material needs of the society and supporting environmental functions.

A veritable evolution in the concept of forest development is observed in all countries of the world. In Turkey great stress is being laid on to recognize the factors that threaten biodiversity in the forest ecosystems, take immediate measures to prevent loss of habitats and species diversity, make thorough inventory of renewable natural resources on forest lands, continue research and update information on these biological resources, develop necessary scientific, technical, legal and administrative measures to improve nation-wide quality and quantity of forest biodiversity, manage and utilize forest biological resources based on sound ecological and sustainable management principles. In relation to the objectives above, about 5% of the country has been reserved for various conservation programs. This small allocation is not sufficient for comprehensive conservation of the natural resources of Turkey. About 4 million ha of land has been set aside for conservation purposes. However, with future conservation program development, it is expected that the area of protected lands will be increased to 10% of the country (Kaya and Raynal, 2001). It should be emphasised that ex-situ methods are made more relevant when they feed directly and specifically into targeted in-situ conservation and that this should become a normal partnership. Seed banking is a vital backup to other conservation methodologies, and that should be supported and expanded. Ex-situ conservation is achieved by establishing gene and seed banks, botanical gardens and arboreta, forest plantations and seed orchards to preserve

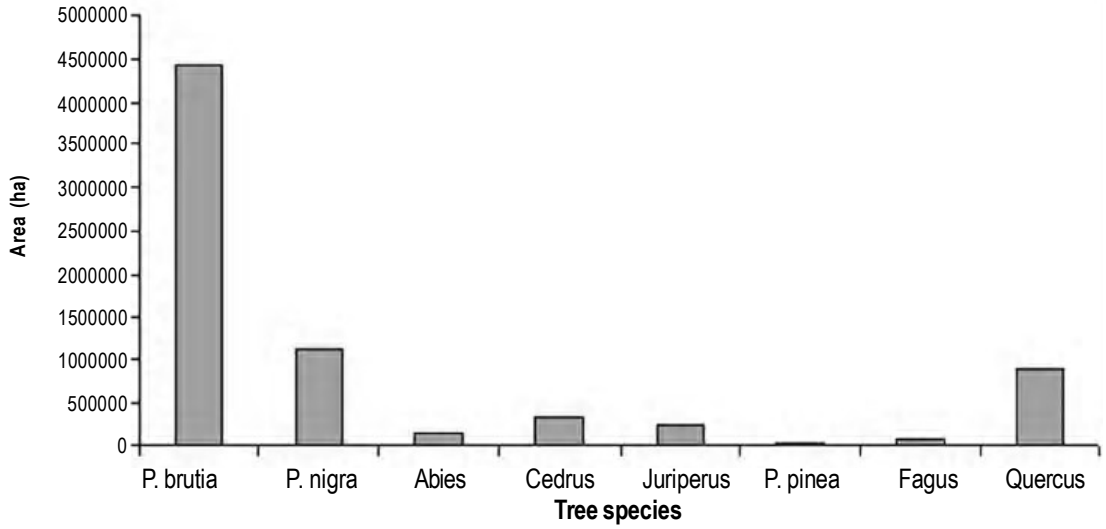

Fig. 3a: The area covered by major forest tree species in the Mediterranean part of Turkey

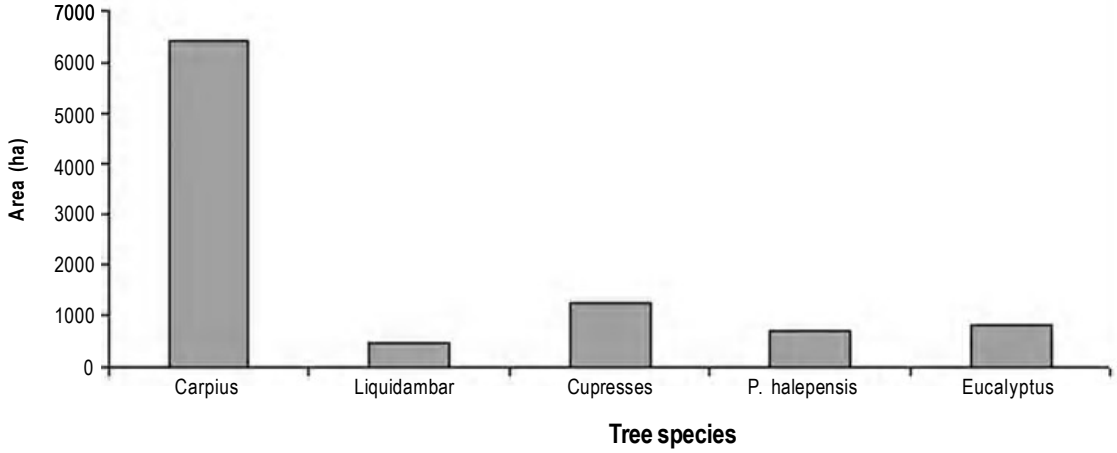

Fig. 3b: The area covered by major forest tree species in the Mediterranean part of Turkey

species and their inherent genetic variability. In-situ conservation involves setting aside natural forest tracts where species are preserved in their natural ecosystems (Atalay, 1994; Anonymous, 1989). In Turkey more than 150 seed orchards with an area of 817 ha have been established for major timber trees (*Pinus brutia*, *Pinus nigra* subsp. *pallasiana*, *Pinus sylvestris*, *Pinus halepensis*., *Cedrus libani*., *Picea orientalis*, *Abies spp.*, *Juglans regia* and *Liquidambar orientalis*). Further orchard development is anticipated. While Turkey has several arboreta and botanical gardens useful for conservation purposes, expansion of such resources is needed. There are several national parks (NP), nature parks (NAP), nature conservation areas (NCA), natural monuments (NM), seed stands (SS), wildlife conservation areas (WCA), and others to promote in-situ conservation of Plant Genetic Diversity (Kaya and Raynal, 2001). Several proposals have been adopted which focus on effectively utilizing the national parks and nature conservation areas, protection forests (PFs) and gene conservation forests (GCF), gene management zones (GMZs), degraded forest lands, and production forests and afforestation sites.

A large number of gene conservation forests have been set aside by the turkish forest trees and seeds improvement research directorate. These provide protection for *Pinus brutia, Pinus nigra subsp. Pallasiana, Pinus pinea, Pinus sylvestris, Cedrus libani, Picea orientalis, Abies cilicica, Abies equi-trojani, Abies bornmulleriana, Cupresus sempervirens*, *Castanea sativa, Quercus spp, Liquidambar orientalis, Fagus orientalis, Tilia spp., Fraxinus spp. and Juniperus spp.* (Anonymous, 1991). New GCFs are needed to ensure better representation of diverse ecosystems and habitats. Ten GMZs in two pilot sites, at Kaz and Bolkar mountains, have been established with a total area of 24374 ha for the target species *Pinus brutia, Pinus nigra subsp. pallasiana*, *Cedrus libani, Abies equi-trojani, Juniperus excelsa*, and *Castanea sativa*. However, new GMZ's representing different habitats in the country along with their management plans are urgently needed for sustainable forestry in the future.

Degraded forestlands need to be converted to appropriate use. Utilizing mixtures of native trees on afforestation and reforestation sites should be encouraged and introduction of exotic, potentially

invasive species should be avoided. In large aforestation areas, patches of unplanted sites should be reserved to create habitat diversity to support biodiversity. Meeting multiple objectives in agriculture and forest development may be possible by promoting agroforestry practices. One of the most successful agroforestry programs in Turkey is poplar farming. Today, annual poplar wood production exceeds 2 million m^3, reducing shortages of unprocessed wood. In addition to state nurseries, private poplar nurseries produce about 10 million seedlings for transplantation. Still, there will be a need for more poplar seedlings in the future because the potential for increasing poplar plantations is great. Gallery production opportunities along at least 100000 km, of stream banks exist (Anonymous, 1989).

While Turkey has numerous laws, regulations, and programs that seek to promote biodiversity, implementation of these guidelines requires increased commitment and vigilance. Conservation programs should be increased in number, particularly in the light of increasing pressure on forest resources. Management plans for all conservation programs require completion and implementation. Creating monitoring programs and building quantitative databases for conservation programs will be essential to assess future success in maintaining biodiversity. Conservation of natural resources requires public education and promoting awareness play a vital role in maintaining a healthy environment for sustainable development.

Forests will play an important and crucial role in the sustainable development of our bodiversity. The key is to make links in unexpected places. They have a lot to offer; in the mobilization, encouragement, and use of scientific knowledge-technology to help achieve sustainability goals and to support the implementation of sustainability practices, conservation and sustainable use of bioresources; in-situ conservation of ecosystem. They can play a pivotal role in delivering the conservation message to the millions of visitors. They offer an insurance policy for the future, the wild plants found in the forests safeguard vanishing native habitats, help in the implementation of adaptive management strategies in vulnerable ecosystems, sustainable management of existing natural vegetation to maintain carbon stocks and the monitoring of new plantings intended to offset carbon emissions, to ensure their ecological suitability. The survival and quality of forests depends on the strength of community forestry organizations formed by the people traditionally involved in forest use. These organizations, with assistance-rather than control-from the government, are essential to promote forest development and limiting forest extraction. New approaches that address people's motivations to develop and nurture forests responsibly are clearly needed (Ozturk, 1995).

Local people are often the most appropriate managers and regulators of forest uses, but this can be acheived by limiting the number of users so that the pressure on the forest resource gets reduced. Traditional forest users as modest and moderate people are typically few in number compared to the total number of potential forest users. They should be given the control over forest uses through customary use rights and not everybody should have access to the forest resources in a particular geographical area. Moreover traditional users in the area have an interest in the long-term sustainability of forest, as long as they know that they will be able continue to enjoy its benefits. They can guard the long-term future of the forest resources. In particular if these people are permited to police the forest, then effective regulation has a real chance and invaders run the risk of facing a whole community mobilized to protect its forest-use rights. Such users are generally more likely to have developed practices that are compatible with the long-term survival of the forest. Other groups, less familiar with the forest, are more likely to engage in short-sighted practices. The list of forest users includes timber cutters, forest plantation workers, community woodlot overseers, gatherers of poles from immature trees, fuelwood gatherers, pine resin tappers, durian fruit gatherers, tourist guides-and tourists, game hunters, herders,and finally prospectors and miners. Despite this diversity of users it should be stressed that they rely on them for only part of their income.

In addition to these there is a need for taxonomists, agronomists, conservation campaigners, ecologists, ethnobotanists, health policy-makers, horticulturists, legal experts, park managers, park planners, pharmacologists, plant breeders, plant genetic resource, plant pathologists, religious leaders, resource economists, seed biologists and traditional health practitioners to use the forests sustainably, improve techniques for cultivation of plants, persuade the public of the need to conserve plants, understand the plants growing in the forest ecosystems, include conservation and utilisation of plants in their policy and planning, cultivate plants, develop effective legal mechanisms that ensure that collection of plants is at levels that are sustainable, conserve plants within their parks and reserves, ensure the park and reserve system contains the maximum diversity of plants, study the application of plants, breed improved strains of plants for cultivation, assess the genetic variation in plants and specialists: maintain seed banks of plants, protect the cultivated plants from pests and diseases without using dangerous chemicals, promote a respect for nature, evaluate the patterns of use and the economic values of plants, understand the germination and storage requirements of the seed of different plants and provide information on the uses and availability of plants. The pharmaceutical companies can open research laboratories for systematic screening of medicinal plants in the search for active compounds, and studying their efficacy. Moreover, fire resistant tree species can prove helpful in the reforestation systems. These are; *Aesculus hippocastanum, Acer campestre, Acer negundo, Acer platanoides, Acer tataricum, Arbutus unedo, Arbutus andrachne, Betula pendula, Colocedrus decurrens, Cupressus sempervirens var. pyramidalis, Eleagnus angustifolia, Fraximis ornus, Gleditsia triacanthos, Juniperus excelsa, Larix occidentalis, Pinus ponderosa, Platanus orientalis, Punica granatum, Robinia pseudoacacia, Sorbus aucuparia, Thuja plicata,* shrubs are; *Abelia grandiflora, Calicotome villosa, Campsis radicans, Cistus salviifolius, Colutea arborescens, Helianthemum nummularium, Lavandula stoechas, Mahonia aquifolium, Nerium oleander, Parthenocissus quinquefolia, Pittosporum tobira, Potentilla fruticosa, Rhododendron caucasicum, Rhododendron ponticum,*

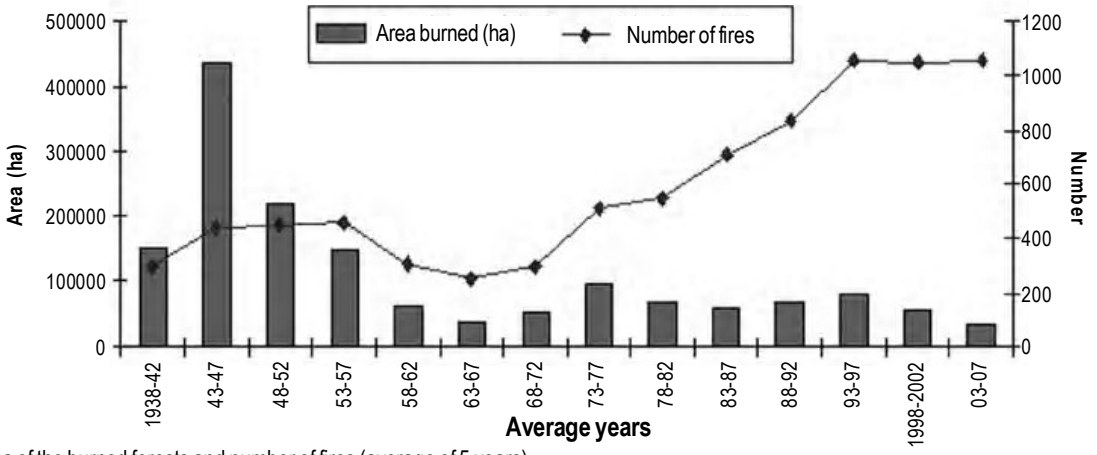

Fig. 4: Area of the burned forests and number of fires (average of 5 years)

Rhododendron smirnowii, Rhododendron urgernii, Rhamnus frangula, Ribes alpinum, Santolina chamaecyparissus, Styrax officinalis, Symphoricarpus albus, Syringa vulgaris perennials are; *Achillea filipendulina, Achillea millefolium, Aegopodium podagraria, Agave Americana, Agropyron cristatum, Allium schoenoprasum, Aloe arborescens, Aloe vera, Armeria maritime, Aubretia deltoidea, Aurinia saxatilis, Capparis spinosa, Convallaria majalis, Dianthus barbatus, Dryopteris dilatata, Epilobium angustifolium, Fragaria vesca, Iris sibirica, Kniphofia uvaria, Lysimachia nummularia, Myosotis alpestris, Oenothera missouriensis, Opuntia ficus-indica, Ranunculus repens, Rosmarinus officinalis, Silene maritime, Stachys byzantina, Vinca minor and* suffricticose plants are; *Ajuga reptans, Artemisia caucasica, Dactylis glomerata, Duchesnea indica, Festuca arundinacea, Festuca rubra, Geranium sanguineum, Hedera helix, Iberis sempervirens, Papaver orientale, Poa pratensis, Rosmarinus officinalis, Sedum acre, Sedum album, Spartium junceum, Thymus praecox* (Dagdas, 2009; Genç *et al.*, 2009). Many species exist only as part of ecosystems and cannot survive unless their ecosystems are preserved along with as much as possible of the biodiversity they contain. *Cistanche deserticola* depends on two fungi for successful completion of its life cycle, it is parasitic to the roots of *Haloxylon* spp., notoriously difficult to cultivate, so they can be conserved only in their natural habitats. Targeted education campaigns can also be carried out. There is need for a collaborative approach to forest species conservation. Ex-situ collections that attempt to recreate habitats become even more relevant in this light.

Forest fires have a major impact on the sustainability of forests. With its complex social, economical and environmental aspects, Turkish forestry presents great challenges to the society in general and the forest service and fire researchers in particular. The pressures brought about by certain realities of ecology and economics, and our increased demands for multiple resources require the development of new policies and attitudes towards fire. At the same time, increasing complexity and sustainable forestry will require a deeper understanding of fire and the development of more effective management systems. Effective management systems will not prove successful unless they include the demands and acknowledge the role of the society on forests.

It is hard to exaggerate the issues posed by climate change, a man-made problem which puts our very way of life in question. It will not be addressed by international agreements alone because the issues run much deeper as a serious challenge to humanity and sustainable development, requiring proactive responses and concerted effort by the international community. The problem is in need of collaborative efforts from politicians, diplomats, scientists, businessmen, ecologists, and leaders from other fields. The world faces year 2009 conscious of the importance of reaching a global agreement on the framework that will govern the international fight against climate change. There is urgency to fashion an agreement that meets the needs of us all and succeeds in creating a framework to head off dangerous anthropogenic interference in the climate system (Sachs, 2009). The link between human activity and climate change has been established. There is uncertainty as to how exactly the physical processes that mediate between greenhouse gases emissions and changes to our planet's climate will unfold, but these processes are not easy to reverse, and may even be irreversible. Catastrophic effects are possible in the long-run and the more we wait the greater the risks. We must step up our efforts to mitigate climate change now as a form of insurance against these growing risks. At the same time, we now know with certainty that climate change will have a larger and more immediate negative impacts (Ahmad, 2008).

There are eight principles put forward by Sachs (2009) which can bridge the gap between rich and poor. The climate change should squarely lie within the context of sustainable development, and this will be the key for achieving a global agreement that represents the interests of humanity on planet Earth. According to Sachs (2009), these principals are; sustainable development lies at the core of climate change control, sustainable development should incorporate the concept of economic

convergence, climate change mitigation and adaptation should be embedded in an ecosystem approach recognizing the multiple human-induced stresses on the world's ecosystems, technological change and technology transfer lie at the core of effective mitigation, national targets on emission reduction should be based on economic convergence and best-available technologies, financing for climate change control should reflect equitable burden sharing which should be based on a robust carbon levy rather than clean development mechanism projects or voluntary contributions, and adaption programs should be integrated into the Millennium development goals. The ecological footprint helps us analyse the negative impact that humans have on nature. The average ecologic footprint of one human being is 2.7 global ha (gha). Humankind will need two planets to maintain its level of consumption. A recent study predicts that climate change in the coming few decades will have a devastating impact on the wild relatives of important crops. In less than hundered years a large part of our plant species could be under threat and a massive 60% of mountain species may vanish.

Depending on the effectiveness of policy and institutional frameworks, there is also an opportunity for countries to promote sustainable development through bioenergy expansion. Bioenergy offers the opportunity of reducing carbon dioxide emissions per unit energy production, reducing dependence on energy imports and, together with other alternative fuels, creating a cap on soaring oil prices. Additionally, investments in technology transfer, research, training and capacity building, can make the private sector voluntarily respond to environmental management. Against this backdrop, and in the face of multiple threats from trade, habitat loss and climate change, forests have an important role to play in securing plant diversity for people and planet (Zedan, 2002; World Bank, 2004). WWF offers us an urgent recipe; reduce consumption, slow down the increase of world population and increase efficiency in the use of resources *i.e.*, Reduce, Re-use and Recycle and cut down on consumption and generate less waste.

Finally the universe around us shows a full balance qualitatively as well as quantitatively. The right to use and destroy this diversity involves a commitment on our part to take care of this all and use it in a moderate way. Presently world is on the sharp edge of an environmental crisis not experienced before. Our anthropocentric thinking is that everything around us is only for human use, which is more a crisis of mind and spirit. The destruction of habitats is expected to increase the number of losses during the coming decades from 20,000 to 50,000 species annually (Zedan, 2002; IUCN, 2006). This serious situation has started gradually attracting public awareness, so education and conservation regarding the plant world has gained a vital importance (Oztürk, 1995). There is a greater need now to start environmental education at home. The answer to all these questions lies in the sustainable development by meeting the needs of the present without compromising the ability of future generations to meet their own needs (ÇOB and UNDP, 2002, Clegg, 2008).

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