

DECLINE OF CONIFER FOREST COVER IN PAKISTAN: A GIS APPROACH

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Abstract

Deforestation is one of the obstinate environmental problems globally. Pakistan, being a developing nation also encompasses crisis of depletion of forest reserves. The rising climate change consequences remain the primary culprit behind this phenomenon. The present study intends to focus attention on one of the threatened vegetation types, the Conifer forests and their consequent reduction in area during the last two decades. GIS techniques have been employed to analyze the change detection in various regions and provinces of Pakistan. The results of current study indicated that Conifer forests have been declining at the rate of 1.27% per annum since 1992, showing negative trends due to various causes associated with climate change i.e. increase in temperature and decrease in rainfall. So, the need for the conservation of these forests should be the basic task to accomplish order to avoid their vulnerability against various environmental and socio economic disturbances.

Introduction

The extended tenure of shrinking of cover of trees' canopy lesser than 10% threshold or transformation of forest for various land use practices is widely termed as 'deforestation' (Anon., 2007a). Whilst forest degradation involves process contributing to deterioration in vegetation cover structure or its density as well as in species composition either temporarily or permanently (Anon., 2007a). Forest resources are vital for conservation of soil, water resources and biological diversity worldwide and play key role in meeting requirements for forest products both woody and non woody (Siry, 2005). The relationships between forest change and its associated driving factors are often complex and non linear (Mas *et al.*, 2004). Pakistan, due to limited forest resources with deforestation rate of 4.6% per annum ranks on the second highest number in world and represents thrashing ecological services nationally (Khan & Khan, 2009). The forests in Pakistan particularly Conifer forests reflect immense climatic and physiographic contrasts and are under constant pressure due to population growth, human activities and commercial harvesting for fuel wood and timber utilization (Anon., 2007a). A variation in the climatic condition that can be recognized by changes in the mean or the changeability in the climatic properties pertain for an unlimited time, generally decades or longer (Anon., 2007b; Shakoor *et al.*, 2011). The most recent impacts of climate changes were also witnessed during the droughts of 1900 to 2000 in Pakistan (Anon., 2007b), owing to exertion of maximum pressure upon country's natural resources and the environment. Due to the significant changes in precipitation in Amazon basin, 40% of area is deforested as shown by the current studies that assessed the consequences of biased deforestation on the region's climate (Costa *et al.*, 2007; Sampaio *et al.*, 2007). The forest change detection can be accurately calculated by means of GIS technology because of its capability to handle spatial and aspatial data effectively (Panigrany *et al.*, 2010). According to Turner *et al.*, (2003), satellite imagery capably provide precise measurement of change and deforestation. A study was conducted in Tam Dao National Park (TDNP) in Vietnam

for the investigation of conversion of primary and secondary forests using remote sensing and MLPNN-M model in region where model forecasted spatial patterns of changes in forests reasonably (Khoi & Murayama, 2010).

In Pakistan, Conifer Forests are located mainly in Khyber Pakhtun Khwa (KPK), Azad Jammu and Kashmir (AJK), Northern Areas, Balochistan and northern Punjab. They are found at altitudes ranging from 1,000 to 4,000 meters. The areas like Mansehra, Dir, Swat, Malakand, and Abbottabad districts of KPK, and Rawalpindi district of the Punjab are mainly areas covered with these forests (Anwar, 2008). Fir (*Abies* spp.), Deodar (*Cedrus deodara*) and Chir Pine (*Pinus roxburghii*) are found on highest, medium heights, and the lower areas. Balochistan hills are also occupied by Coniferous forests. Open and scattered stands of juniper and blue pine forests are found there. The most familiar species found there are Chilghoza Pine (*Pinus gerardiana*) and Juniper (*Juniperous macropoda*) (Anon., 2007c). Besides providing construction timber, their role in protecting land and soil on steep mountain slopes, supply of fuel wood and non wood products, medicinal plants, livestock grazing and as well as forest services including wildlife habitat is well recognized (Khan, 2009).

In the current study, the Conifer forest in various regions and provinces of Pakistan was selected to highlight the subsequent reduction and causes in relation to climate change during the last two decades *i.e.*, 1990-2010. The fundamental objectives of the study were to generate and digitize cover maps of Conifer forests using GIS applications, monitor annual change rate in forest for the last two decades accompanying various climatic conditions.

Materials and Methods

Firstly, the general Pakistan map was retrieved from survey of Pakistan. Using GIS techniques, a thematic map was prepared using general Pakistan map on scale 1:30,000 using ArcGIS 9.2 software. The map was scanned to a suitable resolution. The map was imported in ArcGIS software to create shapefile. After that Geo-referencing was done using WGS 1984 coordinate system

followed by digitization. Secondary data (attribute data) which was gathered through online researches, library and published literatures as well as departments like Divisional forest office, Ministry of Environment, WWF and Pakistan Meteorological Department. Various choropleth maps were developed displaying extent of Conifer forests in the years 1992 and 2010.

Results and Discussions

The present study focused greatly on the decline in cover area of Conifer forests in various regions and provinces of Pakistan. For the visual interpretation of data derived from different sources, ArcMap software was employed to create maps displaying forest change for the last two decades. The data was then analyzed and presented in Table (1).

Table 1. Forest cover change (Conifer) from 1992-2010 in Pakistan.

Province/Territory	Status of vegetation cover (000 ha)					Annual change rate % (Base year 1992)
	1992	1997	2001	2005	2010	
Khyber Pakhtun Khwa	940	805	858	840	845	-0.56
Punjab	30	34	34	38	41	1.22
Sindh	NF	NF	NF	NF	NF	
Balochistan	42	39	35	32	30	-0.6
N.As.	660	312	318	301	285	-0.08
Azad Jammu and Kashmir	241	289	267	288	272	0.71
Total forests	1913	1479	1512	1499	1473	-1.27

NF= Not found

Total Conifer forests at national level reduced at a rate of 40,100 hectares (2.09%) per annum between 1992 and 1997. The rate of decrease was comparatively high as 86,800 hectares per annum (4.54%). However, the analysis of 1997 to 2001 revealed a positive trend whereby coniferous forests have started replenishing at a

rate of 6,600 hectares per annum (Anon., 2007). While Conifer forests had again shown a declining trend at the rate of 0.17% and 0.34% per annum from 2001 to 2005 and 2005 to 2010. Similarly, Figs. 1 & 2 demonstrated how much forest cover area had declined in various regions and provinces of Pakistan in 1992 and 2010.

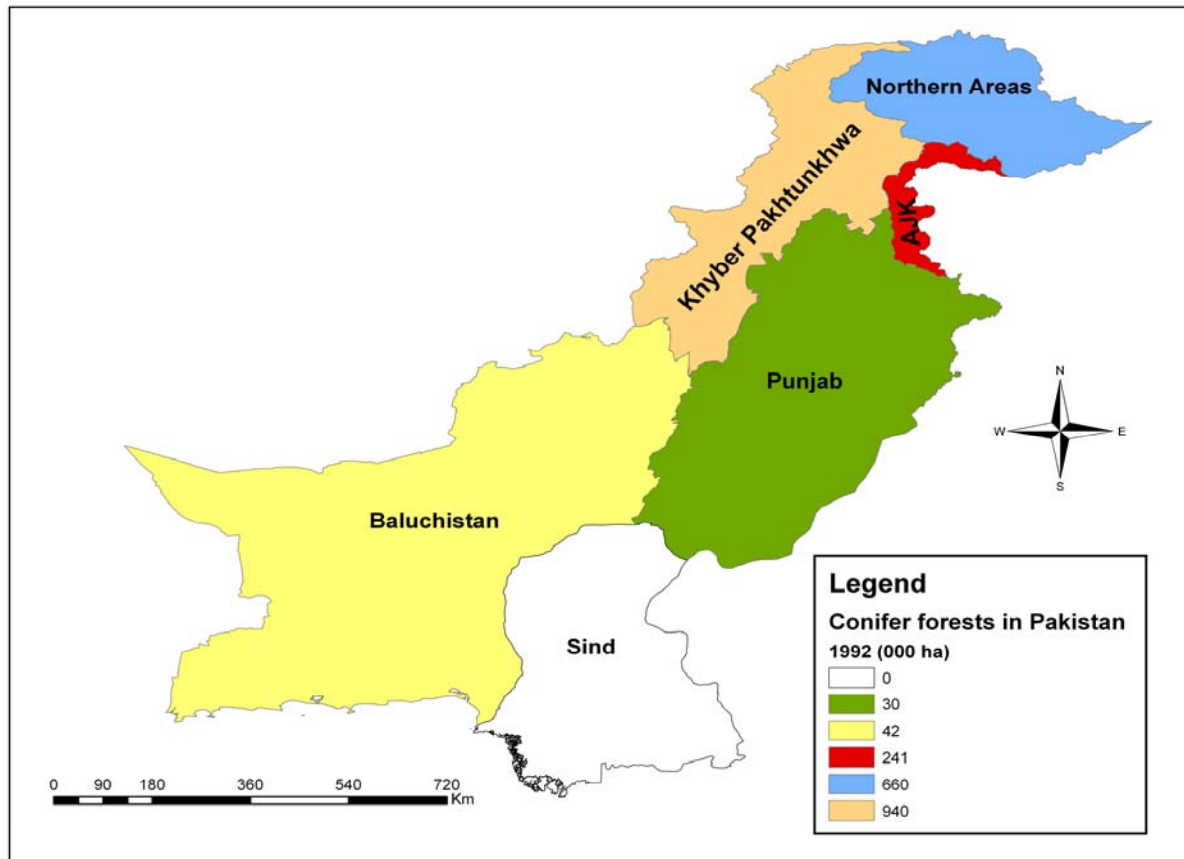


Fig. 1. Extent of Conifer forests in Pakistan in 1992.

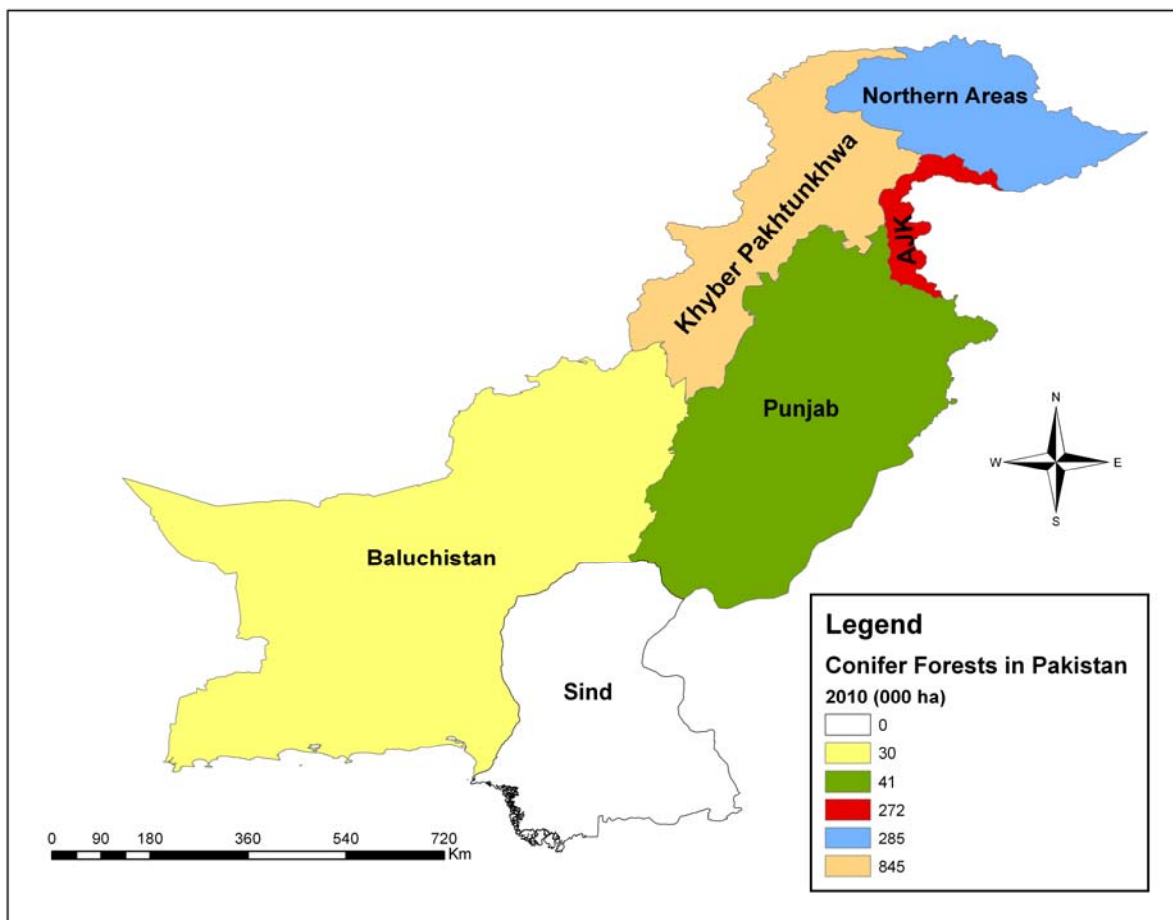


Fig. 2. Extent of Conifer forests in Pakistan in 2010.

In the present study, the annual change rate of conifer forests countrywide over a ten year period (1992-2001) was -2.3%, while the analysis of subsequent ten years (2001-2010) revealed a decline rate of 0.28% which unfolds that forest area had decreased considerably. The NFRA (2004) classification indicated that the most valuable Coniferous forests are declining at the rate of 40,000 hectares annually. Northern areas (Gilgit, Baltistan) and KPK have the highest annual rates of deforestation (about 34,000 hectares in Northern Areas and 8000 hectares in KPK). The conifer forests being the most fragile due to high value timber and location are rapidly degrading; only 9% have the tree cover more than 75%. On the basis of the data obtained from the Meteorological Department Pakistan, the average temperature of KPK, Balochistan, Punjab and AJK has risen from 27.67°C, 30.6°C, 29.24°C and 27.4°C in 1990 to 28°C, 31.16°C, 30.05°C and 28.5°C in 2009. On the other hand, in Northern Areas, the temperature has reduced from 24.9°C to 23.9°C during the last two decades which was relatively appropriate for the growth of these forests in this area. At the same time, average the rainfall on yearly basis decreased from 924.9mm, 269.5mm, 808.7mm and 1830.2mm in 1990 to 476.2mm, 210.9mm, 697.05mm and 1152.7mm in 2009 in Punjab, Balochistan, KPK and regions of AJK. While in Northern

areas of Pakistan, the average rainfall per annum has increased from 89.3mm in 1990 to 141.1mm in 2009. In the light of Pak Swiss INRMP (2010), the deterioration of Conifer forests in KPK was mainly resulting from the fire wood consumption of the local people and the commercial harvesting of timber. Such changes have directly impacted the forest ecosystem. Also, it is assumed that if the temperature continues to increase and rainfall continues to decrease with the passage of time the areas would be degraded. According to a recent study conducted by Ministry of Environment in collaboration with FAO (Food and Agricultural Organization), only 14.29% of coniferous forests have density above 75% in KPK. In Punjab, all coniferous forests have a cover density below 75%. While in Balochistan, these forests need immediate replenishment towards normal stocking as cover density is less than 50%. Northern Areas have even worse condition than other provinces where 72% of area under coniferous forest has a tree cover density below 25%. Remaining 28% forests have a density range of 25-50%. In AJK, coniferous forests are better off as compared to other provinces, where 50% of the forests have a cover density above 75%. In the perspective of various studies conducted such as in the western United States, conifer forests have dramatically departed from conditions that existed prior to Euro American settlement,

after a century of fire suppression (Taylor & Skinner, 1998; Fry & Stephens, 2006). Ahmad (2007, 2009 and 2010) pointed out the urgent needs for the protection of flora to be beneficial for future generations.

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