THE FOREST AND CLIMATE CHANGES IN PAKISTAN

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ABSTRACT

Forests and climate are closely related; and change in either of these affects the other. When climate changes, it tends to bring about many direct and indirect changes in the environment, including in forest ecosystems, the extent of which depends upon rapidity, direction and magnitude of climate changes. Minor changes in climate often occur and are of diurnal, seasonal or decadal and/or of regional nature, such as hot summer droughts of the 1980s in parts of Asia and Africa. Their affect was similar in nature. Climate has also changed in the distant past. Since the depth of the "Little Ice Age" in 1700 A.D., the average temperature has risen by 1.5°C in northern Europe without any noticeable effect on forests. On the other hand, when 5°C warming occurred between 15,000 and 7000 years ago, it caused major changes in the distribution and abundance of forest tree species in some regions of Northern Hemisphere. Similarly, there is evidence to believe that climate has changed in some parts of the world as a result of disappearance of forests. This paper briefly discusses the changes in climate over major parts of Pakistan in the past due to clearance of forests and assesses impact of future climate changes on the remaining forests and future of forestry in the country if present rate of deforestation continues.

Concern for Future Forest and Climate Changes

There is an increasing worldwide concern about future climate change and global warming due to enhancing emission of greenhouse gases into the atmosphere; carbon dioxide (Co_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3) and chlorofluorocarbons (CFCs). It is estimated that earth's surface temperature will rise by 3+ 1.5°C above the current level within next 50 to 100 years if greenhouse gases continue to be emitted at the present rate. This would in turn affect patterns of local temperature, precipitation, soil moisture and sea level with far reaching ecological, social, economic and political implications. Therefore, it is now commonly recognised that the greenhouse effect is the most important problem. It threatens loss of forests, widespread floods, droughts and famines, loss of wild species of plants, insects and animals, top soil and stratospheric ozone. Consequently, the anticipated global climatic change has attracted the attention of both common man and world leaders and is a major topic of discussion at numerous international forums and summit meetings of world leaders.

The forests have also attained prominence in the concern for climate change. Almost 25% of communique of recent summit meeting of industrialized countries in London was devoted to ecology and forest conservation. The awareness about importance of forests for climate control is also increasing in developing countries and all their forest policy announcements reflect it. In Pakistan, the present government has recently announced comprehensive

national forest policy with strong emphasis on forest conservation and extension, social forestry, conservation of biology diversity, and control of environmental degradation and desertifica-tion. It has also formulated a major policy initiative called the National Conservation Strategy. The cause of forestry is receiving considerable political and financial support.

The forests control climate and climate in turn determines the distribution and abundance of plant species in the forest, as well as of the wildlife associated with forests. They play a complex role in climatic control and environmental stability. The problem of climate change has partly arisen due to clearing of forests especially of tropical forests at an alarming rate all over the world. The forests reduce water run-off and help avoid extremes of soil moisture and desiccation and have a moderating effect on air temperature and humidity. Since they cover about 33% of earth's surface, the forests have also a significant role in absorbing and utilizing carbon dioxide from the atmosphere and act as a vast "sink" for this greenhouse gas, and release oxygen in the atmosphere in its place. Clearance of forests, estimated at the rate of 17 million ha in the tropical countries by the FAO, would therefore greatly disturb global climate. The survival of forests is now linked with stability of environment as well as sustainable development all over the world.

In pre-historic times, two-thirds of the earth's land mass was covered with forests. The forest area has now reduced to half of this size due to constantly growing demand for agriculture and grazing land for food production to feed growing population especially in the developing countries. Considerable forest damage has also occurred during last 40 years with increase in the demand for tropical timber and timber products in the developed countries. Another cause of deforestation is the "acid rains" caused by industrial pollution in these countries. They are also responsible for about two third of total carbon dioxide emitted into the atmosphere from burning of fossil fuels, the balance coming from developing countries by clearance of forests for fuelwood, crop production and grazing land. The increase in carbon dioxide emission, which is most important greenhouse gas, and consequent global warming and climate change would directly affect survival of forests and their future geographic distribution and composition as well as their susceptibility to fire and pests. The forest damage due to climate change would be extensive all over the world with far reaching consequences.

Past and Present Forest and Climate Changes in Pakistan

While Pakistan has a wide diversity in physiographic forms and climatic conditions, which vary from tropical coastal marine plains to glaciated mountains, the country has an arid climate over 72% and semi-arid climate over 18% of its area. This means that the aridity prevails over more than 60 million ha out of its total area of 88 million ha. This is partly due to human activities spread over two to three millennia. From all palaeontological, archaeological and historical records, it appears that areas now constituting Pakistan was a thickly vegetated tract, never so arid as it is to-day. According to recent studies the changes in climate and their effect on vegetation has generally been gradual in the past. In Pakistan, these have

accumulated over more than 4000 years. The devastation of forests affected the climate, decreasing the moisture and raising the temperature which, in some parts of the country, was followed by further reduction in forest area.

Some meteorologists are of the view that the cold air-stream from the Mediterranean Sea which now passes over the Punjab, and gives the province its winter rains, apparently also extended over northern Sindh five thousand years ago. The wide spread desiccation of Balochistan and Sindh appears to be due to the deflection of air-currents northwards, as these regions, particularly Balochistan, show ruins of ancient water-storage tanks, which could have been used only in case of high annual rainfalls.

The microfossil studies also indicate that gymnosperms were growing along with angiosperms in the post-cambial period in the Salt Range. In fact, of these, a few patches of chir pine (*Pinus roxburghii* Sarg.) along with oak (*Quercus incana* Roxb.) have survived to-date at Sakesar. It was reported in 1860 that this pine was also naturally growing on the top of Mt. Tilla in Jehlum district. In the central and southern parts of Pakistan, engravings of rhinos, elephants and tigers in Dravidian seals and pottery excavated from Mohenjo-Daro and Harappa and dating back to the period of 3250 BC to 2750 BC indicate a wet climate and dense forests in the plains of Sindh and the Punjab. Similarly, Alexander, the Great was highly impressed with presence of large tracts of forests of large sized trees and abundant wildlife in Jehlum, tract between rivers Indus and the Beas and on the lower slopes of Himalayas.

Fa'Hian, the great Chinese traveller in the 4th century A.D. described the climate of this part of the world as neither cold nor hot. Evidence of similar nature of forests is provided by first Mughal Emperor, Babar in his memoirs for areas now constituting N.W.F.P. and the Punjab.

The destruction of vegetation is still going on. A comparative study of vegetation interpreted from aerial photographs of 1954, Landsat imagery of 1976 and that actually recorded in the field during 1986 for Dingarh area in Cholistan in the Punjab showed that the vegetation during the period had been gradually depleting at the rate of 0.2% due to overgrazing and lack of conservation measures. Another study of rainfall distribution in Pakistan has indicated that except at Karachi, it has been decreasing in recent years.

Presently, Pakistan has a very small forest area of 4.263 million ha or 4.8% of its total area as compared to the world average of about 33%. Further, the productive agriculture is practiced on 21 million ha or 23.7% of the total area, mostly in the plains wherein artificial irrigation facilities are available and the rest of the area constitutes wildlands. About 90% of the forested areas is covered by natural forests and the coniferous forests in north and north-western hilly regions are largest natural forest resources due to favourable ecological conditions. The area of different types of natural forests and artificial plantations in the country under the control of provincial and regional forest departments is given below:

	Type of vegetation	Area (000 ha)	Percent
1.	Coniferous forests	1,928	45.2
2.	Scrub forests	1,271	29.8
3.	Irrigated plantations	220	5.2
4.	Riverain forests	300	7.0
5.	Mangrove forest	345	8.1
6.	Mazri plantations	24	0.6
7.	Linear plantations	16	0.4
8.	Private plantations	159	3.9
	Total	4,263	100.0

Due to the small forest area, there is an intensive pressure of growing population (more than 100 million people with 3.2% growth rate) for goods and services associated with the forests. Consequently, the forest resource has considerably depleted over the years. This situation has also led to widespread scarcity of wood and wood products, desertification, aridity, waterlogging and salinity, soil erosion, land slides avalanches, siltation of river water storage facilities and to general environment degradation. It is further accentuated due to fragile ecosystem under which forests grow in their natural state. The scrub and coniferous forests are found in foot hills and on steep slopes of Himalayan-Hindukush-Karakorum mountain systems respectively, which are prone to soil erosion, landslides and avalanches during high intensity summer monsoon rains and winter snowfalls. The problem is especially acute in those areas which have become bare of vegetation due to heavy pressure of tree cutting for fuel and house construction by the local population as well as by grazing of their cattle. These slopes are also watersheds of all major rivers in the country which supply irrigation water for agriculture in the plains. The deterioration of the forests and watersheds would directly affect the sustainable development of agriculture in the country.

Other large natural forests are riverain and mangrove forests. The riverain forests owe their existence and productivity to annual flooding by the river Indus. The frequency and intensity of flooding has reduced over the years due to building of numerous water storage facilities on river Indus and its tributaries for irrigation. Consequently, ecological conditions of riverain forests are changing and their productivity reducing due to disappearance of commercial species of *Acacia*. Most of the areas are high lying and need massive inputs for their conversion and development into productive irrigated plantations. Similarly, mangrove forests have also depleted due to cutting of trees for fuel and fodder, large scale release of industrial wastes and reduced discharge of river Indus water into the delta ecosystem. The last factor is also responsible for rise in salinity level.

Effect of future climate changes on forests of Pakistan

Different approaches to modelling are generally used to determine ecological responses to climatic change. These include physiological-based plant models, population models, ecosystem models and regional or global models. However, assessment of forest resources 50 to 100 years from now as a result of greenhouse effect has not been done in any systematic manner. Still, it is now increasingly being accepted that anticipated change in the physical and chemical nature of the earth's climate are likely to have a significant impact on the forests and related ecosystems. Further, the effects of climate change on forests have only been examined in some developed countries with mostly temperate climate in which response of temperate forests to climate change has been studied.

It is now generally recognized that at regional levels, a temperature rise by global warming would cause the existing forests to move towards more northerly/southerly latitudes and up elevational gradient from their present locations. Increase in temperature will also lengthen the growing season. A longer growing season will increase forest productivity in the presence of a higher concentration of carbon dioxide in the atmosphere. This may however, reduce frost tolerance of the trees. High temperature and carbon dioxide concentration would also enhance the activities of insect herbivores and plant pathogens. In regions without temperate climate, large climate change resulting in too hot and dry conditions may exceed the tolerance of existing tree species and may therefore cause the death of forests. These changes will require all concerned with promotion and development of forest resources to respond with effective management practices to protect and maintain forest health and productivity. On the other hand, the development of new management techniques is limited by the current lack of information on the state of forests worldwide and by an inability to predict and detect changes in forest health and productivity due to climate change.

According to a recent National Conservation Strategy Report, the implications of climate change as a result of greenhouse effect for Pakistan are though difficult to predict, still could be potentially large, affecting patterns of agriculture, fisheries and forestry. In wet areas, the monsoon is expected to become more vigourous; arid areas could become drier; coniferous forests may shift up elevational gradient from their present locations and low lying areas may become salinized by salt water intrusion owing to sea level rise. As mentioned earlier, the wet areas located in north and north-eastern parts of Pakistan with hilly terrain are highly susceptible to soil erosion. This situation would become worse with increase in monsoon rains if present rate of deforestation is continued and new afforestation efforts on a large scale are not made. Similarly further desiccation of existing arid areas due to warming of climate would jeopardize food production in the plains unless large number of trees are grown on them. The mangrove forests are also expected to be adversely affected by rise in sea level. On the whole, the process of deafforestation should be stopped in the first instance and then reversed by massive afforestation programmes in the country in order to face the challenges of climate change in coming years.

Ecological setting of Vegetation Zones of Pakistan and their possible response to 5°C warming

Forest types of Pakistan, published in 1965, is hitherto the first and the only one detailed descriptive document on the subject. Others improved upon some vegetation types found in Balochistan and clarified some confusions. Due to excessive deforestation, selective cutting of trees from certain zones and the removal of even the last traces of zonal species, both the altitudinal limits and the typal limits of vegetation have over-all obliterated, more in some cases than in others.

Over the period since those publications, some additional knowledge has been gained which could improve the limits of vegetation zones. While this would improve upon that aspect, no picture on ecological setting of vegetation types of the country is available. As apprehended at the present, a picture of total ecological setting of vegetation types of the country is presented in the figure that follows:

Figure 1 shows that a vegetation type is found at 150-300 m higher on the southern aspects at some locality than on the northern aspects at some location. This figure also shows as to where a certain vegetation type is found in relation to total rainfall on one hand and its pattern of distribution on the other. The figure also shows as to which vegetation types grow in various vertical zones and which in horizontal zones. This is a basic document for all land-use planners and land managers.

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FIG. 1 ECOLOGICAL SETTING OF VEGETATION ZONES & THEIR POSSIBLE RESPONSE TO 5 DEG. CELCIUS WARMING