

Full Length Research Paper

Impacts of climate change on Yerramalais forest of Eastern Ghats of Kurnool District, Andhra Pradesh, India and options for adaptation

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Biodiversity is an element of the natural resource base, which is one of the main components of eco-environment system. It would be noted that the biodiversity in the system of natural resources brings the sustainability in the production and utilization of the eco-environment system on the earth. Biodiversity changes caused by anthropogenic activities through over mining, over grazing, deforestation, and forest-fires etc. are studied in Yerramalais forest of Eastern Ghats. Other important factors of global change interacting synergistically with climatic factors are also mentioned, human greed is also one major reason for its degradation as they only think for today and not for their future. The forest vegetation is declining tremendously for the past 50 decades due to climatic changes, resulting in the disappearance of flora at an alarming rate leading to the loss of biodiversity. Climate change poses major new challenges to biodiversity conservation. Increased population and uncontrolled human activities have misused the natural resources which led to the disturbance in the ecosystem and scarcity of natural resources.

Key words: Nallamalais, yerramalais, soil erosion, firewood, tribal communities, deforestation.

INTRODUCTION

India is not only gifted with cultural diversity, geographical diversity, social diversity and climatic diversity but also adorned with biodiversity which broadly include plant biodiversity. Forests play a key role in maintaining a wide range of delicate relationships with nature and its ecosystems. Yerramalais forest is home to many endemic, endangered and threatened species, as well as to the indigenous people, who are dependent on its biological resources. Most of the world's forests especially the temperate and boreal forests, are already being utilized by humansocieties(LindenmayerandFranklin,2002;Kanowski et al., 2005). Effect of anthropogenic activities not only threatens the biodiversity, but also affects the socio-

economic condition of the indige-nous people of the forest. Various activities like habitat loss, deforestation, clear felling and overexploitation amplify the impact of climate change on biodiversity. In recent years, attention has focused on the possible impact of atmospheric and climatic changes on plants and vegetation. Much uncertainty still exists as to the possible effects of such change on ecosystems and soils in the Yerramalais forest, which could have severe biological and economic consequences

Therefore, some management initiatives should be taken for mitigating climate change. Also, more research work needs to be carried out in Yerramalais forest to monitor the susceptibility of biodiversity. We studied the location

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in the forest and suggest the adoption of prescribed system of forest utilization systems as a management policy. Such a policy has two advantages; on one hand, it contributes to sustainable livelihood of the tribal people depending on local forest resources, and on the other hand, it contributes to conservation of plant species diversity.

Excessive mining, loss of forest area due to human activity, loss of agricultural lands increased deforestation for fuel and commercial purposes, encroachment of forest land for agriculture, construction, industrial purpose and mining are some of the activities of humans which led to scarcity and misuse of resources. Climate change poses major new challenges to biodiversity conservation. Today most grasslands and forests have been converted to agricultural land or urban center. It has become the centre of human activity, of man's dominance over the environment. Many plant and animal species are under threat due to habitat loss, over exploitation, intensive agriculture, introduction of exotic species, genetic modification, urbanization, pollution caused by industrialization and tourism industry. Natural calamities like floods, droughts, famine, landslides, earthquake, tsunamis, cyclones, avalanches etc. also help anthropogenic factors in doing irreversible damage to the ecosystem. Biodiversity is the multitude forms of life within each ecosystem. These ecosystems are now at risk as a result of human developmental activities. There is growing concern among the scientific community regarding climate change and scientists have proved its occurrence through ample evidence and tested models (Pounds et al., 1999; Woodward, 2002; Klanderud and Birks, 2003; Chaudhari and Kamal, 2009; Crimmins et al., 2011). Biodiversity is essential for human survival and economic well being, as it regulates ecosystem function and stability (Singh, 2002; Sagar et al., 2003).

Due to anthropogenic activities habitat loss, climate change is now being recognized as one of the greatest threats to future biodiversity. Climate is one of the most important factors controlling the growth, abundance, survival and distribution of species as well as regulating natural ecosystems in a variety of ways (Faisal, 2008). The effect of climate change on the natural system may be diverse, such as change in the timing of phenological events of plants, changes in species abundance and range, shifts in habitat, etc. Today climate change is happening at an increasingly rapid rate. According to the prevailing extinction theory, the larger and more specialized species are likely to be lost due to habitat destruction (Sodhi et al., 2004). Under continuing climate change, tree species will be affected in different ways and ranges will adjust at different rates and by different process (Subedi, 2009). Levin and Levin (2002) have predicted that around the world, a species becomes extinct every 20 min. Although the extinction of various species is a natural phenomenon, the rate of extinction occurring in today's world is exceptional, 100 to 1000 times greater than

normal. The exploitation of natural resources has been degraded at a very rapid speed causing serious threat to the environment. After two centuries of technological progress, we still fail to manage well our natural resources.

Climate is probably the most important determinant of vegetation patterns globally and has significant influence on the distribution, structure and ecology of forests (Kirschbaum et al., 1995). Several research articles have shown that climate changes bring down the changes in ecosystems and biodiversity. Climate change impact is resulted in changing the species composition, productivity and biodiversity. These changes ultimately affect the livelihood of tribal people who are dependent on the forest resources for their livelihood (Gitay et al., 2002). India is a mega-biodiversity country where forests account for about 20% (64 million ha) of the geographical area. (12 State of Forest Report 2001, Forest Survey of India, Ministry of Environment and Forests, Dehra Dun). It is a fact that natural forests are progressively shrinking due to overexploitation and makes it obligatory to investigate scientifically. Over-mining, grazing and forest fires have damaged our environment. They have degraded our surrounding to the extent of driving many flora and fauna species to extinction and threatening, the survival of thousands of others. Deforestation, mainly conversion of forests to agricultural land, continues at an alarmingly high rate. Yet currently, we are losing an estimated 200 km of forests a day. The rates of deforestation and of forest degradation are therefore crucial to better understanding and address recent trends in the status of forest biological diversity. No comparable information is currently available on the rate of forest degradation or the area of degraded forest. However, information does exist on some elements of forest degradation notably the area of forest adversely affected by mining, over grazing and forest fire.

Yerramalais forest consists of 75% weathered rocks and remaining 25% forest is green and are scattered, not in continuous range. Yerramalais forest covers over 1 lakh of the 4 lacs hectares of forest in Kurnool district. Yerramalais receives very low rainfall and they come under the Sothern thorn forest. The vegetation is varied depending upon the climate and edaphic factors. Apparently there are signs of forest becoming degraded from moist deciduous and to scrub type dominated by thorny succulent and xerophytic bushes. Some parts of the forest shows valleys with streams. In Owk, Maddilete, Racherla, North Dhone, Gani and Lanjabanda forest shows slightly degraded deciduous type of vegetation. Deciduous trees met within this region are showing gradual degradation towards disappearance. Factors and underlying causes of the processes deforestation and forest degradation are over mining in PanyamRF, N. Dhone for Bethamcherla slabs, slab kankar. Iron ore mines at Ramallkota RF, Cement factory at Cement nagar RF divisions are some the causes for the degradation of the forest.



Figure 1. Yerramalais forest.

MATERIALS AND METHODS

Study area

The present study was carried out on a different parts of the Yerramalais forest of Kurnool district. Exploration trips were carried out at various places in the forest and recoded the distribution of flora of PanyamRF, BethamchrlaRF and VeldurthyRF; Kurnool district is present in Andhra Pradesh, situated between eastern longitudes of 76 58' - 78 56' and northern latitudes of 14 54; -16 14'. Yerramalais scarcely exceed at any point 606 min height. Yerramalais composed of archaean rocks. The oldest rocks exposed in the study area are metamorphic rocks and comprise of minerals such as auartzites, phylites, schists and amphibiolites. These rocks have been highly folded and intruded into granites and are found exposed in Adoni, Aalur and Pattikonda taluks and western parts of Kurnool and Done taluks. The Cemetnagar RF area possesses deposits of limestones suitable for cement manufacture. It has extensive deposits of constructive material such as granites, dolomites, slates, quartzites etc. Kurnool system is predominantly calcarius with limestone and clacarious shells which are exposed mostly in Banganaplli, Dhone and Koilakuntal taluks. These forests are inhabited by nomadic tribal group called Sugali tribes (Krishna Reddy, 2003).

The climate is characterized by hot summer. The year is divided into four seasons. The period from December to February is dry and comparatively cool season. The summer season is from March to May and it is followed by South West monsoons from June to September, while October and November form the post monsoon season. Generally, mean daily average temperatures are 0 above 73.5°C. Mean daily maximum temperatures are highest in May (48.4°C) and lowest in December 3°C. Like wise, the mean daily minimum temperatures are lowest in December and highest in May. Similarly humidity varies and it is lower in the months from December and January, but seldom drops below 50%. The forest area receives rainfall of 591.6 mm during the South West monsoon and the remaining rainfall was received mostly during the North East monsoon. The monsoon is also erratic apart from being mostly

below normal during the South West monsoon, the area is considered drought prone. The relative humidity varies between 27 and 55%. The major disturbances to these forests were from human activities.

Forest - vegetation

Almost all plain near villages are brought under plough, leaving only hill slopes and forests. The local populations depend on these forests for their needs of fuel, timber, fodder etc. The forests are degraded and even reserve forests are generally devoid of any trees of great height and Qirth. The forests in the study area are classified into 5 types on the basis of their regulation: (a) superior dry mixed deciduous type (b) inferior dry mixed deciduous (c) Hardwickia binate type (d) thorny scrub and (e) bamboo type (Venkataraju and Pullaiah, 1995).

RESULTS

The transitions are forecast to be a collection of different types of changes; the most common being transitions from forest ecosystems to more shrub-dominated vegetation. Due to drastic climate changes most of the Yerramalais forest (Figure 1) shows scrub type of forest dominated by thorny succulent and xerophytic bushes. Plants like *Alangium salvifolium*, *Albizia amara*, *Atalantia monophylla*, *Balanities aegyptiaca*, *Chloroxylon swietenia* and *Zizyphus mauritiana* occupy scrub forest. Plants like *Acacia leucopholea*, *Cadaba fruticosa*, *Corchorus olitorius*, *Capparis sepriaria* and *Zizyphus xlopyrus* occupy middle storey. The undergrowth consists of *Alysicarpus scariousus*, *Caralluma adecendens*, *Corchorus olitorius* and *Hibiscus ovalifolius* (Gamble, 1956).

In some parts, it shows dry deciduous forest with plants like *Cassia fistula* (6), *Dalbergia lanceolaria*, *Diospyros chloroxyylon*, *Grewia damine* and *Anisomeles malabarica*.

Main causes

1. Biotic interference and forest fires, grazing, and firewood are some of the factors, responsible for the degradation of flora of Yerramalais forest of Kurnool district.
2. Indian farmer's poverty and illiteracy obliges them to clear more heritable lands in order to enable them to buy the inputs that would allow them to produce more or less land.
3. Over mining for minerals and metals from earth is another cause for climate change affecting the forest. Mining is a money making business. Not only do mining companies prosper, but governments also make money from revenues. Workers also receive income and benefits; mining at Dhone RF for minerals, mining at Bethamcherla RF for natural stones such as sandstone slabs, limestone tiles, marble, granite, flooring slate stone, cobbles, landscaping pebbles, mosaic patterns, and stone garden decorative items flooring slabs. Manganese, tantalum, cassiterite, copper, tin, nickel, bauxite (aluminum ore), iron ore cleared. As a result, after few years the entire land becomes barren and not fit for growing any trees nor food crops. Large scale mining operations are done by using huge bull-dozers and excavators to extract the metals and minerals from the soil. In order to amalgamate (cluster) the extractions, they use chemicals such as cyanide, mercury, or methyl mercury. These chemicals go through tailings (pipes) and are often discharged into streams. This pollution contaminates all living organisms within the body of water and ultimately the people who depend on the fish for their main.
4. **Excessive use of firewood:** As a primary source of energy for domestic purposes, is leading to severe deforestation. Firewood consumption is a pattern of the tribal communities of Yerramalais forest. The fuel wood is burnt for various activities such as cooking, water heating, lighting and livestock rearing, etc. Among various activities, cooking required maximum energy. Commercial fuel is beyond the reach of the tribal communities due to their poor socio-economic conditions.
5. **Cement factories:** Due establishment of Cement factories like Panayam Cement factory in PanyamRF, Priya cement factory in DhoneRF (Figure 2).
6. **Soil erosion:** The replacement of a forest cover for red soil area for cash is a direct and visible factor, as for example the opening of a road (public or for forest logging) in a forest zone, which, in addition to being a direct factor of relatively small significance (eliminating a strip of forest along the road) attracts farmers in search of land who will clear the forest for cultivation. With regard to the area cleared by these farmers, should one attribute deforestation to the direct factor, to the indirect factor, or to both? In our view, we must always consider the direct

factor either as the only one or as one of the two factors, but under no circumstances can we consider the indirect factor as the only one.

7. **Deforestation:** This involves a decrease in the area covered by forest. However, it cannot be so defined without adding a reference to its use (or allocation). In point of fact, there exist certain forms of forest utilization - and priority objectives of forest management - that clear temporarily the forest cover while guaranteeing its maintenance.

8. **Tribal people:** The semi-nomadic tribal people Sugalis who live in the forest area are called Thandas have slightly affected the vegetation due to shifting cultivation. Usually the tribals cut trees adjacent to their existing agricultural lands in order to increase the extent of cultivable land. Encourage by some political members tribals keep on encroaching the nearby forest in the hope that they will be given rights on the land eventually.

9. **Temperature and Rainfall:** Yerramalais forest receives lowest rainfall and the temperature goes up to 46°C it the main reason for degradation of forest.

Main impacts

The main impact focuses on:

1. **Water resources:** Perhaps the most significant impact of a mining is its effects on water quality and availability of water resources within the project area. Surface and groundwater supplies will remain unfit for human consumption. Mining operations mobilize large amounts of material, and waste piles containing small size particles are easily dispersed by the wind. Particulate matter transported by the wind as a result of excavations, blasting, transportation of materials, wind erosion and nearby fertile lands becoming sterile and barren.

Mining can contaminate soils over a large area. Agricultural activities near a mining project may be particularly affected. Mobile sources of air pollutants include heavy vehicles used in excavation operations, cars that transport personnel at the mining site, and trucks that transport mining materials. Noise pollution associated with mining may include noise from vehicle engines, loading and unloading of rock into steel dumpers, chutes, power generation, and other sources. When mining activities are not adequately managed, the result is degraded soils, water, biodiversity, and forest resources, which are critical to the subsistence of local people. When contamination is not controlled, the cost of the contamination is transferred to other economic activities, such as agriculture and fishing.

2. **Loss of biodiversity:** The forests that are cleared for mining purpose are home to a large number of micro and macro flora and fauna. Indiscriminate and unplanned clearing of the forest leads to loss of home for thousands of animals this make the survival of large number of plant species to be at stake. The cutting down of trees in itself



Figure 2. Cement factory.

is a big threat to a number of plants, trees, birds and animals that dwell in the forests. Various studies have noted that a number of bird, tree, scrub and herb species have migrated. Deciduous trees met in this region are showing gradual degradation towards disappearance. The undergrowth consists of grass of good fodder value. The thorny scrub types of forests are generally found in the bordering villages. These forests have become so depleted of their stock due to over grazing and illicit felling of trees that they consists of an open type of thorn forest.

DISCUSSION

The degradation of forest lands caused by deforestation or overexploitation that voluntary national policies aiming at the regeneration of forest lands were implemented in a generally authoritative manner, following a more or less rapid phase of decline. The industrialized and emerging countries are presently in a phase of forest restoration, unlike the developing world, which is generally in a deforestation phase. In all countries, the decisions to be taken with regard to the occupation of forest lands and

the utilization and management of forests require a good knowledge of the situation and the changes involved at all times and at the appropriate levels. This presupposes the development of human resources and the strengthening of the units responsible for forest inventory in each country, as well as at the international level. This activity should be perceived as a whole with all of its disciplines, including the most modern and appealing, such as remote sensing and geographic information systems, as well as the more classical and frequently neglected ones of forest measure and taxonomy. Cultural degradation also occurs in mining villages. Awareness has to be created in the students, the next generation of scientists, who will undoubtedly face new environmental challenges and have to fully understand that these challenges cannot be dealt with alone.

The future of our environment lies in cooperation-cooperation between scientists, between disciplines and between countries; focusing on strengthening natural resources management such as afforestation, vehicle for regeneration of the depleted forest. School children should be given compulsory primary education so that they will not go into the forest for collection of fodder and fuel

wood. Gramasabha must play important role in the implementation and monitoring of schemes like Vana samrakhsana samithi. Serious efforts of the forest department, local bodies, may protect this diminishing forest; starting awareness campaign among youth in the forest so that they accept forest protection as a moral duty. Over grazing of animals should be avoided, stopping of uncontrolled fire setting. Apparently, there are signs of becoming degraded from moist deciduous to deciduous and to scrub jungles.

Preventive measures have to be taken like establishing a forum for the exchange of information on forest vegetation management techniques, methodology, and research through periodic meetings and other appropriate means. Cooperate with local, state, regional, and national agencies, both public and private, in the identification and solution of forest vegetation management needs. Promoting awareness by the public and concerned agencies on the need for forest vegetation management encourages research on forest vegetation management methods by both government and private agencies. Promoting uniformity and coordination of activities among agencies concerned with the regulatory aspects of forest vegetation management and symposiums have to be conducted where ecologist, social scientists, physicist, economist, community representatives should share their views and thoughts about conservation of forests. Successful implementation of environmental polices has to be legislated. We have to analyze the failures and success of polices implemented in the forest development and conservation throughout the developed countries. Strict planning and monitoring of our conservation efforts use satellite technology for conservation.

People biodiversity centers are established at rural level and grazing by animals may be prevented by providing subsidy from government to cultivate forage crops as an alternative. Tribals appointed by government on temporary basis as forest protection force will be made permanent for better protection. Vana Samrakshna Samithies (VSS) are to be constituted involving tribals and other villagers. In order to stop exploitation of timber yielding plants permission given by government to tribals and others for procuring honey, gum bamboo etc is an indirect conservational measure. Exploitation of medicinal plants by tribals and pharmaceutical companies through them should be stopped. Forest fires which destroy both flora and fauna should be prevented. It may damage temple property and hamper tourists also. To stop deforestation, gobar gas plants should be established by using agriculture and animal waste, and social forestry may be developed for domestic and agriculture purpose. Keeping in mind the threatened category of plants, entry should be prevented in protected areas of identified medicinal plants to avoid exploitation. Only the students and researchers may be allowed for study purpose. Hence, Yerramalis forest which is rich in floristic diversity, a treasure trove of rare, medicinal and economically potential plants can be

maintained for the welfare of local farmers, villagers and for rural development by its conservation.

Conclusion

Conservation of biodiversity requires the foremost importance from the government at the centre as well as the state. Thus political will in terms of formulation of proper policies with specific focus on critical physio-graphic areas, adequate budgetary grants, formation of regulating, implementing and appellate authority is necessary. Crime control Board, Forest guards and tough laws towards poachers and piracy need to be looked at. The recent initiatives of the government towards adopting a National Action Plan for Climate Change are a welcome step. Environmental Impact Assessment, use of public forums, setting up of new parks and sanctuary and creating a complete database are other. The most important link to the role in conservation is to be played by our scientific intelligentsia areas which is being focused at by the central government. Environment and climatic implications of man developmental activities are posing an unsustainable pressure on the biodiversity of the region. Timely maneuvered step requires the proper estimation and compilation of the diversity database and moreover coordination on various fronts.

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