

Tropical Forest and Ecosystems Services in Indian Context

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Abstract

Tropical forest are sensitive, adaptive and vital ecosystem. They cover approximately 7% dry land area on earth. The productive, protective and regulative functions of the forests are economically valuable enough to the tune of billion of US \$ per year. The goods and services including timber, food, fodder, medicines, hydrological cycle, shelter, culture, aesthetic and recreation are provided by them. Growing development is causing threat to the existence of these useful and important ecosystem. Major threat to these forests are population explosion, growing urbanization, agriculture, industrialization, deforestation, overexploitation of resources, excessive mining, climate change, fragmentation and habitat destruction. These factors have been destroying the forests very rapidly putting a great number of plants and animals in danger of extinction. Therefore, it is necessary to formulate a correct conservation strategy and sound management plan for restoration of these critical ecosystem.



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Introduction

The rich and varied ecosystem providing most of the goods and services to the man kind is none other than the tropical forest. These are the most important ecosystem in the nature, on the planet earth. They provide rich varied resources to the world, upon which human society has continued to thrive from the time immemorial and are considered as the most complex and species rich ecosystem of the world^{1,2}. These forests spread across a wide range of ecoclimatic conditions along the equatorial

region, from the tropical rain forests, representing appreciably hot low land to snow-clad mountain and area of unusually no seasonality in precipitation to persistently humid conditions³. Tropical forests are no more recognized merely a habitat of charismatic, rare, unique endangered species of plants and animals including reptiles, birds, and mammals providing particular habitat of special interest, but also better known to provide timber, fuel wood, climate amelioration, soil and water conservation, clean air and regulating climate, floods, pollination,

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also providing various cultural and economic services and various kinds of raw material with enormous social benefits^{4,5,6,7,8}. They are in fact the life support ecosystems on the earth.

Ecological importance of tropical forest is undoubted, yet these are threatened due to population increase, urbanization, deforestation, agriculture, fragmentation, habitat loss, legal and illegal logging, mining, fire and climate changes^{6,9,10,11}. These above factors alter the role of forest resulting adversely in reducing the services such as regulation of floods, biodiversity, landslides, loss of soil productivity provision of food and livelihoods, declining security to million of people living in and around the forest^{12,13}.

The present review is an effort to establish the related problems and propose recommendation for achieving the conservation goals along with suitable measures for restoration of tropical forests.

Function

Tropical forest are fragile ecosystem which perform three major functions: productive, protective and regulative⁶. Productive function include timber, firewood, food, fodder, fiber and medicinal plants etc.¹⁴. Protective function showed that forest soil readily absorb water and as a result, surface runoff rarely occurs outside the stream channel in the forest areas, causing important water catchment to form water table beneath the forests¹⁵. Evapotranspiration in the forest area maintain the atmospheric moisture regulating the environmental temperature of the region^{16,17,18}. They also prevent desertification, radiation, landslides and pollution^{4,13,19}.

Regulative function involve the biogeochemical cycles, floods, drought etc. Forest play an important role in global carbon cycle. Most of the carbon enters in the ecosystem through photosynthesis. The Net sink of carbon from forests depends on human behavior, if disturbed by human or natural causes, carbon emission into atmosphere increase or result in decline in the sequestration potential²⁰. Tropical forest are the largest sink of carbon in the world²¹. Tropical forests contain about 40 % of global terrestrial carbon which account for more than half the global gross productivity and sequester large amount of CO₂ from the atmosphere^{22,23}. Carbon

stocks in the forest predominantly in live biomass and in soils, with smaller amounts in coarse woody debris^{24,25,26,27}. In tropical forest world wide, about 50 % of the total carbon is stored in the above ground biomass and 50 % is stored in top 1 meter of the soil²⁸. However, there are marked differences among the sites observed by various workers in different countries^{29,30}. The litter fall and death of organisms, its detritus decomposition add organic carbon into soil by microbial activities³¹. During the period from 1995 to 2005, carbon stock, in the forests have been estimated to increase from 6244.78 million tons to 6621.55 million tones, there by registering annual increment of 37.68 million tones of carbon³². Several studies have established the fact that carbon sequestration by forest could provide relatively low-cost net emission reduction^{33,34}. The tropical forest are more effective in carbon sequestration than other forests³⁵. Forests regulate hydrological cycle which include increasing precipitation, flood water detention, ground water discharge and sediments retention, preventing mitigation consequences of floods³⁶. They also play important role in hydrological cycle, regulating the water flows and sub soil water regimes, recharging of aquifers and maintaining the flow of water in rivers and rivulets as they are the source of large number of rivers and rivulets in the country⁷.

Goods and Services

Forests provide valuable goods such as timber, fuel wood, fodder to be major and direct contribution for their higher economic value along with non timber forest products (NTFPs) including fruits, nuts, pods, barks, gums, resins and medicinal plants to the human being^{15,37,38,39}. Bamboos are commonly known as poor man's timber, due to its utility and accessibility to common people, is an important resource from the forest. The total bamboos bearing area of our country has been estimated 13.96 million ha³⁸. The paper mills are the main consumers of bamboos, purchasing it at an average rate of Rs. 1500/- per tonne and total economic value of annually harvestable bamboos is estimated to be Rs 24298.25 crore per year⁷.

Ecosystem services of the forests have been evaluated to be its indirect contribution. Climatic amelioration is one of the major role of the forests

providing clean air and pollution free environment. In our country, the people are enjoying clean air and pollution free environment in the villages which are located in the fringes of forest area⁴⁰. Various workers have evaluated the services provided by the trees from time to time. The services of a tree serving for about 50 years in terms of monetary value has been estimated, which by providing oxygen worth 31250 US. dollars, air pollution and soil erosion control worth 62000 US. dollar, soil fertility worth US.\$ 31250, water recycle worth US \$ 37500 and shelter for birds and animals worth U.S.\$ 31250⁴¹. United states forest have been estimated to produce climatic control benefits annually worth US.\$ 18.5 billion⁴². Role of forest in reducing air pollution through SO₂ and particulate matter absorption through tree has been established by⁴³, by extending life expectancy of the population and reducing hospitalization. The population living in pollution free forest area are benefited by reduction in the amount saved on healthcare expenditure⁴⁴. Water is known to perform number of ecological functions like hydrological cycle, nutrient cycle, temperature control, life support to plants and animals⁴⁵. Forest ecosystem maintain large number of rivers and rivulets. Forest water shed have better available quality of water. Shimla catchment forest is the best example showing drinking water supply to township⁷.

Forest provide seeds for growing local crops in the fringe area villages which have minimum chances of attack by the organisms causing diseases and damage to the crops, providing biological control and also minimize the use of insecticides and pesticides⁶. The role of birds, bees and plants has been estimated to the tune of enormous economic value⁴⁶. Though it is very difficult to assess its exact economic value yet they amount to worth of billions of U.S.dollars per annum globally^{47,48}.

Forests play important role in ensuring food security to the society as well as they provide habitat for animal, birds and insects which have enormous value. Recreational opportunities and amenities are another important services generated by the forests. National parks and wild life sanctuaries in the country attract a large number of domestic and international tourist, visiting these areas and other

ecotourism destinations which are increasing day by day^{49,50,51}. The other important services rendered by the forest is from the trees where a single tree after surviving for about 100 years provide goods and services worth Rs 64 lacs, as oxygen worth Rs 11.00 lac, fertilizers and prevention of soil erosion worth Rs 12.8 lacs, absorption of air pollution worth Rs 21.00 lac, shelter to animals and birds worth Rs 10.6 lacs and fruits, flowers, medicines etc. worth Rs 8.6 lacs¹⁹.

Above given description clearly mentions the large quantum of goods and services provided by the forests regularly for the mankind. The economic value of goods and services generated by the forests of India have been estimated to be around 43.79% (Rs. 305110.95 crores) by direct benefits including fodder, NTFPs, timber, bamboos and fuel wood, where rest 56.21% (Rs. 391712.2 crores) share is contributed by indirect benefits including prevention of soil erosion and landslides, climate amelioration, water retention and water supply, pollination, recreation, food and water security, carbon sequestration and biological control⁷.

Biodiversity

Tropical forests are one of the richest terrestrial ecosystem which support variety of life forms and maintain huge global biodiversity. They cover 7% of the earth land surface yet they harbour high biological diversity supporting about 50% of the described and even large number of undescribed species^{52,53,54}. India is One of the 12 mega biodiversity countries of the world consisting of 17000 flowering plant species having 8% global biodiversity though it covers only 2.4% of the earth surface yet it is also one of the biodiversity hot spots of the richest and highly endangered eco-regions of the world^{55,56}.

Biodiversity is essential for human survival and economic well-being and for the ecosystem function and stability⁵⁷. Studies on the biodiversity in relation to the ecosystem functioning have revealed that species diversity enhances productivity and stability of ecosystem^{58,59}. It effects the strength and capacity of ecosystem to provide essential goods and services necessary for well being and prosperity of human population in both developed and developing countries⁴. Importance of tropical

forests and its high biodiversity value for wide range of endangered species including insects, amphibians, reptiles, and terrestrial plants have been well established and provide essential resources for millions^{60,61,62,63}.

Threats

Tropical forests are one of the most threatened ecosystems of the world due to increasing human population, land use pattern, deforestation fragmentation, agriculture, logged repeatedly, intensive hunting, climatic changes and degradation leading to loss of habitat destruction^{64,65,66,67,68,69,70}. Deforestation causes loss of biological diversity with a reduction of ecosystem services such as carbon sequestration and storage, soil quality, habitat for bird and insect community providing and regulating the pollination services^{71,72}. Effect of fragmentation on plant species include loss of species population, reduction in remnant population sizes, changes in densities of reproductive individuals, reduced reproductive success and increased isolation of remnant population^{73,74,75}. Anthropogenic effect on tropical forests can be grouped into two broad categories such as local effect which include local land cover changes, invasive species and global effect include changes in atmosphere and climatic condition caused largely by fossil fuel consumption and remote land cover changes^{76,77,78}.

The population of tropical countries increased from 1.8 billion in 1950 to 4.9 billion in 2000 and has been projected to grow by further 2 billion before 2030⁷⁹. India is a rural country with about three fourth of its population residing in villages. The total population of 147 million is located in the vicinity of forests in the world⁸⁰. Vast majority depend upon the forests for meeting their basic needs of food, fodder, fuel, timber, medicinal plant and pollution free^{7,13,40,81,82}. The depletion rate of these forests have been very rapid in the recent past. These uncontrolled activities of the human beings have to be strictly monitored else it would be very difficult to recover and restore the forest area for our future.

Conclusion

The tropical forests are very useful and important ecosystem which harbor a vast majority of biodiversity

which is declining due to natural and manmade reasons. There is an urgent need of scientists and social workers to find out the measures to protect and conserve these ecosystem as they are economically important for the human societies, specially for those residing near the fringes of these ecosystem in the villages which cover a majority of the Indian population and economy. Some of the suggested measures are: Awareness programs should be arranged by involving NGO's and making participation of masses to educate them for the care, protection and conservation of the forests. The forest products should be considered and be taken care of and such plantation in the fringes of villages be ensured to lessen their dependence on the forests to let these plant species grow there in the forest. The agricultural fields be extended in these areas to make their use for producing these forest products there in. The modern approaches of the government in providing gas fuel for the kitchens of the villages be extended at large to save wood cutting, otherwise used as fuel. The laws should be enforced strictly to save the forests wood. Government arrangements should be made to save the destruction of forest by using fire fighting steps which are otherwise used at later stages should be applied at the primary level, because by the time advance measures are taken, it becomes too late to save the loss in the forest. The illegal mining should be dealt with very strictly by enforcing severe punishment to save the nature conserving these forests in their natural state. There should be strict monitoring by the agencies specially made for the purpose to act on ground for conserving these forests with power to recommend for the execution of those involved in illegal acts destroying the forest. It is the high time for the government to involve their machinery with the help of NGO,s and the public, making the "save forest" a movement for our own future.

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