

Ecosystem services valuation of the forests of Arunachal Pradesh State, India

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Abstract. Ecosystem services are the outcome of ecosystem functions of the forests benefitting human beings and their economies immensely. Valuation and accounting of ecosystem services emanating from forests is necessary to generate awareness among stakeholders, for green accounting and land use planning. An approximate real worth of the Arunachal Pradesh forests, covering more than 81% of the state's geographical area, has been estimated in the paper. A preliminary and conservative estimate amounting to Rs. 1,518 billion per year about the ecosystem services emanating from the forests of the state has been made which is about 1.7 times the value of the growing stock. There is a need for a detailed study based on primary survey and ground truthing of state's floral/faunal wealth and water bodies like lakes, rivers and waterfalls/springs assessing accurate magnitude of the ecosystem services emanating from the forests of the state and incorporating them in Gross State Domestic Product (GSDP).

Keywords: Biodiversity conservation, Ecosystem services, Environmental economics.

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Introduction

Forest ecosystems are responsible for providing a wide range of goods and services to the human beings, sustaining their livelihoods and survival. Interest in ecosystem services, both at research and policy level, has grown rapidly (Braat and De Groot, 2012; Costanza and Kubiszewski, 2012). The first major study towards estimation of global ecosystem services, including forest based ecosystems, was conducted by Costanza et al. (1997). A team of researchers led by Robert Costanza put an average price tag of US\$ 33 trillion per year on these fundamental services emanating from various ecosystems, which was significantly higher than the global GDP of that period. Recently this figure has been updated and modified as US\$ 125

trillion per year at 2011 price level (Costanza et al, 2014). The second major milestone in this direction was Millennium Ecosystem Assessment (MEA), an exercise carried out between 2001 and 2005 by 1360 experts from 95 countries. The assessment mentioned that about sixty percent of the ecosystem services examined worldwide were in degraded state. According to MEA, humans have failed to value and protect the services of nature because these are viewed as free and limitless. In short, it provides a framework for understanding and valuing ecosystem services (Verma, 2008).

A United Nations Environmental programme (UNEP) initiative called 'the Economics of Ecosystem and Biodiversity' (TEEB) is the latest effort towards valuing biodiversity and ecosystem services emanating out of natural resources (TEEB

foundations, 2010). After appearance of this report from TEEB, hundreds of projects involving universities/institutions, NGOs and other stakeholders are currently

undergoing worldwide towards better understanding, valuation and management of ecosystem services and natural capital (Costanza et al, 2014).

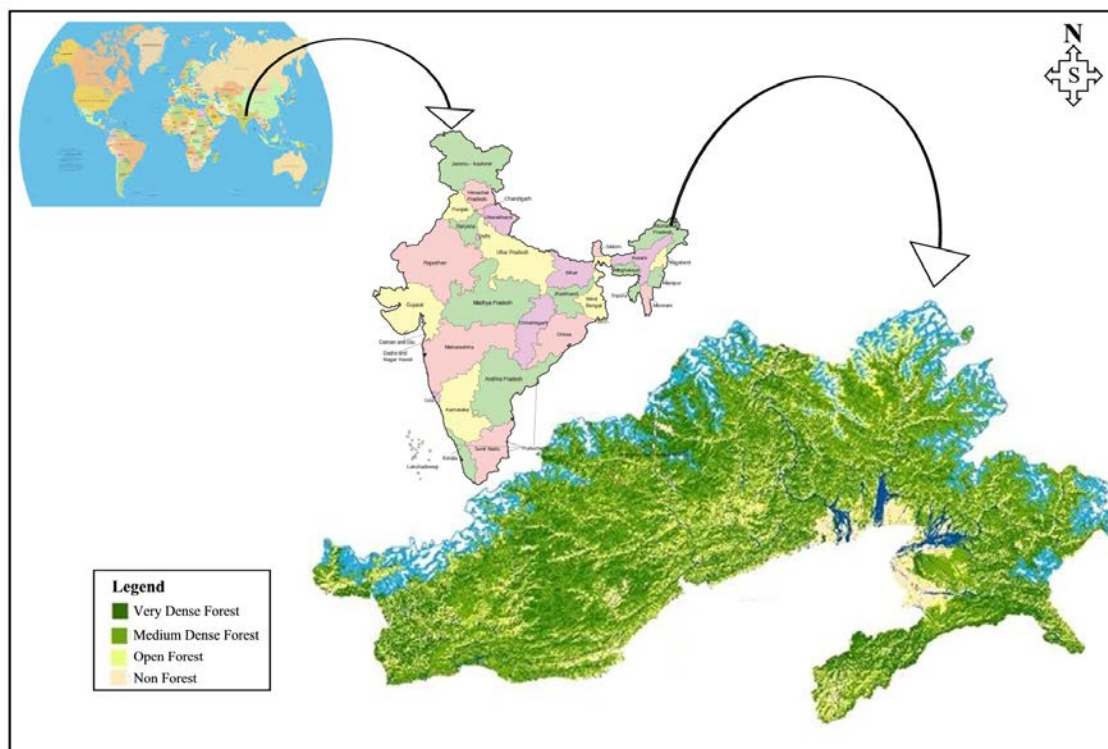


Figure 1. Forest Cover of Arunachal Pradesh State, India. Source: FSI (2013).

Arunachal Pradesh forests and biodiversity

Forests are the second largest land-based resource after agriculture with the potential to reduce poverty in India as they not only provide small timber, fuelwood, fodder and non wood forest produce to the marginalized communities living around forests but also support industrial and commercial activities and provide a large number of ecological services. If managed properly, forests in India can play a very important role in addressing Millennium Development Goals (Verma, 2008). Forests are the prominent resource in the state of Arunachal Pradesh with the predominantly large tribal population living in close association with forests and highly

dependent on it. The total forest and tree cover of the state is 6.79 million ha, which is about 81% of the geographical area of the state (FSI, 2013).

The Protected Areas (PAs) constitute 11.82% of the geographical area of the state, whereas national average is below 5%. Due to large altitudinal range (150 m to 7,000 m), the state has variety of forests ranging from tropical wet evergreen, semi evergreen, sub tropical, temperate to alpine forests.

These forests are the storehouse of a variety of flora and fauna. The floral diversity contains 96 species of mammals, 113 species of reptiles, 525 species of birds and 115 species of fishes. The faunal diversity has about 4,500 species of angiosperms, 34 species of gymnosperms,

more than 550 species of orchids, more than 350 species of ferns and bryophytes, more than 70 species of bamboos and 17 species of canes. With a view to conserve precious wildlife and floral diversity of the state, the State Government has established eleven wildlife sanctuaries, one orchid sanctuary, two national parks, two tiger reserves, two elephant reserves and one biosphere reserve covering about twelve percent of forest/tree cover of the state. The distribution of forests along with crown densities in the state is provided in Figure 1.

Moderately dense forests account for about 37.51% of the forest area followed by very dense forests accounting for about 24.87%. The rich biodiversity (both flora and fauna) of the state has contributed to its recognition as one of the 18 'Biodiversity hotspots' in the world. Apart from vulnerability due to climate change, the forests of the state face several threats and biotic pressures in the form of shifting cultivation, grazing, forest fires, encroachment, commercial plantations, human-animal conflicts and illegal extraction of timber along interstate borders with Assam and Nagaland (APSAPCC, 2011).

Concept of ecosystem services

To understand ecosystem services, the term 'ecology' is important as it relates to the study of the relationships between organisms and their environment. Ecosystem services are fundamental life support services provided by natural ecosystems like forests, grasslands, deserts, oceans etc upon which the well being of all societies depends. According to Daily (1997), ecosystem services may include carbon storage and sequestration, water storage and filtration, biodiversity maintenance, air purification, waste decomposition and detoxification, crops and natural vegetation pollination, seeds dispersal, nutrients recycling, control of agricultural pests, climate stabilization, weather extremes moderation and provisions of aesthetic beauty. Marcot

(2004) defined ecosystem services as the array of natural resources and processes that are valued by humans and that sustain ecological communities and ecosystems. Broadly five categories have been prescribed by the author to encompass these services:

- Ecological services (pollination, carbon sequestration etc).
- Biophysical services (soil fertility services, water regulation, air quality and atmospheric services, vegetation services).
- Ethno-biotic services (medicinal plants used by local people, aesthetic beauty etc).
- Economic services (biological controls, recreational services etc).
- Natural resource services (timber, clean water, fauna/flora etc).

Millennium Ecosystem Assessment (MEA) categorized ecosystem services in to four main categories namely: Provisioning services which include firewood, fodder, timber, pulpwood, non wood forest produce, Regulating services which include soil and water conservation, climate amelioration, maintenance of genetic pool, maintenance of gaseous balance mainly carbon dioxide and oxygen in the atmosphere, cultural services which include aesthetic, artistic, spiritual, recreational, scientific, educational values and supporting services which include soil formation and nutrient cycling (MEA, 2005).

Based on 109 research studies conducted on tropical forests worldwide using environmental economics techniques like direct market pricing, travel cost method, hedonic pricing and contingent valuation method etc, TEEB has come out with values of different ecosystem services emanating out of these assets, which are given in Table 1 (TEEB, 2009).

It is observed from Table 1 that provisioning services, for which humans mostly recognize forests, constitute only 21% of overall ecosystem value, whereas regulation services which are the main life

Table 1. Values of ecosystem services in tropical forests.

Ecosystem service	Value of ecosystem services (US \$/ha/yr)-2007 prices		No. of studies
	Average	Maximum	
Provisioning services			
Food	75	552	19
Water	143	411	3
Raw materials	431	1,418	26
Genetic resources	483	1,756	4
Medicinal resources	181	562	4
Regulation services			
Influence on air quality	230	449	2
Climate regulation	1,965	3,218	10
Water flow regulation	1,360	5,235	6
Waste treatment/water purification	177	506	6
Erosion prevention	694	1,084	9
Cultural services			
Recreational and tourism opportunities	381	1,171	20
Total	6,120	16,362	109

Table 2. Forest resource contribution vs other economic parameters.

	Himachal Pradesh (Verma 2000)	Arunachal Pradesh (Present analysis)
1. Physical value of growing stock	102.50 million cu m	439.51 million cu m (FSI, 2013)
2. Monetary value of growing stock	Rs. 408.60 billion	Rs. 879.00 billion (based on average royalty rates)
3. Total economic value of forests per year	Rs. 1066 billion	Rs. 1518 billion
4. Average annual expenditure incurred on forest management and administration	Rs. 1.09 billion	Rs. 2.70 billion
5. Annual revenue realized by forests	Rs. 0.41 billion	Rs. 0.18 billion
6. Value of goods & services in terms of area under forest and tree cover (Rs per ha)	Rs. 7.43 lakh	Rs. 2.24 lakh
7. Total Gross State Domestic Product (GSDP)	Rs. 92.58 billion	Rs. 104.00 billion
8. Forestry & Logging	Rs. 4.87 billion	Rs. 1.97 billion
9. Forestry as % of GSDP	5.26%	1.9%
10. TEV of forests	Rs. 1066 billion	Rs. 1518 billion
11. Corrected GSDP	Rs. 1154.34 billion	Rs. 1624.00 billion
12. Forestry as % of corrected GSDP	92.40%	93.50%

supporting services on the earth constitute more than 72% of overall ecosystem value of the tropical forests. The Supreme Court of India accepted Central Empowered Committee's recommendations of charging

Net present value (NPV) rates varying from Rs. 4.38 lakh to Rs. 10.43 lakh per ha depending upon Forest Eco-Value Class and canopy cover density class (Verma, 2014). These NPV rates are being charged

since 2008, when forest land in different parts of India is diverted for non forestry purposes under Forest Conservation Act, 1980. However, latest estimate of total economic value (TEV) of tropical forests given by de Groot et al (2012) is slightly on lower side, i.e. US\$ 5,264 per ha per year and for temperate forests as US\$ 3,013 per ha per year and used in present analysis in order to have a conservative estimate of TEV of Arunachal Pradesh forests.

Value of Arunachal Forest ecosystem services

Due to varied altitudinal range and climatic conditions, the state has variety of forests ranging from tropical wet evergreen, semi evergreen, sub tropical, temperate to alpine forests. Out of 67,945 km² of forest and tree cover of the state, both tropical and temperate forest types roughly occupy fifty percent of the geographical area. Deducting open and scrub forest area of around ten percent, around 30,575 km² area is covered by tropical evergreen, semi evergreen, sub tropical broad leaved and pine forests. Similarly around 30,575 km² of area is covered by temperate and alpine forests.

Considering the latest total economic value estimate of tropical and temperate forests given by De Groot et al (2012) in above section, and one US\$ equal to sixty Indian Rs, we get a conservative estimate of the ecosystem services emanated by Arunachal Pradesh forests as Rs 1,518 billion per year (one billion is equal to 10⁹). The annual total economic value of the forests of the state of Himachal Pradesh was estimated to be around Rs 1,066 billion per year by Verma (2000), whereas in another study, Verma (2007) estimated the total economic value of the forests of the State of Uttarakhand to be in the range of Rs 1,619 billion per year. Table 2 presents a comparison between the states of Arunachal Pradesh and Himachal Pradesh in terms of various economic parameters.

Discussion

The importance of forest ecosystems to human well-beings cannot be understated. These multifunctional ecosystems provide various services on all spatial and temporal levels (Verma et al 2014). Many countries identify more than 100 different kinds of services from forests (Sheingauz and Sapozhnikov 1988; Mater 1999). This multifunctionality of forests has also been recognized in the Forest Principles agreed at the United Nations Conference on Environment and Development held at Rio de Janeiro, Brazil, in 1992. Some researchers have estimated economic values of these ecosystem services in respect of forests in different countries, for example, the lower bound annual value of Mexico's forests was estimated to be about US\$ 4 billion (Adger et al., 1994), net economic value of Canada's forests was assessed around US\$ 27 billion per year by Anielski and Wilson (2005). In the Indian context, Bahuguna and Bisht (2013) found the lower bound contribution of Indian forests towards country's GDP, which was around seven percent.

Without the ecosystem services emanating from forests, life on earth would not be possible. The livelihood security of the people and support to other sectors like agriculture, horticulture, hydro power, tourism and animal husbandry in a hill state like Arunachal Pradesh is possible only through ecological security of the forests of the state. The ecological contribution of the forests in economic development of the state is immense but the real worth of forest stock in the form of tangible and intangible benefits or marketed and non marketed benefits is not properly understood by policy makers, planners and stakeholders dealing or dependent on forests.

Table 2 reveals that annual expenditure incurred and annual revenue realized is negligible in relation to total economic value of the forests of Himachal

Pradesh and Arunachal Pradesh. Similarly value of growing stock is also quite less than the total economic value of the state forests in the two states. Actual contribution of forestry and logging sector towards Gross state domestic product (GSDP) is not properly accounted for. When this is taken into account, the contribution of forestry and logging sector increases to above 90 % (Table 2).

Conclusion

The valuation of ecosystem services of forests is necessary for raising awareness level of stakeholders, for green or full cost accounting, land use planning and for payment for ecosystem services concept (Costanza et al., 2014). In India, not much has been done on above aspects related to forests. The present paper is a small step in moving forward the idea of estimating real worth of the forests of Arunachal Pradesh State. A preliminary estimate about the total economic value of the forests of the state has been made in the paper. This value would be definitely higher than the present estimate of Rs 1,518 billion as the value of supporting services like role of forests in maintenance of soil fertility, genetic diversity, pollination and nutrient cycling have not been considered. A detailed follow up study is recommended taking in to account the results of primary survey or ground truthing of flora/faunal species and other natural features found in the forests like lakes, rivers and springs.

Conflict of interest statement

Authors declare that they have no conflict of interests.

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