

# **Natural Capital Accounting: an application of the valuing forest ecosystem services in Karnataka<sup>1</sup>**

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## **Abstract**

Natural capital such as provisioning, regulating and cultural services has been a vital role in human well-being. Most of the forest ecosystem services have not been estimated as economic value or missing in the market for bought and sold. Furthermore, the existing national income accounts have been missing the value of forest ecosystem services and integrating into the state and national level. In addition, the United Nations has developed new framework on accounting for ecosystem services includes physical and monetary terms. In the above context, the main objective of the paper is to estimate the economic value of forest ecosystem services such as provisioning, regulating and cultural services. In addition, this paper has developed ecosystem asset values by types of ecosystem services for three protected areas in the Western Ghats region in Karnataka through System of Environmental Economic Accounts. This study has used both primary and secondary data for estimating economic value of ecosystem services such as provisioning services through the 148 *soliga* tribal household for involving collection of Non-timber forest products and the value of carbon sequestration, soil prevention based on secondary data. Finally, the value of recreational services through the individual travel cost method for three protected areas (Bilgiri Rangasamy Wildlife Sanctuary, Nagarhole National Park, Bannarghatta National Park). The result of the study has found that the total economic value of forest ecosystem services at Rs 138.4 million from the three protected areas in Karnataka. This study has also found that recreation value is the highest among the other ecosystem services followed by carbon sequestration, soil erosion and provisioning ecosystem services. Furthermore, this study has also estimated consumer surplus for three protected areas. The main policy implication of the study is to provide information in support of policy and decision-maker related to the environmental management and natural resources at the local level. In addition the importance of ecosystem services and integrating into the state and national income accounts for achieving SDGs.

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## 1 Introduction

Natural capital<sup>2</sup> is one the importance source of human well-being (Barbier, 2016). Natural capital is also vital role in the economic wealth of all nations the world. For instance, Daily et al (2000) described that “the world’s ecosystem are capital assets. It is including the production of goods (such as seafood food and timber), life support processes (such as pollination and water purification), and life-fulfilling (for instance beauty and serenity). In addition, natural capital is vital role in the socio and economic support of many developing countries. Natural capital has considered two types renewables and non-renewables natural resources. Renewable resources are including forests, fisheries etc. Non-renewable resources are things nature gives us for free such as oil, gas, copper, lead and so on. Ecosystem services are provide number of benefits to human being such as provisioning services (the materials and goods which we directly extracted from the environment: freshwater, food and raw materials), regulating services: (the services ecosystem provide by acting as environmental regulators e.g freshwater purification, climate and air quality regulation): cultural services (the non-material benefits that we derive from natural landscapes and natural in general e.g aesthetic, spiritual or recreational use). For instance, natural capital (ecosystem services) provided 40 percent of household income in 29 Zimbabwe villages. In addition, Angelsen et al (2014) estimated natural capital provided 27 per cent income of 24 developing countries especially 77% of income from natural forests. Furthermore, natural capital is one of the important tools for achieving Sustainable Development Goals (SDGs).

Natural capital accounting is the important tool for integrating natural resources into the national income accounts. Furthermore, it measures the changes in the stock of natural capital, on various scales. Natural capital accounting has also provides insights into the economic significance in the wealth creation, livelihood and poverty reduction in many developing countries. There are number of efforts to create accounts for environmental goods and services in the everyday decision making (Costanza et al 1997; Bateman et al 2015; Balasubramanian M 2019). The existing national income accounts are not included the value of natural resources in terms of positive externality or negative externality from the environmental goods and services. Furthermore, the United Nations have been developed a methodology for environmental goods and services called environmental and natural resources accounting. The System of Environmental Economics Accounting (SEEA), the SEEA central framework that includes physical and monetary accounts for a range of natural resources such as renewable and non-renewable resources. Physical flow accounts covered the flows of natural inputs, products and residuals with interaction between economy and environment. Furthermore, SEEA central framework is a multipurpose conceptual methodology for illustrating the linkages between the economy and environment, and the stocks and changes in stocks of environmental assets (UN, 2012). In addition, the World Bank (2018) had estimated the value of global wealth in the context of physical, human and natural capital. Table 2 has indicates that the total wealth has been changed at US\$ 39651 from 1995 to 2014. Produced, natural and human capitals have been increased in terms of economic value at the global level. The economic value of forest including timber and non-timber forest products has been declined from at \$US 137 and \$US 328 respectively. Table 3 presented share of natural capital at the global level. The value non-renewable natural

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<sup>2</sup> Barbier (2019) “ Natural capital including land, forests, fossil fuels, minerals, fisheries and all other natural resources, regardless of whether or not they are exchanged on markets or owned” (p.14).

resources including oil, coal, metals and minerals have been increased compared than the value of renewable natural resources. This is clearly indicated that the demand for non-renewable natural resources has been increased at the global level.

### *1.1 Natural Capital Accounting in India*

India has two global biological diversities the Western Ghats and the Eastern Himalayas. Verma (2018) reviewed currently, the 146 ecosystem services studies have been conducted at the all India level. The valuation of ecosystem studies are including 34 terrestrial wetlands, 68 forests, 19 marine, coastal, mangroves, including coastal wetlands and marshlands and 25 urban ecosystem, agro-ecological system in India. Furthermore, India has been received support from Millennium Ecosystem Assessment (MEA) and The Economics of Ecosystem and Biodiversity (TEEB). Moreover, United Nations Statistical Division has given pilot project on ecosystem accounting in India. The main aim of the project is the national level, several ecosystem services will be modelled in physical and monetary terms, including nature-based recreation and crop provisioning services. In addition, the national level soil accounts will be developed through the S-World model and the state of Karnataka, a whole suite of ecosystem accounts will be developed in physical and monetary terms. Furthermore, Central Statistics Office (CSO) under the Ministry of Statistics and Programme Implementation has been bringing out regular “Compendium of Environmental Statistics” and Statistics related to Climate Change”.

MoSPI (2018) found that level of change in natural capital during 2005 to 2015. In addition, Madhya Pradesh, Maharashtra, Manipur and Rajasthan have been increased greater than 5% of natural capital. Andhra Pradesh, Arunachal Pradesh, Chhattisgarh, Goa, Haryana, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Nagaland, Odisha, Sikkim, UP and West Bengal's natural capital has been increased between 0-5 percent. In addition, some states including Assam, Bihar, Gujarat, Jharkhand, Karnataka, Kerala, Mizoram, Punjab, Tamil Nadu, Tripura and Uttarakhand's natural capital has been negatively changed due to various reasons. Furthermore, MoSPI has been developed a methodology on Green National Accounts in India A Framework under the Chair of Prof Partha Dasgupa, Cambridge University, UK. This methodology has been included physical asset, flow and monetary accounts for agricultural land, forest land, timber, mineral and soil resources in India. Meanwhile, there are few reports have been prepared on Natural Resource Accounting (NRA) through the SEEA methodology. Pilot studies have been undertaken for a few states including Karnataka, Tamil Nadu, Goa, and Meghalaya. World Bank (2018) had estimated the value of produced, human and natural capital based on comprehensive wealth accounting methodology from 1995 to 2014. Table 4 indicated that the total wealth has been increased at US\$9479 and produced capital, natural capital and human capital has been increased at a positive economic value. The value of nature capital in India has been presented in the table 5. The exhaustible natural resources like subsoil assets, iron ore, coal, gas and oil has been increased and renewable natural resources like forest timber and non-timber forest products has been decreased negatively.

## **2 The Valuation of Ecosystem Services in Karnataka**

About 60% of the Western Ghats are located in the Karnataka State. Karnataka is the rich biological diversity with flora and fauna. Karnataka state has number of forest type including tropical evergreen, moist and dry deciduous, high altitude shoals, savannas and scrubs. Karnataka Biodiversity Board (2010) had estimated total number of species 1.2 lakhs including 4500 flowering plants, 508 birds' species, 150 mammals species, 405 fishes (marine & brackish water), fishes (fresh water) 289 species and 1493 medicinal plants including 300 species in commercial use. There are number of valuation studies have been conducted in the region for example, Ninan and Kontoleon (2016) had estimated the economic value of forest ecosystem services and disservices provided by Nagarhole National Park in Karnataka. The total economic value of ecosystem services at US\$ 13 – 148 million per annum. Balasubramanian M (forthcoming) had estimated the economic value of Bilgiri Rangasamy Wildlife Sanctuary (BRTWLS) at Rs 23.9 million in 2018. In addition, there are few studies on economic value of ecosystem services for example; Balasubramanian M (2017) had estimated the value of urban ecosystem services at Rs 19.7 million for Lal bagh botanical garden in Bangalore. Furthermore, natural resource accounting especially forest has been conducted by Panchamukhi et al (2008) had estimated the unrecorded value of Non-timber forest products constituted about 1.45 percent of State Domestic Product in 2002-03. The total recreational value of forest in Karnataka constituted 0.02% of Gross State Domestic Products. In addition, the value of carbon sequestration about 14.6% of Gross State Domestic Products had estimated. Ramachandra T V (2016) had estimated the total value of ecosystem goods and services provided by forest, Uttara Kannada districts at Rs 84,321 crores in 2016.

### **2.1 Current Case Studies in Karnataka**

The present study has been estimated the economic value of provisioning, regulating (soil erosion prevention, carbon sequestration) and the value of recreational services provided by three protected areas such as Bilgiri Rangasamy Wildlife Sanctuary (BRTWLS), Nagarhole National Park (NNP), Bannerghatta National Park (BNP). Karnataka has rich natural resources in terms stock and flows from forests, and other non-renewable natural resources. Therefore, need to assess the value of natural resources for better understanding about the importance of ecosystem services for better natural resource management for achieving Sustainable Development Goals (SDGs) at the local level.

### **2.2 Methodology**

The present study has used various methods for estimating economic value of forest ecosystem services. Furthermore, the value of provisioning services has estimated through the market price method. Non-timber forest products data collection and utilisation information had obtained through the household survey in 148 *Soliga* tribal communities in the Bilgiri Rangasamy Temple Wildlife Sanctuary (BRTWLS) in Chamarajnagar district in Karnataka. The value of soil erosion prevention and carbon sequestration has been estimated through the secondary data obtained from Bilgiri Rangasamy Temple Wildlife Sanctuary (BRTWLS), Nagarhole National Park (NNP), Bannerghatta National Park (BNP) in Karnataka. Finally, the value of recreation services has been estimated through the individual travel cost method of 450 tourist visitors in three protected areas in Karnataka. The present

study has also estimated average consumer surplus per person/visit to the park. The detail methodology has presented in the table 1. A basic econometric model used in this study shows the number of visitors to BRTWLS, BNP and NNP as functional factors such as travel cost, time spent in travelling, age, marital status, household size, educational status, residential location, household income and quality of the park. Thus, the econometric model can be written as follows:

Where  $r_i$  the dependent variable stands for the number of visits by the  $i$ th individual to BRT wildlife sanctuary, BNP and NNP per period of time; *travel cost* denotes the round trip total cost from an individual's residence to and from the site and includes the opportunity cost of travel time and stay at the park.  $D_1$  indicates 1, if urban dweller, and 0 otherwise,  $D_2$  indicates 1 if the visitor's perception about the site's recreational facilities is good and 0, if bad

### 2.3 Results and Discussion

The total economic value of forest ecosystem services has been estimated at Rs 138.4 million provided by three protected areas in Karnataka. This study has found that Nagarhole National Park has the highest economic value (Rs 90 million), followed by Bannerghatta National Park (24.5 million) and Bilgiri Rangasamy Wildlife Sanctuary (23.9 million). The present study have estimated only four ecosystem services such as provisioning services, value of soil erosion prevention, carbon sequestration and value of recreation services in the three protected area in Karnataka. The value of recreation services has been highest share in the total economic value (Rs 78.6 million) followed by regulating services (Rs 56.2 million) and the value of provisioning services (Rs 3.6 million). This study has also estimated the average annual income of *Soliga* tribal has estimated between Rs 10000 to RS 12000 from the non-timber forest products in BRTWLS in Karnataka. Ninan and Kontoleon (2016) had estimated the economic value of non-timber forest products at US\$ 1.73 million and the value of grazing services at the US\$ 3.19 million from Nagarhole National Park in Karnataka. Rajashekariah (2015) had estimated the economic value of ecosystem services provided by Kunigal Lake, Tumkur District in Karnataka. The value of provisioning services (domestic water supply, fisheries, water for crops and pastures) at the Rs 19.5 million and regulation services (micro climate, water regulation/recharge and carbon sequestration) at the Rs 1339.6 million per year. Jala and Nandagiri (2015) had estimated the value of recreational services provided by Pilikula Lake in Mangalore. Through the travel cost and contingent valuation method the value of average willingness to pay at the Rs 238. Yashoda and Reddy (2012) had estimated the value of recreational services at the Rs 846 provided by Basavana Betta State Forest in Karnataka.

The existing valuation studies have not enough for better understanding the importance of ecosystem services in every day decision making. Strand et al (2018) discussed without economic values for unpriced services, stakeholders tend to over emphasise benefits from deforestation and forest degradation. Costanza et al (2017) and Pearce et al (1989) argued economic valuation of forest ecosystem services can assist policy-makers in managing different elements of human well-being, thus providing the basis for both environmental and economic sustainability. In addition, estimating the value of ecosystem services has also

identified regions where high ecosystem services values area together as possible information to local decision makers for better ecosystem and biodiversity management. Phelps et al (2017) discussed the economic valuation has a number of potential policy applications. Furthermore, environmental valuation is the advanced general understanding of the environment and support to land use management. In Karnataka, there is some studies on economic value of recreation services for example Balasubramanian (2017); Jala and Nandagiri, (2015); Ninan and Kontoleon (2016); Rajashekariah, (2015); Yashoda and Reddy (2012). The valuation of recreation services is better for designing entry fee for various protected areas in the State. Table 8 presented regression results of three protected areas. Travel cost in the three study area has negative relationship with distance of the park. Furthermore, age, marital status, household size, residential local and household income are statistically significant. However, the Western Ghats and other reserved and open forest have been providing number of benefits to human being such as regulating services. Balasubramanian M (2019) argues most of the regulating ecosystem services have not been properly estimated in terms of economic value and are also ignored in the everyday decision making process. In Karnataka, there is few economic value of regulating ecosystem services for example, Ninan and Kontoleon (2016) had estimated the value of soil protection at the US\$ 132.33 and carbon sequestration US\$ 0.38, nutrient recycling US\$ 0.18, air purification US\$ 1.91 and the value of pollination services US\$ 1.19 provided by Nagarhole National Park in Karnataka.

### **3 Natural Capital Accounting in Karnataka**

The System of Environmental Economics Accounting (SEEA) has developed a methodology for natural resources are integrating in the national accounts. Furthermore, before integrating value in state or national income accounts first need economic valuation estimates of forest ecosystem services. United Nations (2019) had developed a new framework for ecosystem accounting on Experimental Ecosystem Accounting. The main aim of the framework is integration of ecosystem and economic information is intended mainstream information on ecosystems in decision-making. The fundamental principle of valuation in an accounting context is that the first step should be the valuation of individual ecosystem services. The monetary valuation in SEEA (Experimental Ecosystem Accounts) is applied to ecosystem services and assets, with the relevant valuation concept for ecosystem accounting being exchange value. Furthermore, many ecosystem services contribute to benefits that are not closely connected to existing markets. Frequently, these are services that may be regarded as providing public goods, as in the case, e.g of the contribution of ecosystems to flood protection. Table 9 has indicated that the possible presentation of ecosystem asset values by types of ecosystem services developed by SEEA EEA. Table 9 mentioned that the selected ecosystem services such as provisioning, regulating and cultural services. The present study has estimated the value of provisioning services (non-timber forest products) Rs 0.6 million and crop production Rs 2.9 million. Regulating ecosystem services has estimated the value of soil erosion prevention at Rs 31.2 million and economic value of carbon sequestration at Rs 25.8 million. Finally the value of recreation services at Rs 78.6 million from three protected areas in Karnataka.

### **4 Conclusion**

This is the first natural capital accounting study in Karnataka followed by new System of Environmental Economic Accounting with Experimental Ecosystem Accounts developed by United Nations. The total economic value of forest ecosystem services at Rs 138.4 million in 2018-19 in Karnataka. The value of recreation services Rs 78.6 million followed by economic value of regulating ecosystem services both soil erosion prevention and carbon sequestration Rs 56.2 million and the value of provisioning ecosystem services Rs 3.6 million including the value of non-timber forest products and crop production in the BRTWLS in Karnataka. The main implication of the study is to identify which regions where high ecosystem services value produced as potential information to support local decision making. Furthermore, the natural capital accounting can assist policy – makers in managing different elements of human wellbeing thus providing the basis for both economic and environmental sustainability at the local level.

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## **Appendix**

**Table 1: Methods and measurement of the valuation of ecosystem services in Karnataka**

Ecosystem services	Names of data	Values or methods	Sources
Provisioning Services	Household Survey	Market price method	Large-scale Adivasis Multi-purpose society
Soil erosion prevention ii)	Sediment removal cost iv)	US\$2.5t <sup>-1</sup>	Xi (2009)
	Rate of erosion of broad leaved forest v)	0.5t ha <sup>-1</sup> yr <sup>-1</sup>	PPWS (2015)
	Rate of erosion of non-forest land vi)	319.8t ha <sup>-1</sup> yr <sup>-1</sup>	Xi (2009)
Carbon sequestration i)	Area of evergreen forest vii)	54486.81 ha	Ramachandra et al (2012)
	Area of semi-evergreen forest viii)	1151.91 ha	IPCC (2000)
	Total area ix)	55638.72 ha	World Bank et al (2016)
	Net carbon sequestration of logged evergreen x)	2.65t C ha <sup>-1</sup> yr <sup>-1</sup>	
	Net carbon sequestration of logged semi evergreen xi)	1.1 tC ha <sup>-1</sup> yr <sup>-1</sup>	
	Carbon price xii)	US\$54/tC	
	Carbon price xiii)	US\$86/tC	
Recreation	Tourist visitors to national park and wildlife sanctuary	Travel Cost Method	Primary Survey

**Table 2: Produced, Human and Natural Capital at the Global (Per capita (constant 2014 \$US))**

Per Capita, constant 2014 USD	1995	2000	2005	2010	2014
Produced capital	30,793	32,801	37,237	41,570	44,760
Natural capital	9,803	9,463	11,487	15,019	15,841
Forests, timber resources	490	406	342	360	353
Forests, non-timber resources	1,523	1,419	1,330	1,249	1,195
Protected areas	700	735	834	990	1,149
Cropland	3,060	2,946	3,069	3,486	3,819
Pastureland	1,772	1,625	1,659	1,838	2,063
Sub-soil assets	2,258	2,332	4,254	7,095	7,262
Oil	1,566	1,709	2,817	3,983	4,254
Natural gas	323	311	600	591	488
Coal (all grades)	182	155	463	1,136	1,023
Metals and minerals	186	157	374	1,386	1,497
Human capital	88,874	96,478	97,707	1,02,170	1,08,654
Net foreign assets	-540	-678	-539	-395	-676
Population	5.35E+09	5.73E+09	6.09E+09	6.47E+09	6.78E+09
Total wealth	1,28,929	1,38,064	1,45,891	1,58,363	1,68,580

Source: World Bank (2018)

**Table 3: Share of Natural Capital (%)**



<b>Share of natural capital</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2010</b>	<b>2014</b>
Forests, timber resources	5%	4%	3%	2%	2%
Forests, non-timber resources	16%	15%	12%	8%	8%
Protected areas	7%	8%	7%	7%	7%
Cropland	31%	31%	27%	23%	24%
Pastureland	18%	17%	14%	12%	13%
Oil	16%	18%	25%	27%	27%
Natural gas	3%	3%	5%	4%	3%
Coal (all grades)	2%	2%	4%	8%	6%
Metals and minerals	2%	2%	3%	9%	9%
Total Natural Capital	100%	100%	100%	100%	100%

Source: World Bank (2018)

**Table 4: Produced, Human and Natural Capital in India (constant 2014 US\$)**

<b>Types of Capital</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2010</b>	<b>2014</b>
Human capital per capita	4191.744	4941.256	6385.892	7390.229	8755.388
Natural capital per capita	2619.464	2617.088	2776.277	4070.769	4738.808
Produced capital per capita	2059.468	2340.235	2973.355	4189.439	5161.343
Net foreign assets per capita	-138.066	-125.494	-146.662	-315.057	-444.483
Total wealth per capita	8732.61	9773.085	11988.86	15335.38	18211.06

Source: World Bank (2018)

**Table 5: Natural Capital in India (constant 2014 US\$)**

Source: World Bank (2018)

<b>Natural Capital</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2010</b>	<b>2014</b>
Forests	71.88916	65.36604	59.38007	69.62837	74.71554
Forests: non-timber	47.05385	43.3991	41.37068	39.64028	38.05747
Forests: timber	24.83531	21.96694	18.00939	29.98808	36.65807
Protected areas	82.87008	87.92464	82.22784	94.98188	94.37301
Subsoil assets	211.6935	216.9407	430.7447	1025.636	1105.408
bauxite	4.775117	3.50819	3.84324	5.996757	3.355304
gold	0.057219	0.01461	0.186829	0.462482	0.546652
iron ore	30.03126	31.64283	82.91865	344.7917	344.5273
lead	0.004891	0.038182	0.156707	1.693219	1.554233
coal	101.849	88.74932	189.7413	451.677	487.3924
gas	3.417816	5.7462	17.70935	27.09832	41.05684
oil	71.55823	87.2414	136.1158	186.0251	219.7332

**Table 6: Economic Value of Ecosystem Services in Karnataka**

<b>Protected Area</b>	<b>Provisioning Services</b>	<b>Regulating Services</b>	<b>Cultural Services</b>	<b>Total (Rs in Millions)</b>
BRTWLS	3.6	16.5	3.8	23.9

NNP	NA	34.2	55.8	90
BNP	NA	5.5	19	24.5

Source: Author's estimate, NA (Data not available)

**Table 7: Consumer Surplus**

Name of the Protected Area	Value in (Rs) per capita	Total Rs million
Billigiri Rangasamy Wildlife Sanctuary	Rs 38.24	Rs 3.8 million
Bannerghatta National Park	Rs 191.73	Rs 19 million
Nagarhole National Park	Rs 557.33	Rs 55.8 million

Source: Author's estimate

**Table 8 Regression results of recreational values of BRTWLS, BNP and NNP**

Variables	Coefficients t-statistics) BRTWLS	Coefficients (t-statistics) BNP	Coefficient t-statistics) NNP
Intercept	1.444 (2.757)	0.159 (0.270)	0.980 (2.761)
Travel Cost	-0.013 (-0.115)	-0.074 (-0.899)	-1.014E-5 (-1.716)**
Age	-0.115 (-1.148)	-0.06 (2.592)	-0.009 (-2.136)**
Marital Status	0.080 (0.803)	0.231 (2.592)**	0.113 (1.110)
Household size	0.228 (1.936)**	-0.051 (-0.559)	0.060 (1.264)
Educational status	-0.082 (-0.864)	0.000 (-0.002)	-0.017 (-1.285)
Residential location	-0.178 (-1.714)**	-0.068 (-0.823)	0.139 (1.969)**
Household Income	-0.184 (-1.714)**	-0.279 (3.096)***	3.880E-6 (2.108)**
Quality of the park	-0.072 (-0.795)	-0.095 (1.237)	-0.47 (-1.258)
R <sup>2</sup>	0.70	0.18	14.0
F-Statistics	1.097	4.068	2.837

**Table 9 Possible Presentation of ecosystem asset values by types of ecosystem services**

	Opening value (currency)	Closing value (currency)
Ecosystem Services		
<b>Provisioning Services</b>		

Biomass accumulation	NA	NA
Timber and Non-timber	NA	Rs 0.6 million
Crop	NA	Rs 2.9 million
Grass/fodder	NA	NA
Fish	NA	NA
Water abstraction	NA	NA
<b>Regulating Services</b>		
Carbon sequestration	NA	Rs 25.8 million
Water regulation	NA	NA
Water purification	NA	NA
Air filtration	NA	NA
Nutrient/waste remediation	NA	NA
Pest and disease control	NA	NA
Soil retention	NA	Rs 31.2 million
<b>Cultural Services</b>		
Enabling tourism and recreation	NA	Rs 78.6 million
Enabling nature-based education and research	NA	NA
Enabling nature based religious and spiritual experiences	NA	NA
<b>Total</b>		<b>Rs 138.4 million</b>

Source: Author's estimate based on SEEA EEA methodology UN (2019)