Factoring Forest Intangibles in Accounting Framework: Experience from India

Forum of Experts in SEEA Experimental Ecosystem Accounting 2018
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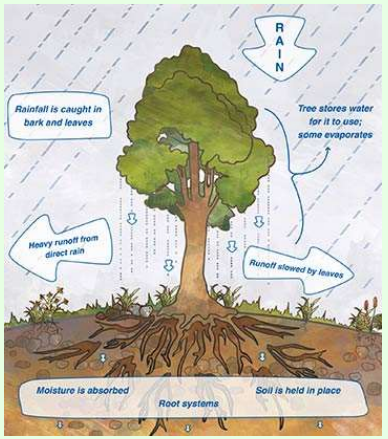
National Tree Benefits Calculator, USA

- "i-Tree", it is a software suite to quantify benefits derived by trees for forests and individual trees.
- Developed by the United States Forest Service
- "i-Tree Streets", is an analysis tool in the suite for urban forest managers that uses tree inventory data to quantify the monetary value
- ES spectrum includes environmental and aesthetic benefits: energy conservation, air quality improvement, CO_2 reduction, storm water control, and property value increase.



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Hyde Park's trees "worth £173m" in benefits

17 May 2018, by Gavin McEwan

The trees in London's Hyde Park have an amenity asset value of £173 million, according to work by arboricultural consultancy Treeconomics commissioned by the Royal Parks.

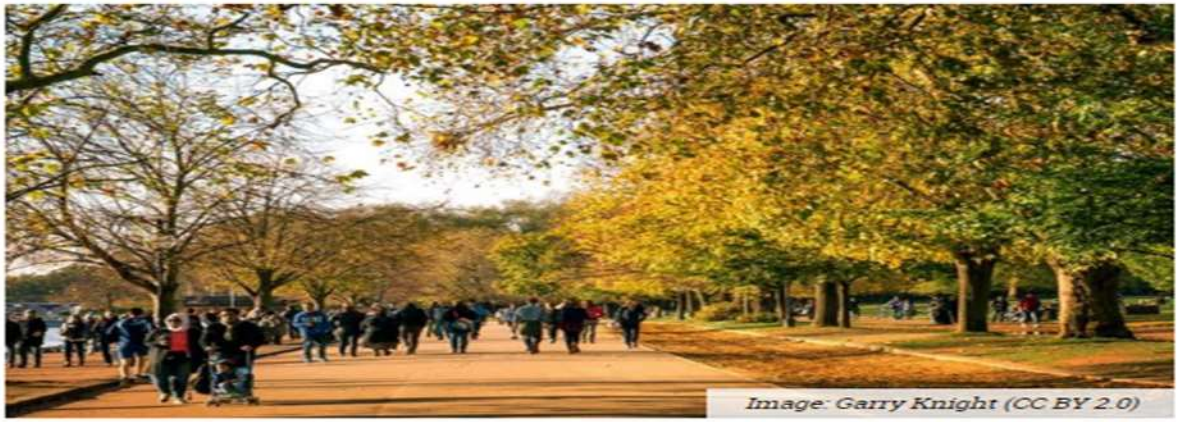


Image: Garry Knight (CC BY 2.0)

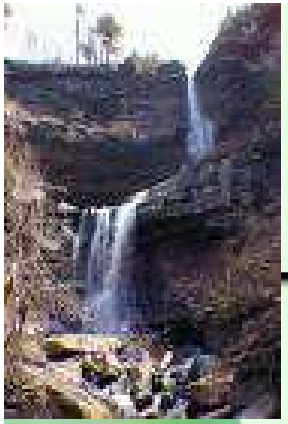
Based on the i-Tree and CAVAT valuation systems, the study found that each year, the trees of the world-famous park

- remove 2.71 tonnes of pollution,
- store 3,872 tonnes of carbon,
- sequester 88 tonnes of carbon, and
- intercept 3,584 cubic metres of rainfall.

Royal Parks tree manager Ian Rodger said: "This report places an amenity value of £52,378 each on some of our plane trees. I have come to believe in the practice of putting a monetary value on trees and this proves they are worth every penny."

The report's principal author, Treeconomics manager Kenton Rogers, added: "Identifying

https://www.hortweek.com/hyde-parks-trees-worth-173m-benefits/arboriculture/article/1465058



Making Conservation Profitable : Philanthropy and government regulations alone simply aren't up to the task of rescuing nature, and it's time for some well designed appeals to people's self-interest.

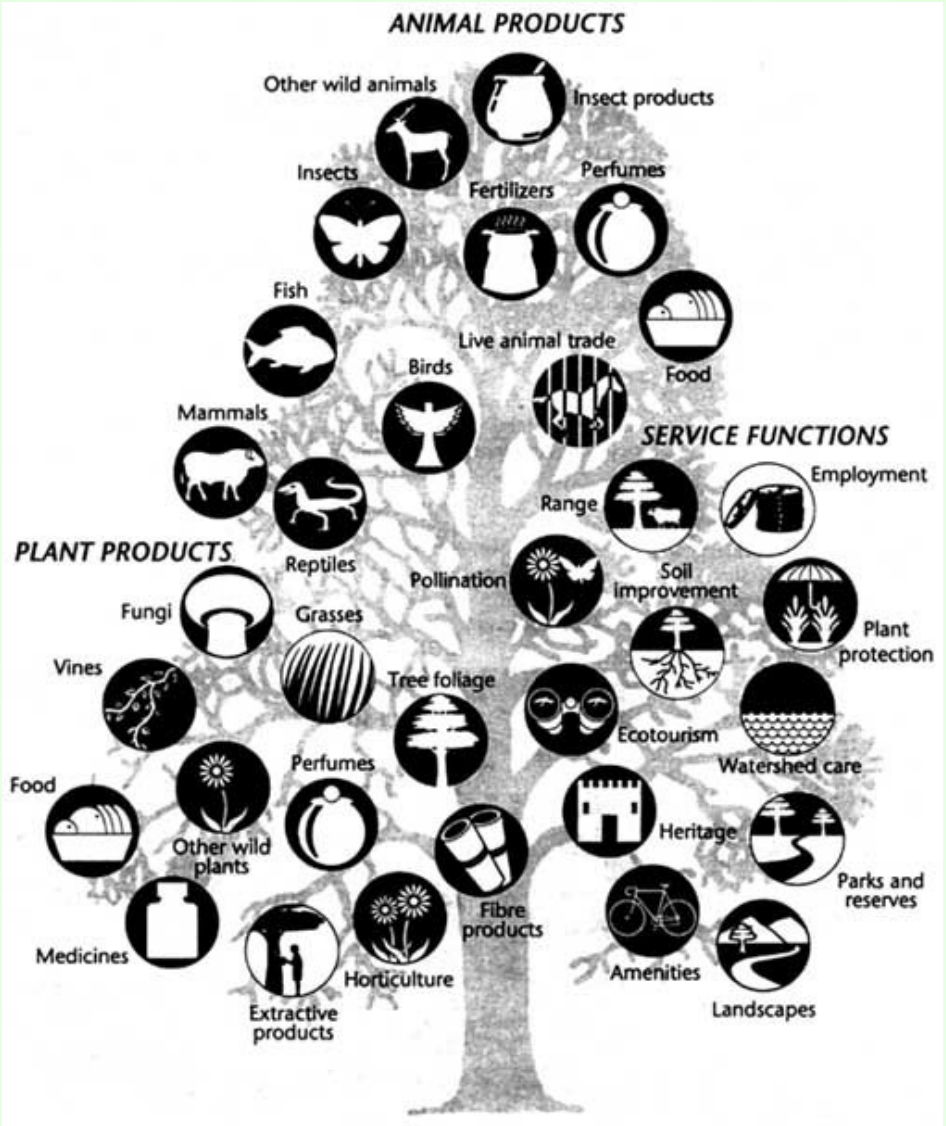
(Source: Katherine Ellison and Gretchen C. Daily Spring 2003 Vol 4 no. 2)

- The city gets 90% of its water supply from Catskill and Delaware watersheds. Forests constitute 75% of the area of these watersheds.

- Faced with increasing microbial and phosphorus pollution in 1997 the city had two alternatives - either to invest in a, filtration plant costing US$6-8 billion (plus annual maintenance of US$ 300-500 million) or to invest US$ 1 - 1.5 billion in the improvement of management of watersheds thereby reducing the pollution at source.

- The city choose the later by raising money through additional taxes on water bills. These funds were invested in promotion of soil and water conservation and improved forest management, which in turn improved the city's water supply

FAO's Tree Diagram



Monetary value of a Medium Sized tree over a period of 50 years.

Indian Biologist, Vol XI, No. 1-2, 1979)

Of concern to all!
A tree is worth
$193,250

according to Professor T.M.Das of the University of Calcutta. A tree living for 50 years will generate $31,250 worth of oxygen, provide $62,000 worth of air pollution control, control soil erosion and increase soil fertility to the tune of $31,250, recycle $37,500 worth of water and provide a home for animals worth $31,250. This figure does not include the value of fruits, lumber or beauty derived from trees. Just another sensible reason to take care of our forests.

Chipko Movement, India, 1973 : Tree Hugging Community

India's Forest and Its current contribution to GDP

- **India ranks 10th in the list of most forested nations in the world.**
- **The total Forest Cover of India is 21.54 % of its Total Geographical Area.**
- **Currently forestry & logging sectors contribution accounts for 1.23 % of the total GDP.**
- **Current allocation of budget to Forestry sector is less than 1% of the total budget**

Density-wise Forest Cover of India

Class	Area (sq km)	Percent of Geographic Area
Very Dense Forest	98,158	2.99
Moderately Dense Forest	3,08,318	9.38
Open Forest	3,01,797	9.18
Total Forest Cover *	**7,08,273**	**21.54**
Scrub	45,979	1.40
Non-Forest	25,33,217	77.06
Total Geographic Area	**32,87,469**	**100.00**

*Includes 4,921 sq km under Mangrove Cover
Percentage rounded off

Source: Indian State Forest Report 2017

Major stages of Ecosystem Services Valuation studies in India

1980 TM DAS "Price of Tree"

1992-2000 Capacity 21 Program for Environment Economics linkages

Participatory, Integrated Decentralised Approach.

1998-2003 EERC Studies. (51 studies in Total)

Ministry of Environment, Forest & Climate Change

Environmental Economics Research Committee under EMcaB

MILLENNIUM ECOSYSTEM ASSESSMENT

2005- Millennium Ecosystem Assessment

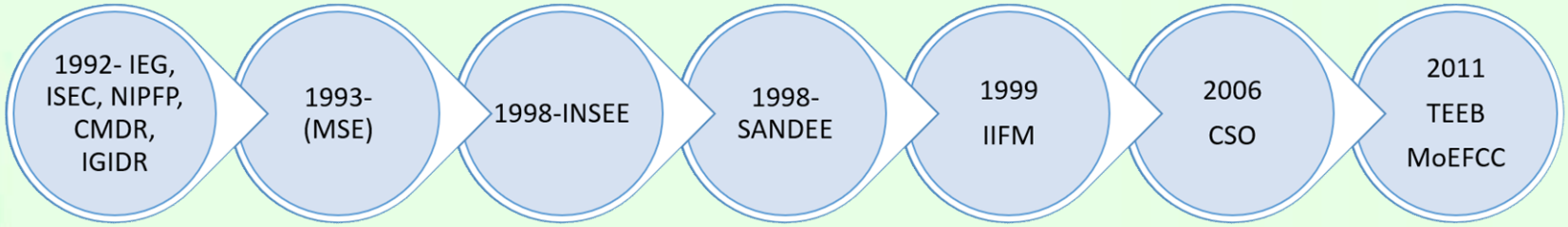
2006-2008 CSO studies of Green accounting

Government of India
Ministry of Statistics and Programme Implementation

2011-2013 TEEB India Initiatives 12 studies

Large no of independent studies by various institutions

Timeline for Environmental Economics Study Initiatives by various Institutions



Institute of Economic Growth (IEG)

National Institute of Public Finance & Policy (NIPFP)

Indira Gandhi Institute of Development Research (IGIDR)

South Asian Network for Development & Environmental Economics (SANDEE)

Indian Institute of Forest Management (IIFM)

The Economics, Ecosystems and Biodiversity (TEEB)

Institute for Social & Economic Change (ISEC)

Madras School of Economics (MSE)

Indian Society for Ecological Economics (INSEE)

Centre for Multi-disciplinary Development Research (CMDR)

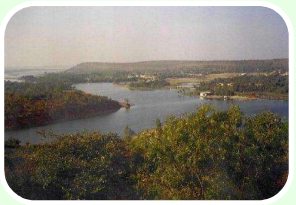
Central Statistics Organisation (CSO)

Ministry of Environment, Forests & Climate Change (MoEFCC)

Ecosystem wise analysis of studies – An Overview

- Four broad categories of ecosystems are considered
- A total of 146 studies conducted in India were reviewed

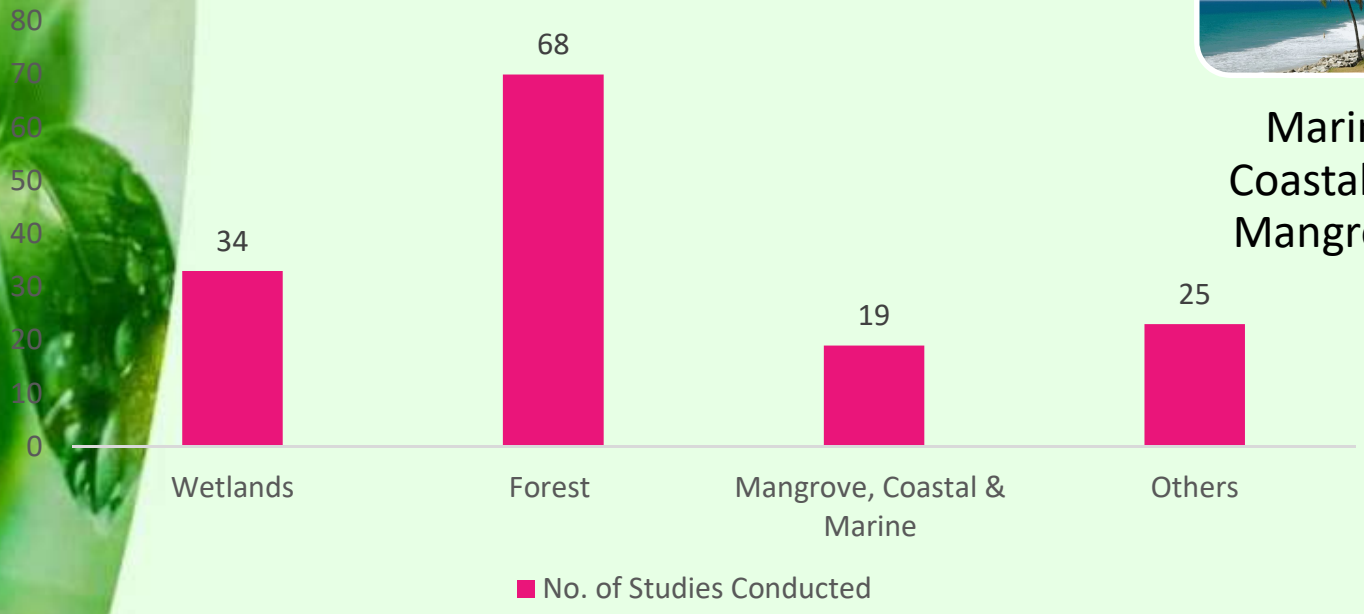
Forest



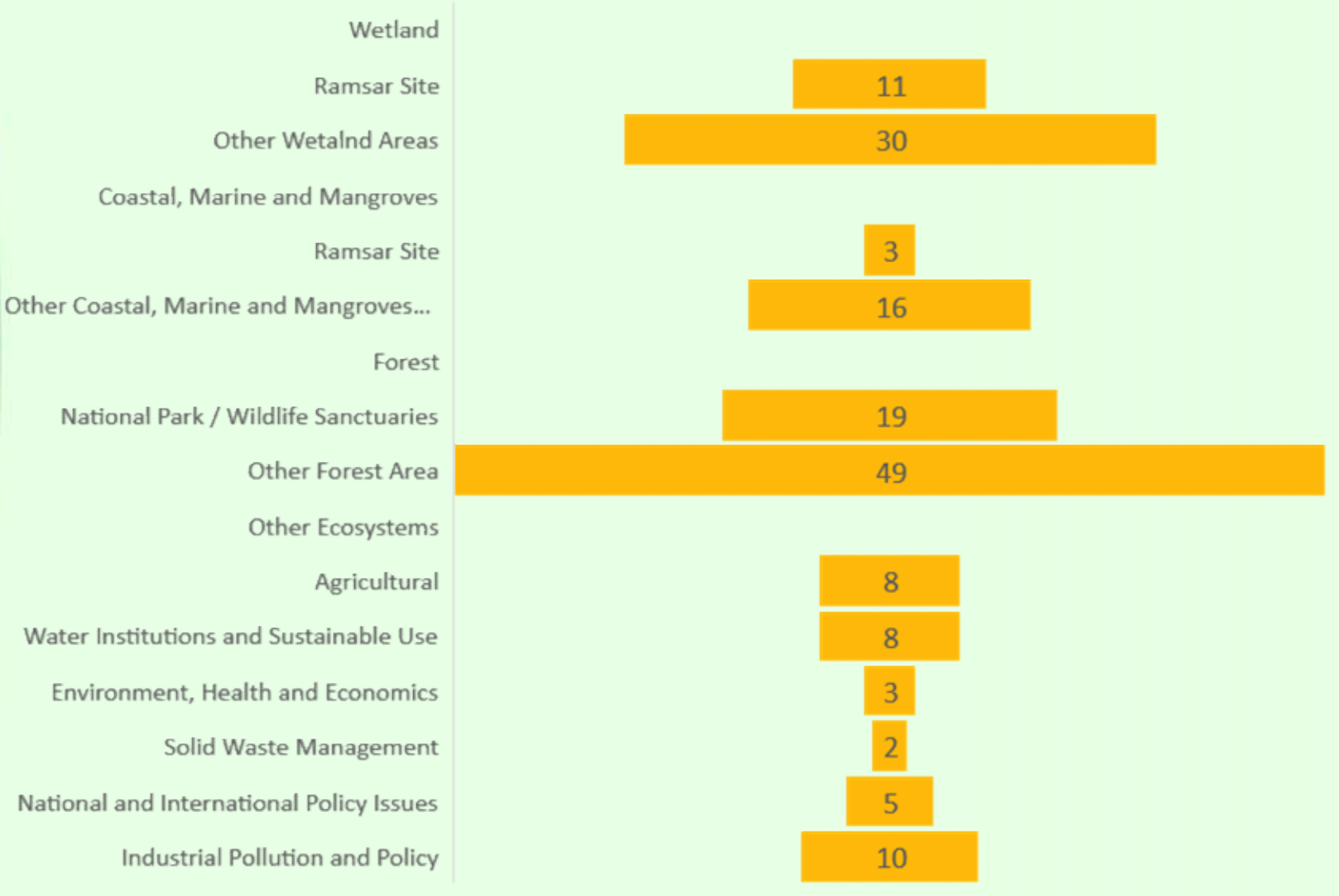
Wetland

Marine, Coastal and Mangroves

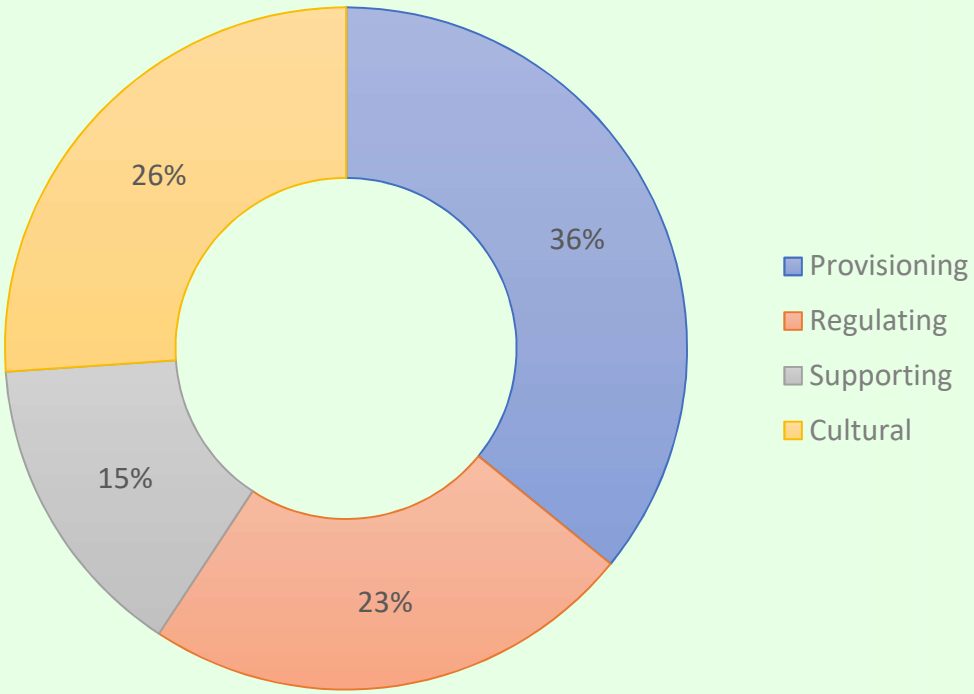
Other Ecosystems



Ecosystem wise analysis of studies – An Overview



Composition of coverage of studies for Forest Ecosystem



Mapping Ecosystem Services: Spatial Models

Spatial Models being used currently in India to Map Ecosystem Services (In Physical and Monetary Terms)

InVEST	SWAT (Soil and Water Assessment Tool)	Carbon Assessment FSI (based on IPCC Guidelines)
• Biophysical assessment and monetary value of Forest Ecosystem Services • A comprehensive GIS tool currently being used for mapping and is at nascent stage in India	• Biophysical Assessment (Stream Flow) • Watershed Management-Provisioning Services	• Biophysical assessment using National Forest Inventory : carbon Storage and Sequestration

National level ES valuation studies and Range of values

- Three major studies estimated ES values in Indian forests
- Verma et al. – Estimated ES value for different classes of forests
- World Bank – Estimated the upper and lower bounds from the Indian Green Accounting Study
- Bahuguna and Bisht – Estimated the values of goods and services based on other national and international studies

Authors	Title of study	Study period	Valuation technique	Total Forest ES Value (Billion USD / year)		
Verma M, Negandhi D, Wahal AK, Kumar R, Kinhal, G. A., and Kumar, A.	Revision of rates of NPV applicable for different class/category of forests	2013-2014	Stakeholder survey, Opportunity cost	207-800 (VDF)	607-2070 (MDF)	436-1200 (OF)
World Bank	Diagnostic Assessment of Select Environmental Challenges Valuation of Biodiversity and Ecosystem Services in India	2013	Benefit transfer		3 – 6	
V. K. Bahuguna And N. S. Bisht	Valuation of ecosystem goods and services from forests in India	2013	Market price, substitution cost, Travel cost, Opportunity cost		102	

Forest ES Valuation studies

Authors	Title of study	Location	Study period	Type of ES valuated	Valuation technique
Ruchi Badola, Syed Ainul Hussain, Bidyut Kumar Mishra, Bidyarani Konthoujam, Sneha Thapliyal, Parag Madhukar Dhakate	An assessment of ecosystem services of Corbett Tiger Reserve, India	Corbett Tiger Reserve, India	Various, 2004-2007	Provisioning, regulating, and cultural services	Travel cost, Replacement cost, Opportunity cost
Gunjan Joshi & Girish C.S. Negi	Quantification and valuation of forest ecosystem services in the western Himalayan region of India	Western Himalayas	Not mentioned	Provisioning and regulating services	Market price
K. N. Ninan, A. Kontoleon	Valuation of forest ecosystem services and disservices- Case Study of a protected area in India	Karnataka, Nagarhole National Park	2013	Provisioning, regulating and cultural services	Alternate cost, Hedonic pricing, Market price, Benefit transfer, Opportunity cost, Damage cost, Travel cost
Arun Pandit, A. Ekka, A. P. Sharma, B. K. Bhattacharjya, P. K. Katiha and D. K. Biswas	Economic valuation of natural ecosystems - an empirical study in a stretch of Bramhaputra River in Assam, North-east India	Assam	2012	Provisioning, regulating, supporting and cultural services	Market price, Revenue generation, Travel cost
Bhaskar Sinha, Sameera Mishra	Ecosystem services valuation for enhancing conservation and livelihoods in a sacred landscape of the Indian Himalaya	Indian Himalayas	2010	Cultural Services	Contingent valuation
Ravindranath, N.H., Gundimeda, H., & Murthy, I.K.	Valuation of Forest Ecosystem Services and Biodiversity in The Western Ghats Case Study in Uttara Kannada	Western Ghats	Various, 2014	Provisioning, regulating, supporting and cultural services	Market price, Benefit-transfer, Contingent valuation
Sukumar, R. & Pani, N.	The Economics and Efficacy of Elephant-Human Conflict Mitigation Measures in Southern India	Karnataka	Nov 2014-Jan 2015	Cultural Services	Benefit-transfer, Contingent valuation

Studies focussing on developing economic instruments

- Some of the studies that helped in filling gaps in the economic structure and analysis of ecosystem services

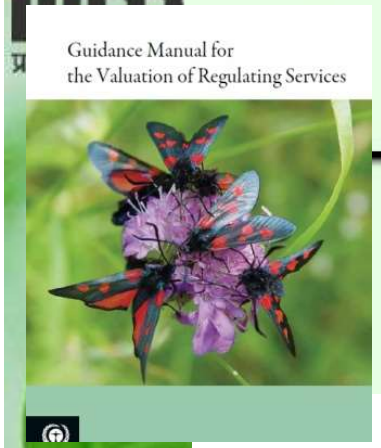
Authors	Title of study	Location	Study period	Type of ES valuated	Year published
Madhu Verma and Dhaval Negandhi	Desired institutional and legal environment for implementing PES mechanisms in India	India	-	Provisioning, regulating, supporting and cultural services	2011
R. B. Lal, Madhu Verma, Swapan Mehra, Priyanka Batra	Nuts and bolts for India's REDD+ calculus	India	-	Provisioning services	2011
K. N. Ninan, Makoto Inoue	Valuing forest ecosystem services: What we know and what we don't	India	-	Provisioning, regulating, supporting and cultural services	2013
LEAD India	Valuing ecosystem services flowing from the Himalayan states for incorporation into national accounting	Himalayan States	-	Provisioning, regulating, supporting and cultural services	2013
Ruchi Badola, Syed Ainul Hussain, Pariva Dobriyal & Shivani Barthwal	Assessing the effectiveness of policies in sustaining and promoting ecosystem services in the Indian Himalayas	Himalayan Regions	1927-2008	Provisioning, regulating, supporting and cultural services	2015
S. Ferrier, K N Ninan, P.Leadely, R. Alkemade and others (eds)	The Methodological Assessment of Scenarios and Models of Biodiversity and Ecosystem Services	India	-	Provisioning, regulating, supporting and cultural services	2016

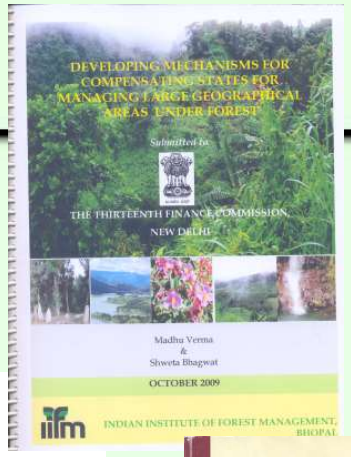
Ecosystem Service Valuation studies in Indian Forest (National, Regional and State-level)

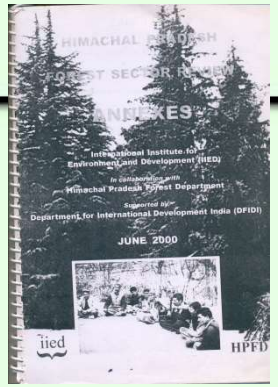
Forests

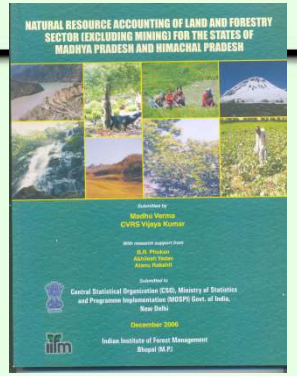
S. No	Dataset	Data source
1	Natural Capital (Timber, NTFP etc.)	FSI and FRI National Level studies, Local Studies
2	Carbon Data	FSI, Studies by Local Institutions, Primary data by sampling
3	Soil Data	Primary Data, Secondary data from: Indian Institute of Soil Science, Central Soil Salinity Research Institute
4	Land Use Land Cover	USGS and ISRO, FSI, WII
5	Administrative boundary	Survey of India, Individual Protected areas, State Forest Departments
6	Meteorological data	Indian Meteorological Department
7	Demographic and other data	CSO, Census report of India, National statistical office, Department of Economic Affairs.
8	Ecotourism	State Tourism Department
9	Pollution Data	CPCB, SPCB

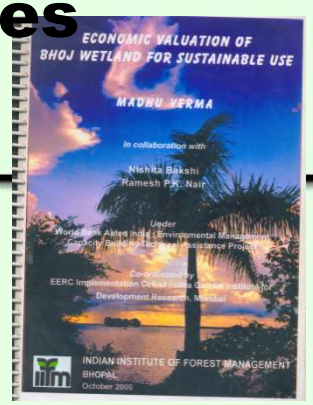
CESM-IIFM's Studies on Valuation and Accounting of Ecosystem Services

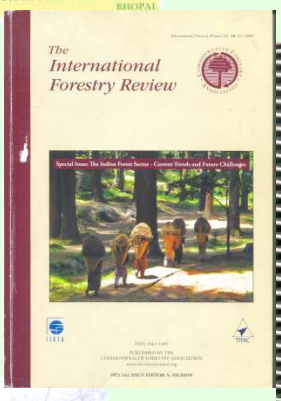


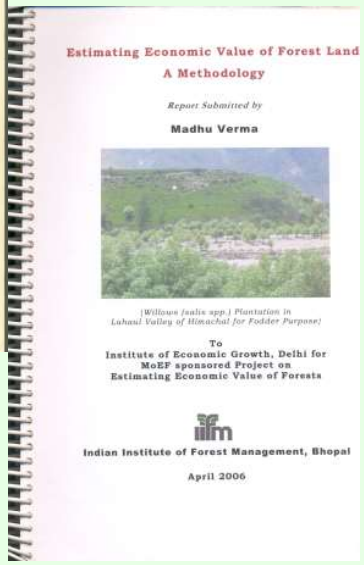


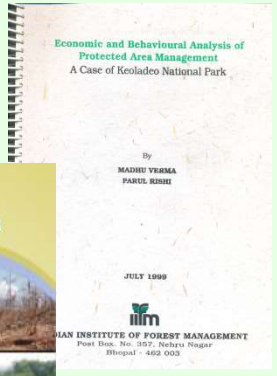


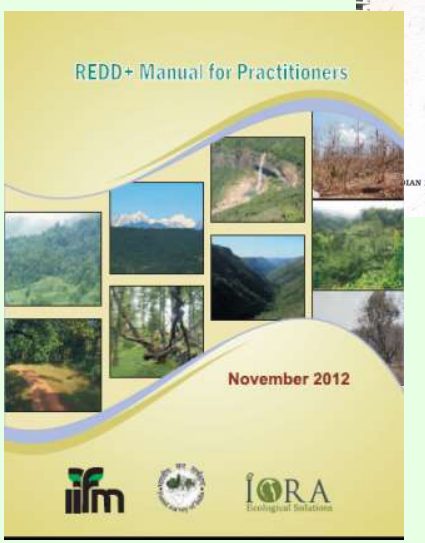


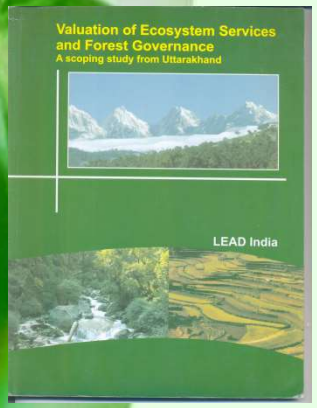


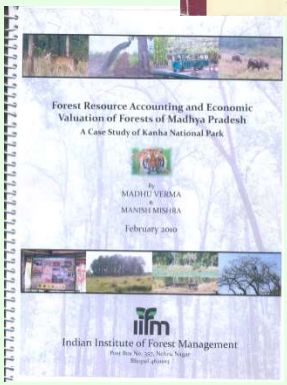










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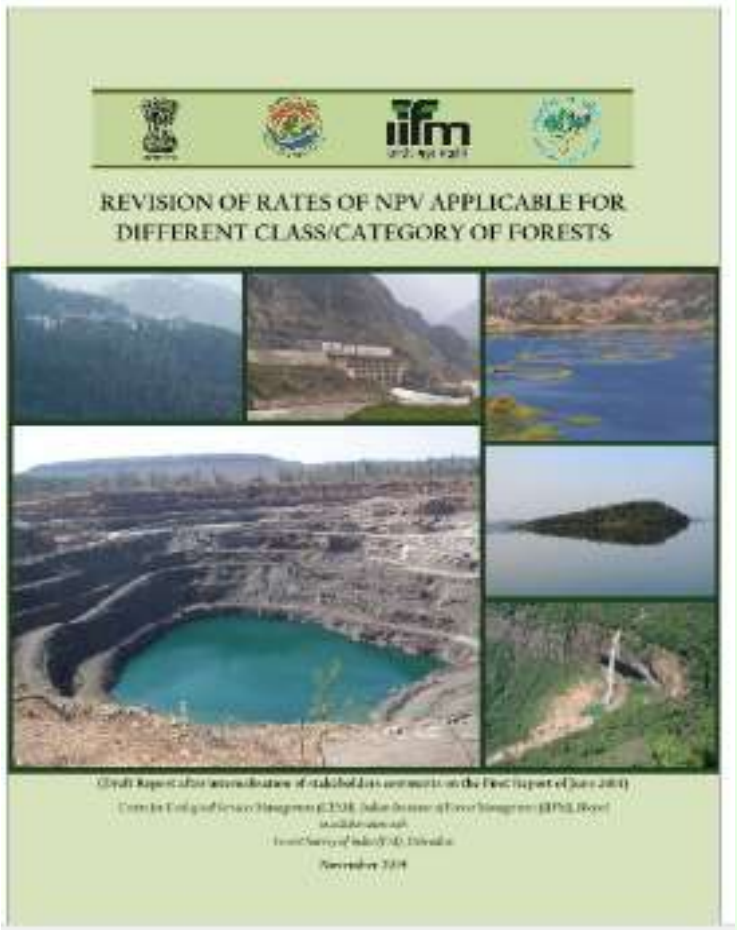
प्रगतेः मूलं प्रकृतिः
REVISION OF RATES OF NPV APPLICABLE FOR DIFFERENT CLASS/CATEGORY OF FORESTS
Centre for Ecological Services Management (CESM), Indian Institute of Forest Management (IIFM), Bhopal
in collaboration with
Forest Survey of India (FSI), Dehradun
June 2013
Guidelines of cost-benefit analysis for forest diversion
Centre for Ecological Services Management,
Indian Institute of Forest Management
High Conservation Value Forests:
An Instrument for Effective Forest Fiscal Federalism in India
Draft Report on
Ecosystem
Services Valuation and Accounting of
Himachal Forests
Lead Authors
Madhu Verma
R.B. Lal
Geetanjali Shahi
Contributing Authors
Dhaval Negandhi
Chandan Khanna
Submitted to
Himachal Pradesh Forest Department, Shimla
Executed by
Centre for Ecological Services Management,
Indian Institute of Forest Management
January 2013
ECONOMIC VALUATION OF TIGER RESERVES IN INDIA
A VALUE+ APPROACH
JANUARY 2015
Centre for Ecological Services Management (CESM),
Indian Institute of Forest Management, Bhopal
VALUATION OF ECOSYSTEM SERVICES FROM TIGER AND SNOW LEOPARD LANDSCAPES
A manual on economic valuation approaches for practitioners
Executed by
Centre for Ecological Services Management,
Indian Institute of Forest Management, Bhopal, India
"With the support of"
GTF
GTI Council
WORLD BANK GROUP
Wildlife Conservation Trust
WWF

International Processes & Reports

- Responses Working Group of the Millennium Ecosystem Assessment (MA),Contributing Authour for Chapter 10 (2005)
- The Economics of Ecosystems and Biodiversity (TEEB), Chapters in DO & D1 Reports funded by UNEP, DEFRA, European Union, Federal Ministry of Environment, Nature Conservation and Nuclear Safety (2009–2010).
- Inter Governmental Policy Platform for Biodiversity and Ecosystem Services (IPBES) : UNEP Initiative (2012…)
- Building regional and technical capacity for economic valuation of tiger landscapes in select Tiger and Snow Leopard range countries. Global Tiger Forum
- Preliminary guide regarding diverse conceptualization of multiple values of nature and its benefits, including biodiversity and ecosystem functions and services. DECEMBER 2014.
- Global Assessment of Biodiversity and Ecosystem Services – under process (IPBES)

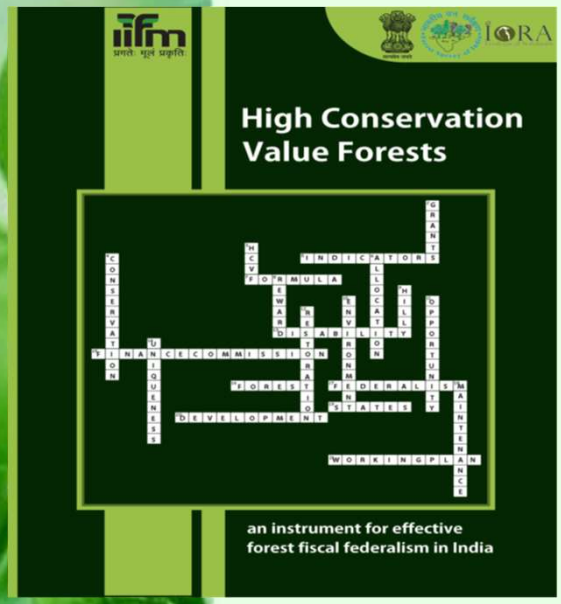
Revision of Rates of NPV Applicable for Different Class/Category of Forests (2014): MOEFCC



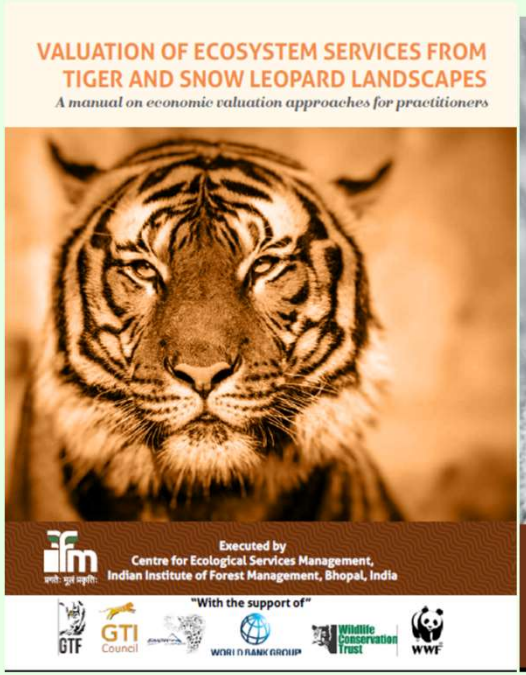
Proposed and Currently Prevalent NPV Rates (in ₹ Lakhs/ha); figures in parenthesis indicate %change w.r.t. current rates	VDF		MDF		OF	
NPV Rates	Proposed	Current	Proposed	Current	Proposed	Current
Tropical Wet Evergreen Forests – North East	₹ 38.85	₹ 10.43	₹ 21.27	₹ 9.39	₹ 19.03	₹ 7.30
	[272%]		[127%]		[161%]	
Tropical Wet Evergreen Forests – Western Ghats	₹ 43.34	₹ 10.43	₹ 31.31	₹ 9.39	₹ 14.22	₹ 7.30
	[316%]		[233%]		[95%]	
Tropical Semi Evergreen Forests - North East	₹ 23.62	₹ 10.43	₹ 17.78	₹ 9.39	₹ 9.87	₹ 7.30
	[126%]		[89%]		[35%]	
Tropical Semi Evergreen Forests - Eastern Deccan	₹ 55.55	₹ 10.43	₹ 45.68	₹ 9.39	₹ 26.97	₹ 7.30
	[433%]		[386%]		[269%]	
Tropical Semi Evergreen Forests - Western Ghats	₹ 33.89	₹ 10.43	₹ 23.66	₹ 9.39	₹ 15.44	₹ 7.30
	[225%]		[152%]		[112%]	
Tropical Moist Deciduous Forests	₹ 30.32	₹ 10.43	₹ 22.25	₹ 9.39	₹ 13.55	₹ 7.30
	[191%]		[137%]		[86%]	
Littoral & Swamp Forests	₹ 49.02	₹ 10.43	₹ 35.12	₹ 9.39	₹ 22.58	₹ 7.30
	[370%]		[274%]		[209%]	
Tropical Dry Deciduous Forests	₹ 25.08	₹ 8.87	₹ 18.62	₹ 8.03	₹ 11.17	₹ 6.26
	[183%]		[132%]		[78%]	
Tropical Thorn Forests	₹ 14.37	₹ 6.26	₹ 13.41	₹ 5.63	₹ 10.57	₹ 4.38
	[130%]		[138%]		[141%]	
Tropical & Subtropical Dry Evergreen Forests[3]	₹ 28.38	₹ 7.83	₹ 21.43	₹ 7.04	₹ 13.24	₹ 5.47
	[262%]		[204%]		[142%]	
Subtropical Pine/Broadleaved Hill Forests	₹ 22.74	₹ 9.39	₹ 17.97	₹ 8.45	₹ 11.63	₹ 6.57
	[142%]		[113%]		[77%]	
Montane & Moist Temperate Forest	₹ 30.14	₹ 9.91	₹ 23.78	₹ 8.97	₹ 13.54	₹ 6.99
	[204%]		[165%]		[94%]	
Sub Alpine & Dry Temperate Forest	₹ 25.29	₹ 9.91	₹ 20.07	₹ 8.97	₹ 11.29	₹ 6.99
	[155%]		[124%]		[62%]	
Alpine Scrub	₹ 27.23	₹ 9.91	₹ 19.14	₹ 8.97	₹ 10.70	₹ 6.99
	[175%]		[113%]		[53%]	

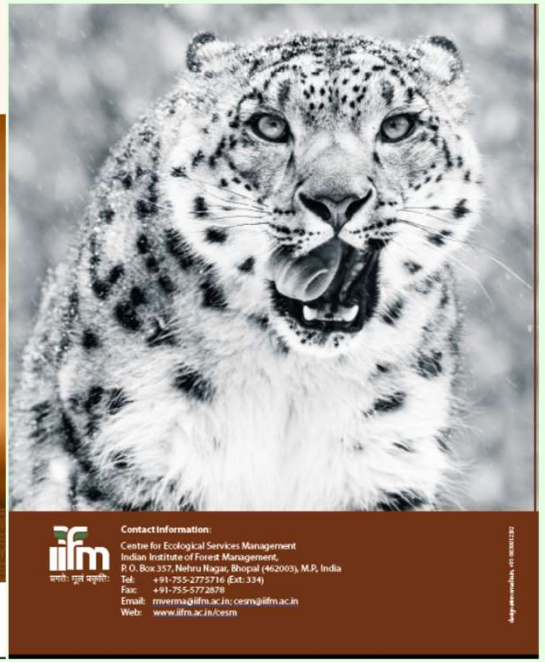
Revision of Rates of NPV Applicable for Different Class/Category of Forests (2014): 14th Finance Commission

XIV FC assigned 7.5 per cent weight asper Horizontal Devolution Formula, to the forest cover.



Formula used by the XIII Finance Commission		Suggested formula for the XIV Finance Commission by incorporating the HCVF Index Score	
$G_i = \frac{\left[\left\{\frac{F_i}{\sum F_i} + R_i\right\} \times \left\{1 + \left(\frac{M_i + 2H_i}{A_i}\right)\right\}\right]}{\sum_{i=1}^{n}\left\{\frac{F_i}{\sum F_i} + R_i\right\} \times \left\{1 + \left(\frac{M_i + 2H_i}{A_i}\right)\right\}}$		$G_i = \frac{\left(\left[\left\{\frac{F_i}{\sum F_i} + \boldsymbol{R_i}\right\} \times \left\{1 + \left(\frac{M_i + 2H_i}{\boldsymbol{C_i}}\right)\right\}\right] + \frac{\boldsymbol{HCVF_i}}{\sum \boldsymbol{HCVF_i}}\right)}{\sum_{i=1}^{n}\left(\left[\left\{\frac{F_i}{\sum F_i} + \boldsymbol{R_i}\right\} \times \left\{1 + \left(\frac{M_i + 2H_i}{\boldsymbol{C_i}}\right)\right\}\right] + \frac{\boldsymbol{HCVF_i}}{\sum \boldsymbol{HCVF_i}}\right)}$	
G_i	Share for state *i*	G_i	Share for state *i*
A_i	Geographical area of state *i*	A_i	Geographical area of state *i*
F_i	Total forest cover of state *i*	F_i	Total **recorded forest area** of state *i*
M_i	Moderately dense forest area of state *i*	M_i	Moderately dense forest area of state *i*
H_i	Highly dense forest area of state *i*	H_i	Highly dense forest area of state *i*
R_i	$max\left[0, \left\{\frac{F_i}{A_i} - \frac{\sum F_i}{\sum A_i}\right\}/100\right]$	R_i	$max\left[0, \left\{\frac{F_i}{A_i} - \frac{\sum F_i}{\sum A_i}\right\}/\mathbf{10}\right]$
n	Number of States i.e. 28	$\boldsymbol{C_i}$	**Forest cover of state *i***
		$\boldsymbol{HCVF_i}$	**High conservation value forest index of state *i***
		n	Number of States i.e. 28



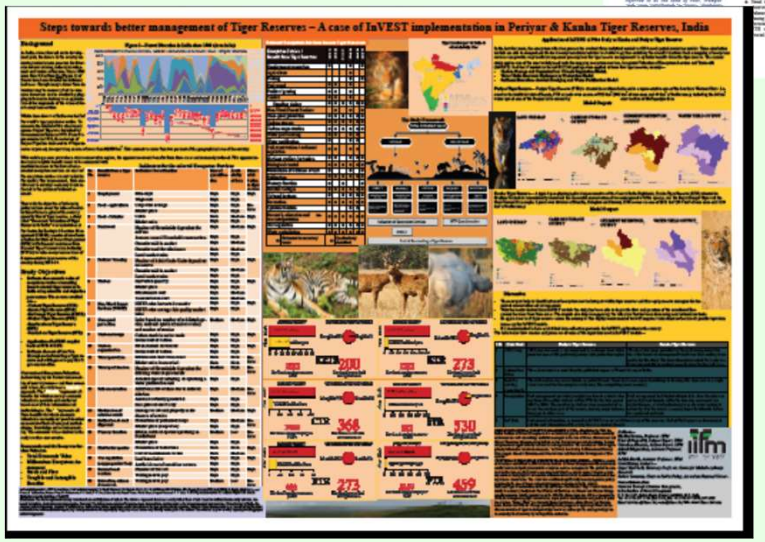


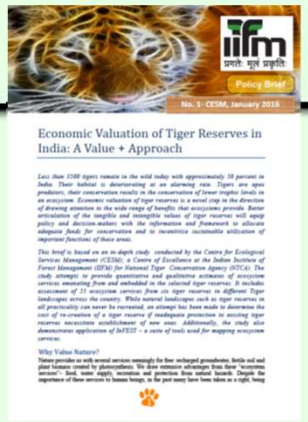
Launch : 24/08/2017 at ISLECF, Bishkek, Kyrgyzstan

A. Economic Valuation of Tiger Reserves in India: A Value+ Approach

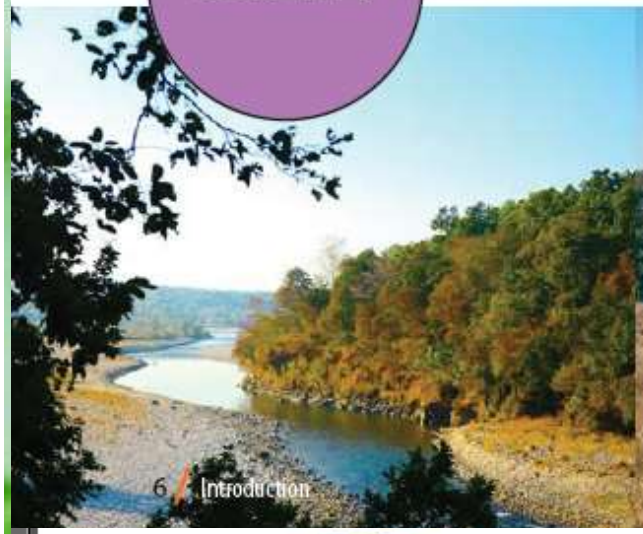
Study Outputs

- Main Report
- Overall Policy Brief
- Tiger Reserve wise Policy Briefs
- One page Information Sheet for GTF
- Standee for 3rd AMC
- Poster for NATCAP workshop on InVEST Models in Stanford University in March 2013





CORBETT



KANHA

KAZIRANGA

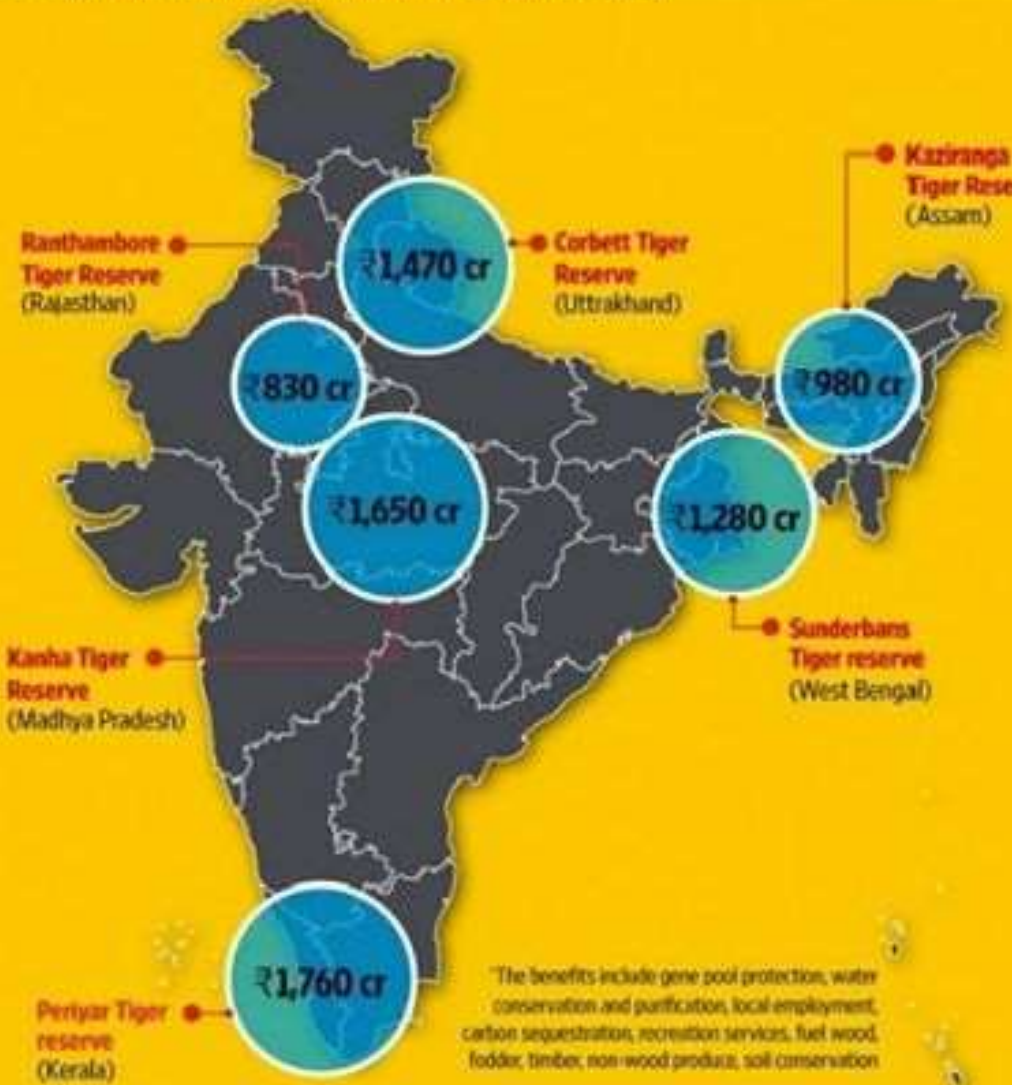
RANTHAMBORE

PERIYAR

SUNDARBANS

WHAT TIGER RESERVES ADD TO THE ECONOMY

A study 'Economic Valuation of Tiger Reserves' released on Tuesday shows that six tiger reserves provide economic benefits* worth ₹8,000 crore a year



*The benefits include gene pool protection, water conservation and purification, local employment, carbon sequestration, recreation services, fuel wood, fodder, timber, non-wood produce, soil conservation

ALL-INDIA TIGER ESTIMATES

Shivalik-Gangetic Plains Landscape Complex	2006	2010	2014
Uttarakhand	178	227	340
Uttar Pradesh	109	118	117
Bihar	10	8	28
Shivalik-Gangetic	297	353	485
Central Indian Landscape Complex and Eastern Ghats Landscape Complex			
Andhra Pradesh (including Telangana)	95	72	68
Chhattisgarh	26	26	46
Madhya Pradesh	300	257	308
Maharashtra	103	169	190
Odisha	45	32	28
Rajasthan	32	36	45
Jharkhand	-	10	3+
Central India	601	601	688
Western Ghats Landscape Complex			
Karnataka	290	300	406
Kerala	46	71	136
Tamil Nadu	76	163	229
Goa	-	-	5
Western Ghats	402	534	776
North Eastern Hills and Brahmaputra Flood Plains			
Assam	70	143	167
Arunachal Pradesh	14	-	28
Mizoram	6	5	3+
Northern West Bengal	10	-	3
North East Hills, and Brahmaputra	100	148	201
Sunderbans	-	70	76
TOTAL	1,411	1,706	2,226

Source: Government of India

Graphic: Yatish Asthana/Mint

M2

Ecosystem Services from Tiger Reserves

Flow Benefits | Stock Benefits

Gene-pool protection	Habitat / refugia
Water provisioning	Waste assimilation
Fisheries	Carbon sequestration
Water purification	Pollination
Recreation	Biological control
Timber	Standing Timber
Gas regulation	Moderation of extreme events
Nutrient cycling	Carbon storage
Soil conservation	Non-Wood Forest Produce
Nursery function	Agriculture
Cultural heritage	Employment generation
Spiritual tourism	Research and nature interpretation
Fodder / grazing	Fuel wood

* Ecosystem Services Symbols from www.teebweb.org

Slide 27

M2 add icon

Madhu, 12-04-2016

Ecosystem service wise methodology

Ecosystem service / Benefit from Tiger Reserve	Methodology / Indicator
Employment generation	Number of man-days generated
Agriculture	Value of agriculture produce
Fishing	Value of fish catch
Fuel wood	Quantity of fuel wood collected
Fodder / Grazing	Dependent Adult Cattle Units
Timber	Quantity harvested
Standing Timber	Growing stock
Non-Wood Forest Produce	Quantity harvested
Gene-pool protection	Benefits Transfer (land cover)
Carbon storage	Carbon stock in 5 pools
Carbon sequestration	Growing stock
Water provisioning	Agriculture Production Function / Water Recharge
Water purification	Avoided cost of water purification

Ecosystem service wise methodology

Ecosystem service / Benefit from Tiger Reserve	Methodology / Indicator
Soil conservation	Soil erosion; cost of excavation
Nutrient cycling / retention	Nutrient loss (NPK); cost of fertilizers
Biological control	Benefits Transfer (land cover)
Moderation of extreme events	Avoided damage to life and property
Pollination	Benefits Transfer (land cover)
Nursery function	Production Function
Habitat / refugia	Benefits Transfer (land cover)
Cultural heritage	Qualitative description
Recreation	Travel Cost Method; Consumer Surplus
Research and education	Qualitative description; number of studies
Gas regulation	Benefits Transfer (land cover)
Waste assimilation	Avoided cost of waste treatment plant / Benefits Transfer (land cover)

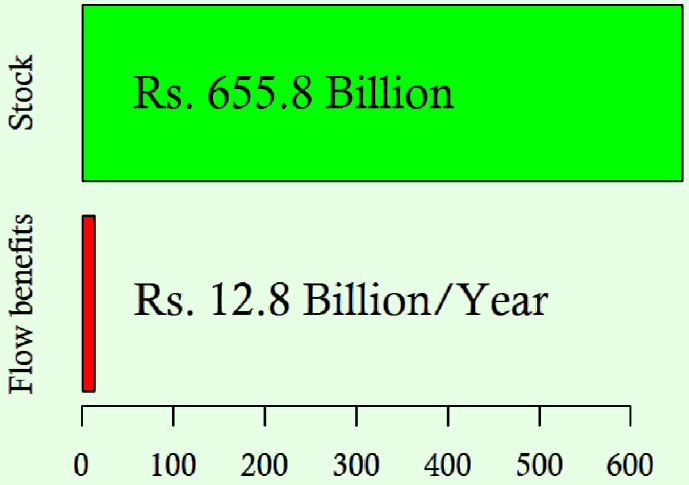
Benefits and Beneficiaries

- Total Stock Value* : Rs. 1,60,000 Crores (US$ 25 bn)
- Total Annual Flow Value* : Rs. 7967 Crores (US$1.2 bn);
  - Rs. 50,000 to 190,000 (US$ 770–2920) per ha
- 96% of Benefits are used but not paid for
- Investment Multiplier: 200 to 530
- 90% benefits to National and Global beneficiaries
- Recipients of benefits from Tiger Reserves
  - Villages, Agriculture, Cities, Industries, Global

* From Six Tiger Reserves

Sundarbans Tiger Reserve

STOCK & FLOW



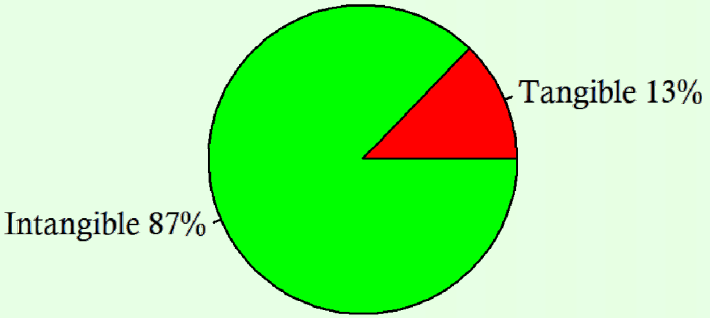
Flow benefits per hectare per year (Rs. Lakh)

0.5

Flow benefits as a ratio of management costs

530

TANGIBLES & INTANGIBLES



Major Ecosystem Services from STR

Nursery function: Rs. 5.17 billion p.a.

Gene-pool protection: Rs. 2.87 billion p.a.

Provisioning of fish: Rs. 1.6 billion p.a.

Waste assimilation: Rs. 1.5 billion p.a.

Other Ecosystem Services from STR

Moderation of cyclonic storms: Rs. 275 million p.a.

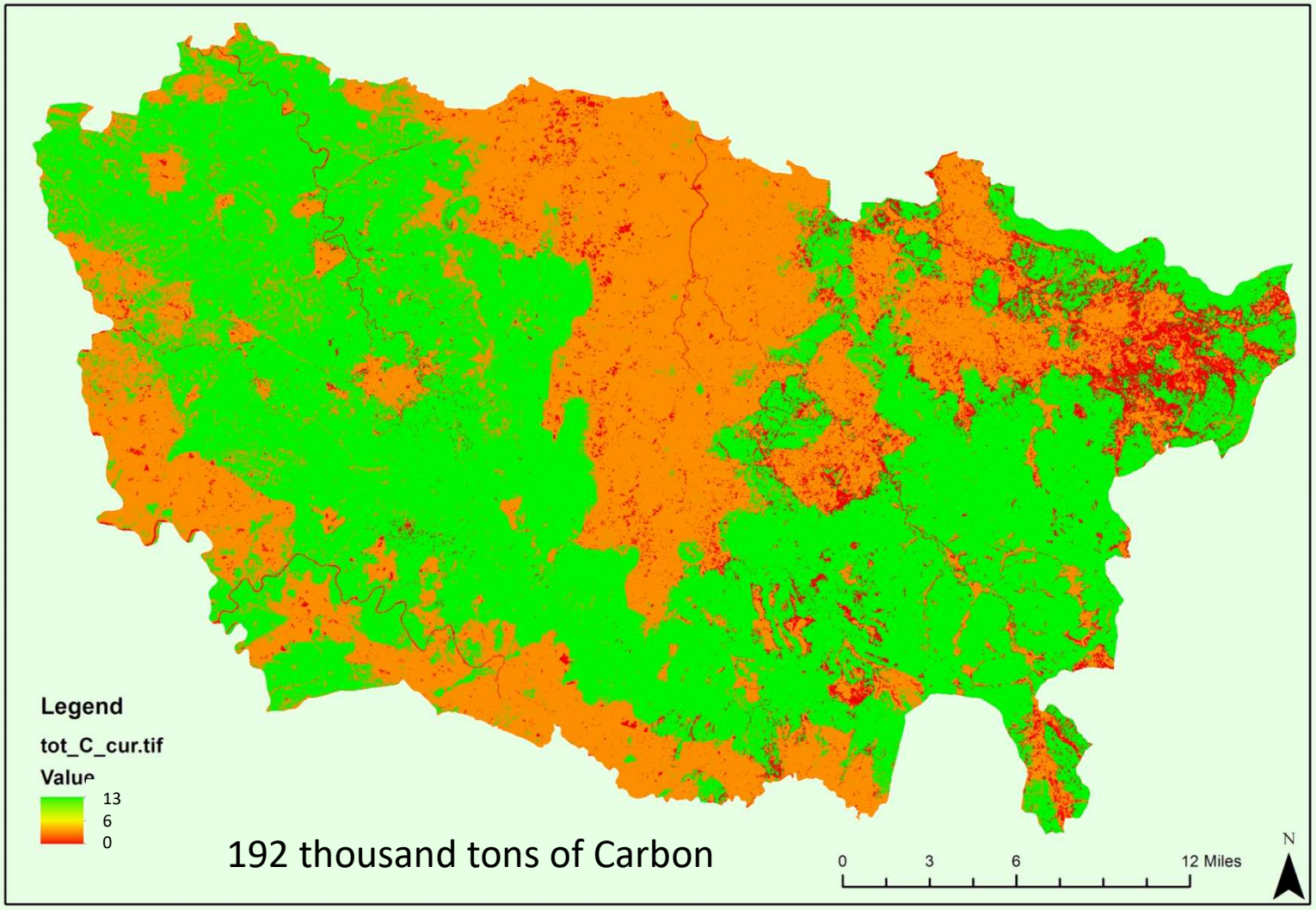
Carbon sequestration: Rs. 462 million p.a.

Mapping Ecosystem Services: InVEST

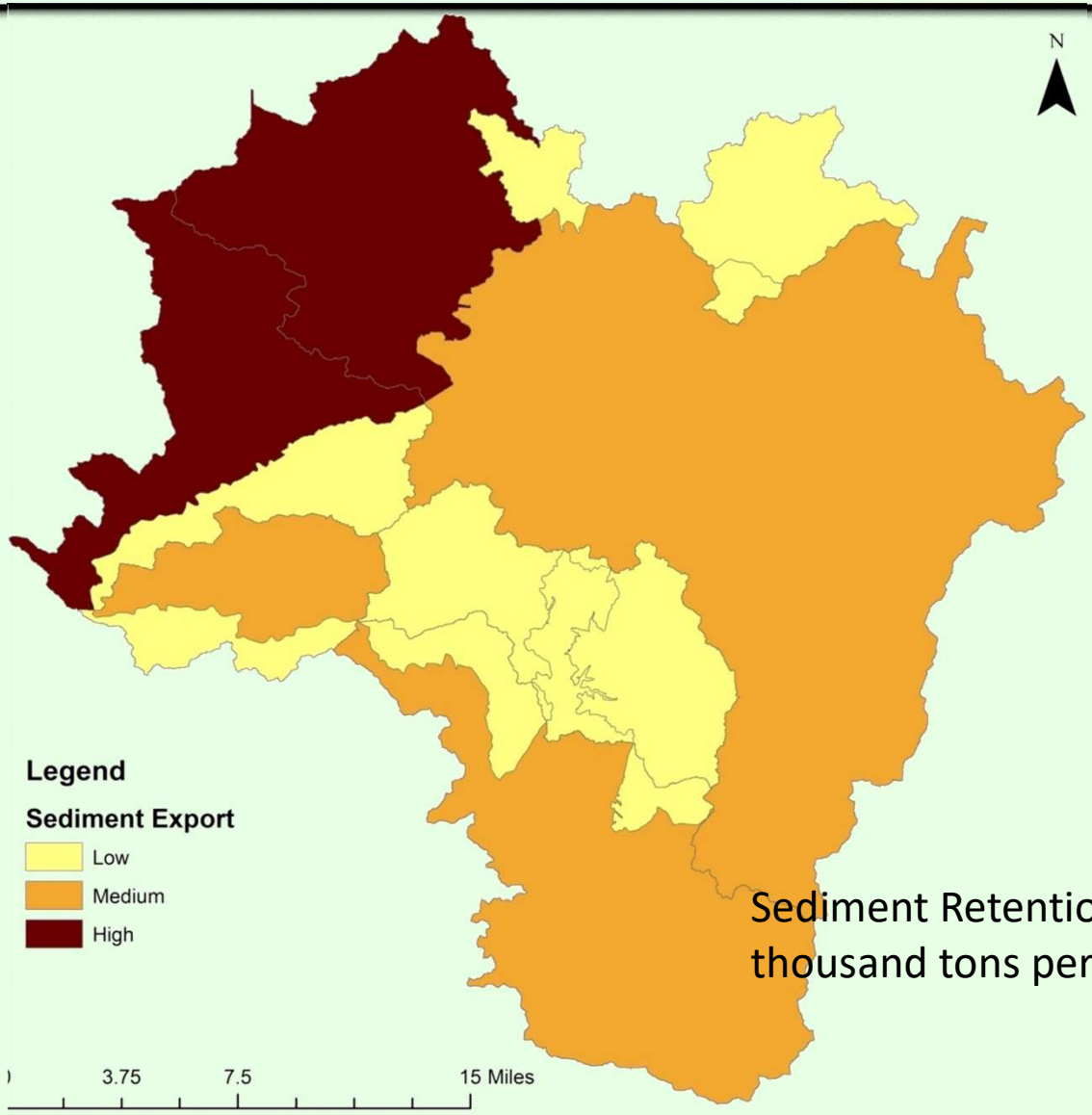
(In collaboration with the Woods Institute for Environment, Stanford University, USA)

- A suite of software models to map and value the goods and services from nature
- Mapping of 3 ecosystem services (Carbon storage, Water yield, Sediment retention) at 2 tiger reserves : Kanha and Periyar
- Identifying ecosystem service hotspots where investment in natural capital can enhance human development and conservation.
- Useful management prescriptions but data hungry

Carbon Storage – Kanha

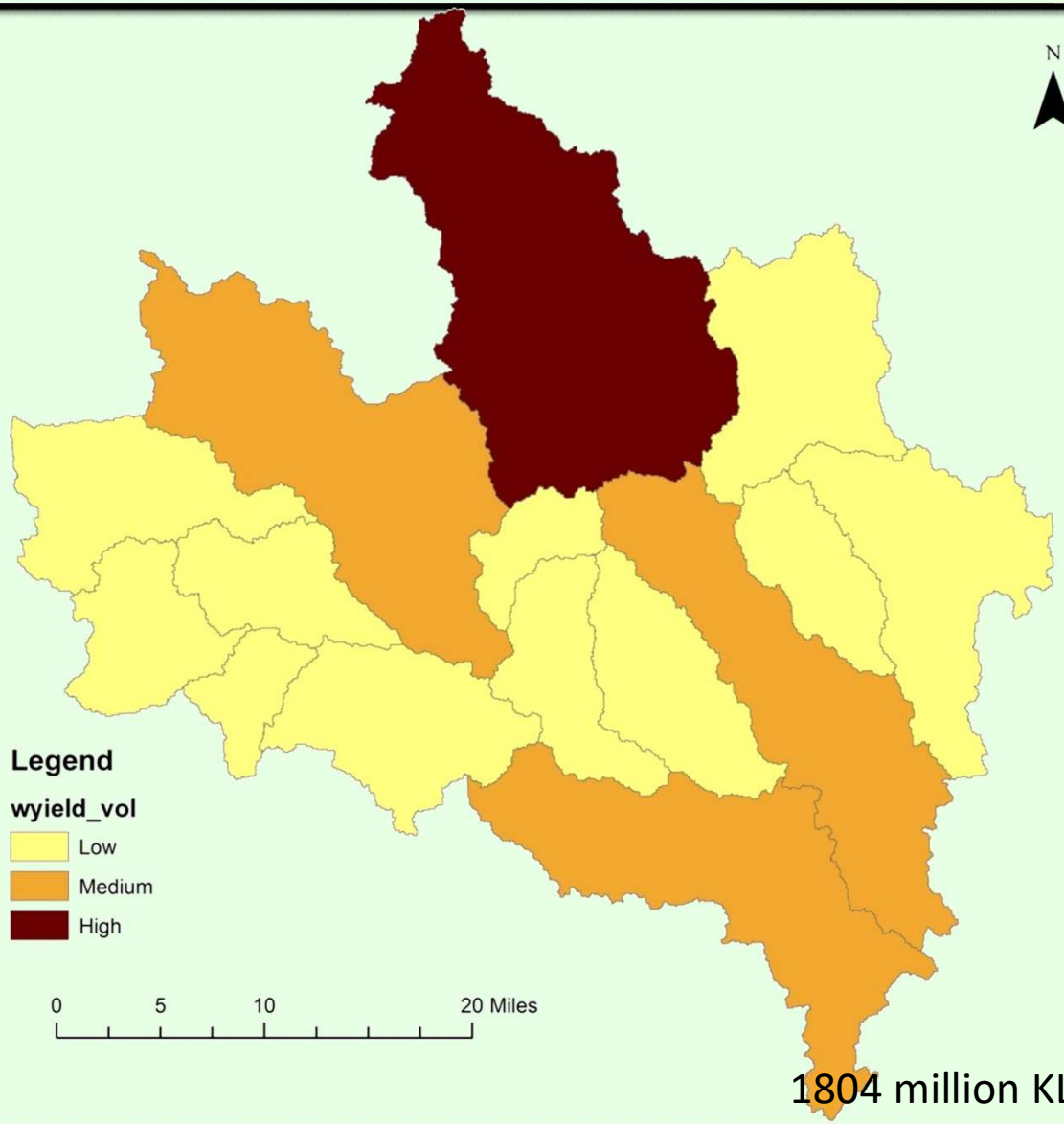


Sediment Retention – Periyar



Sediment Retention = 18,573 thousand tons per annum

Water Yield – Kanha



1804 million KL per annum

Recreating a Tiger Reserve

- Cost of inaction; impossible to re-create
- Assessment in for a patch of 1000 km^2 in Pilibhit-Dudhwa (only few costs included)
  - ₹500 billion (US$7.7 billion)

Conservation of genetic repository not guaranteed

Summary of Costs

Sr. No.	Head	Cost (Rs. Crores)
1	Land Acquisition	38,533.00
2	Rehabilitation & Resettlement	10,102.00
3	Habitat Development	498.27
4	Park Fencing	0.43
5	Infrastructure	46.11
6	Tourism (Excluding Buildings)	0.70
Total		49,180.51 (7.7 B$)

Thanks