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Natural Capital of Wetlands

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Natural Capital of Wetlands
Synthesis of the Wetlands Thematic Area of TII (The Economics of Ecosystems and Biodiversity India Initiative)

Supported by
Ministry of Environment, Forest and Climate Change, Government of India
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Natural Capital of Wetlands

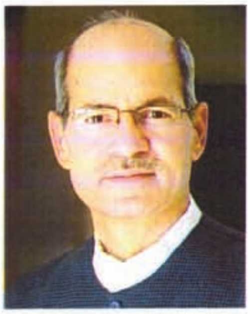
Synthesis of the Wetlands Thematic Area of TII (The Economics of Ecosystems and Biodiversity India Initiative)

January 2017

अनिल माधव दवे
Anil Madhav Dave

सत्यमेव जयते

राज्य मंत्री (स्वतंत्र प्रभार)
MINISTER OF STATE (INDEPENDENT CHARGE)
पर्यावरण, वन एवं जलवायु परिवर्तन
ENVIRONMENT, FOREST & CLIMATE CHANGE
भारत सरकार / GOVERNMENT OF INDIA



MESSAGE

Water is life, and wetlands are the life support systems that ensure optimal functioning of water cycle. India is endowed by a rich diversity of wetlands, ranging from high altitude wetlands of Himalayas, floodplains of mighty rivers such as the Ganga and Brahmaputra, lagoons and mangrove marshes on the coastline and reefs in the marine environment.

Despite their tremendous value, wetlands are also one of the most rapidly degrading ecosystems. At the crux of wetland degradation is limited consideration in developmental programming, for the value of their wide-ranging ecosystem services and biodiversity. While the more tangible provisioning services of wetlands are well recognized, the relatively intangible services such as regulating functions of wetlands are seldom recognized. The lop-sided developmental programming, therefore, creates a range of drivers and pressures on fragile wetland ecosystems.

The Economics of Ecosystems and Biodiversity – India Initiative (TII) was launched by our Ministry with the support of the German Federal Ministry for Economic Cooperation and Development (BMZ). This was done aiming at highlighting the economic consequences of biodiversity loss and associated decline in ecosystem services. TII has focused on inland wetlands, forests and coastal and marine ecosystems. Economic valuation tools have been applied to make the values of these ecosystems explicit in economic terms, and to help develop strategies for mainstreaming these values in broader developmental programming.

Valuation is an important means of expressing linkages of human societies with natural resources, their ecosystem services and biodiversity. It provides a tool for self-reflection, alerting us to the consequences of our choices and behaviour on various dimensions of both human and natural capital.

I am pleased to observe that TII has supported nine pilot projects wherein wetland ecosystem services were assessed and recommendations for conservation and wise use derived. The results of the pilot studies have been synthesized in the form of a report for the use of conservation planners and decision makers.

I congratulate the study team for undertaking this important endeavour.

Date: 19-1-2017
Place: Delhi

(Anil Madhav Dave)

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अजय नारायण झा
AJAY NARAYAN JHA, IAS

सत्यमेव जयते

सचिव
भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
Secretary
Government of India
Ministry of Environment, Forest and Climate Change

FOREWORD

Wetland ecosystems play a critical role in ensuring our food, water and climate security. Wetlands help stabilize water supplies, cleanse polluted waters, protect shorelines, recharge groundwater, store carbon and provide buffer against extreme events. Yet, these ecosystems are under threat from a number of anthropogenic and non-anthropogenic drivers and pressures, thereby undermining their wide ranging ecosystem services and biodiversity values. Degradation and loss of wetlands have distinct economic consequences which are unfortunately underestimated leading to less than satisfactory conservation of these important ecosystems.

The TII (The Economics of Ecosystems and Biodiversity – India Initiative) was launched by the Ministry of Environment, Forest & Climate Change in 2011 as an effort to highlight the economic consequences of loss of our biological diversity and ecosystem services. TII envisioned mainstreaming ecosystem services and biodiversity values in developmental programming being pursued within states and at national level. The focus of TII was on three priority ecosystems: wetlands, coastal and marine, and forest ecosystems

The TII, in variance with similar initiatives being undertaken in other countries, has used an evidence building approach in the form of pilot projects to highlight pathways for using economic arguments to address policy issues related with conservation and wise use of wetlands. Within nine wetland sites, multidisciplinary teams have looked into the ways in which ecosystem services and biodiversity values could be used to address policy issues related to wetland restoration, land use planning and regulation, integrated water resources management, property rights and distribution of costs and benefits, role of market based instruments, and financing. The outputs of these pilot projects have been placed in the national context in the form of a sectoral synthesis report.

I would like to thank Dr. Amita Prasad (Additional Secretary, MoEFCC), the Federal Ministry for Economic Cooperation and Development (BMZ), Government of the Federal Republic of Germany and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH for their support to the TII process. I put on record my appreciation for the time and effort of the Scientific and Technical Advisory Group (under Chairmanship of Dr Kirit Parikh) in providing strategic guidance to the initiative and ensuring policy connect in the pilot projects. I congratulate the synthesis lead authors, Dr. Ritesh Kumar (Wetlands International South Asia), Mr. Shantanu Goel (GIZ) and Dr. J.R. Bhatt (Advisor, MoEFCC) for cogently analyzing each of the pilot project outcomes in the context of overall management challenges faced in planning for wetland conservation and wise use in the country. I also congratulate all the contributing authors for implementing pilot projects and developing specific recommendations for improving integration of wetland biodiversity and ecosystem services values in planning and decision making at various levels.

I hope that the findings of TII will be used to strengthen delivery of national and state level programmes for conserving wetlands.

Date: 25-1-2017
Place: Delhi

(A.N. Jha)

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1. Introduction

Late Ashwin Pomal

Flamingoes at Flamingo City, Anda Bet, Kachchh, Gujarat

- Wetlands underpin societal well-being through their wide ranging ecosystem services and biodiversity values, yet continue to be under threat from a number of natural and human induced drivers and pressures.
- Making the value of wetlands visible to society creates an evidence base for more targeted and cost-effective management solutions.
- TII uses an evidence building approach for demonstrating the use of economic approaches for mainstreaming wetland ecosystem services and biodiversity values in development programming.

Purpose and scope

Wetlands underpin societal well-being in a number of ways, yet are under threat from a range of anthropogenic, and non-anthropogenic drivers and pressures. As public goods, a large category of wetland ecosystem services and biodiversity values are not factored in decision-making, thereby resulting in wetlands being converted for alternate uses. The resultant losses in ecosystem services and biodiversity have direct economic consequences, which are unfortunately underestimated. Making the value of wetlands visible to society creates an evidence base for more targeted and cost-effective solutions to secure continued functioning of these ecosystems.

The Economics of Ecosystems and Biodiversity - India Initiative (TII) was launched in 2010 by the Ministry of Environment, Forest and Climate Change, (the then Ministry of Environment and Forests) Government of India (MoEFCC, GoI) to highlight economic consequences of loss of biological diversity and decline in ecosystem services. The initiative envisioned mainstreaming of ecosystem services and biodiversity values in developmental programming using an evidence building approach for three ecosystem types, namely inland wetlands, forests and coastal and marine ecosystems. Implementation of TII was led by MoEFCC in collaboration with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) Gmbh under Indo-German Development Cooperation.

TII was structured on the lines of international TEEB (The Economics of Ecosystems and Biodiversity). Initiated in 2007 by the G8 and five major developing economies (India, Brazil, China, Mexico and South Africa), the international TEEB study compiled and presented a compelling case for the economic basis for conservation of ecosystems and biodiversity. TEEB aimed at analyzing the global economic benefits of biological diversity, the costs of the loss of biodiversity, and the failure to take protective measures versus the costs of effective conservation. The study recommended a structured approach for valuation in order to help decision-makers recognize the wide range of benefits provided by ecosystems and biodiversity, demonstrate their values in economic terms and, where appropriate, suggest how to capture those values in decision-making (TEEB, 2010).

TEEB outcomes contribute to several international processes and commitments, in particular the Convention on Biological Diversity (CBD) Strategic Plan for Biodiversity 2011-2020, which recognizes the importance of economic valuation of biodiversity for "addressing the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society" (Strategic Goal A). The following three Targets under Strategic Goal A deserve specific mention:

Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

Target 3: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio-economic conditions.

While adopting the international TEEB approach, TII implementation was based on evidence building pilots for the three ecosystem types, namely forests, wetlands and coastal and marine ecosystems. Pilot projects were commissioned for 14 sites in order to assess feasibility of application of economic approaches for addressing policy issues related to management of three ecosystems. Nine of the 14 study sites addressed policy dimensions related to wetland conservation and wise use.

TII implementation was structured in three phases. In its scoping phase implemented during March – September 2011, status and trends for each of the three prioritized ecosystems were assessed using existing information. This review was used to identify specific contexts in which economics based approaches can be applied to support wetland conservation and wise use. The scoping phase was followed by a demonstration phase (January 2014 – June 2015) wherein pilot projects were implemented. The study sites were selected based on an open call for proposals on themes emerging from the scoping phase. In the third and final stage, a sectoral synthesis was developed relating the outcomes of scoping phase with the knowledge base on ecosystem services and biodiversity values generated from pilot projects.

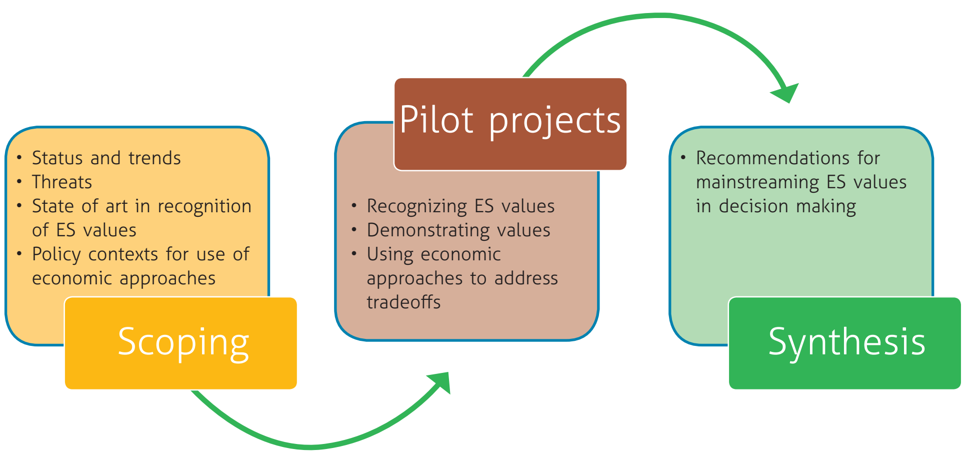

Fig 1: Phasing of TII implementation

The Scientific and Technical Advisory Group (STAG) and Steering Committee of TII provided the overarching technical guidance in the three phases of the study. The studies were conducted by respective proponent organizations, with Wetlands International South Asia entrusted the task of developing a synthesis, catering to specific needs of MoEFCC, wetland managers within respective states and other related stakeholders.

During the XI Conference of Parties (CoP) of the Convention on Biological Diversity (CBD) hosted by India in October 2010, the first report of the initiative, entitled 'TEEB – India: Initial Assessment and Scoping Report – Working Document' was released, containing the outputs of scoping studies commissioned for the three priority ecosystems (Parikh et al., 2012). This was followed with an interim report 'The Economics of Ecosystems and Biodiversity - India Initiative: Interim Report – Working Document' elaborating the study approach and method (MoEFCC and GIZ, 2014). The present report synthesizes the knowledge base developed under the initiative and outputs of the pilot projects to recommend measures for applying economic approaches for conservation and wise use of wetlands in India. The scope of this report includes the following:

- Status and trends of wetlands extent, ecosystem services and biodiversity;
- Overview of key threats and management issues that impact wetland biodiversity and ecosystem services;
- Illustration of ecological, economic and institutional impacts of loss of ecosystem services and biological diversity through case studies;
- Potential relevance of economics based approaches for strengthening conservation and sustainable management of wetlands;
- Overview of existing evidence on economic values of wetlands, and application in policy and decision-making; and
- Recommendations for integration of ecosystem service and biological diversity values to help improve conservation and wise use of wetlands

Structure

The synthesis report is presented in five sections. Following a context setting introduction, section 2 outlines the status, trends and key management challenges facing wetlands of India. Section 3 summarizes the need for and the state-of-the-art of valuation of wetland ecosystem services in India. Section 4 summarizes the outputs from the pilot projects. Section 5 provides recommendations for various stakeholder groups to support mainstreaming of wetland biodiversity and ecosystem services values in developmental programming.

2. Wetlands in India

Status, Trends and Key Management Challenges


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Mangroves at Pitchavaram, Tamil Nadu

- India, owing to her wide geomorphological and climatic variability, is endowed with a rich diversity of inland and coastal wetlands. As per National Wetland Atlas of 2011, these ecosystems span 15.26 million ha, accounting for 4.63 per cent of the country's geographical area.
- Wetlands are vital societal assets contributing to food, water and livelihood security and cultural identity for a large population. These ecosystems are also inhabited by a diverse range of plant and animal species, several of high conservation significance.
- National programming for wetland conservation and sustainable management is focused around a network of sites prioritized by state governments. Programmatic framework and regulatory mechanism for management of these ecosystems have evolved within the broad ambit of National Environment Policy.
- Despite their wide-ranging ecosystem services and biodiversity values, wetlands have continued to degrade. As per conservative estimates, nearly 30 per cent of natural wetlands have been lost in the last five decades alone. Lack of consideration of wetland biodiversity and ecosystem services values in developmental programming has a significant influence on the drivers of degradation.
- Through nine pilot studies, TII has endeavoured to demonstrate application of economic approaches to wetland management. Decision-making contexts assessed in these studies relate to wetland restoration, integrated land and water resources management, property rights and distribution of costs and benefits, and use of market based instruments for financing management.

Wetlands: Biodiversity and ecosystem services values

Wetlands are coalesce of land and water, combining attributes of both terrestrial and purely aquatic ecosystems. Key characteristics of these ecosystems include presence of water at or near the surface for at least part of the year, plants adapted to wet conditions (hydrophytes), and soils that are saturated or flooded long enough to develop anaerobic conditions (hydric soils). The Ramsar Convention (1971), a globally coordinated institutional framework for conservation of wetlands, uses a broad approach for defining these ecosystem as 'areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six metres. Article 2.1 of the Convention provides that wetlands 'may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands'. The definition thus covers a large number of inland wetlands (such as swamps, marshes, lakes and peatlands); coastal and nearshore marine wetlands (such as coral reefs, mangroves, seagrass beds and estuaries) and human-made wetlands (such as rice-paddies, dams, reservoirs and fish ponds).

India is endowed with a rich diversity of wetlands, owing to the extremes of climatic, geological and topographic diversity experienced in the country. Wetlands in India range from high altitude lakes in the Himalayas, marshes and swamps in the Terai, floodplains and ox-bows in the Gangetic-Brahmaputra alluvial plains, saline flats in the Great Indian Desert, tanks and reservoirs in the Deccan region, and extensive mangrove marshes and coral reef areas interspersed along the country's over 8,000 km long coastline. These ecosystems range in areas from small village ponds (having area less than an acre) to large lagoons such as Chilika and

Vembanad backwaters having expanse of over a thousand square kilometer.

Wetlands are central to water and food security of the country. Many large cities, for example, Bhopal in Madhya Pradesh (Verma et al., 2001), Delhi (Trisal et al., 2008), and Kollam in Kerala (Ramsar, 2002) depend on wetlands for their water supplies. Kumar et al. (2005) have assessed that the recharge of groundwater from the floodplain wetlands associated with the major river systems in India exceed 430 km^3 per annum, which is atleast 38 per cent of the available water resources of the country. The high altitude Himalayan wetlands capture the glacial melt and form the source of the eight largest rivers of Asia, basins of which support nearly one-fifth of global population (Trisal and Kumar, 2008). The floodplains of Ganga and Brahmaputra account for over 40 per cent of the total cultivated area in the country, and are a major source of the country's rice and fish production. These floodplains also hold the germplasm of Indian major carps, which are the backbone of India's freshwater aquaculture (Dehadrai and Yadava, 2004). Besides fish, aquatic plants such as *Euryale ferox, Trapa bispinosa* and *Nelumbo* spp. contribute significantly to food and nutritional security in northern India. Nearly 1.2 million tanks of southern states of Andhra Pradesh, Telangana, Karnataka, and Tamil Nadu support around 60 per cent of India's tank irrigated area (Palanisami et al., 2010). East Kolkata Wetlands (West Bengal) are an important component of the wastewater treatment infrastructure of the city. These wetlands help treat nearly 600 million litres of sewage daily through an ingenious practice of waste-based pisciculture, agriculture and horticulture (Kundu et al., 2008).

Wetlands also act as buffers against extreme events. A significant proportion of summer flows of Jhelum River draining the picturesque Kashmir Valley are absorbed by Wular Lake (WISA, 2007). Conversion of wetlands and encroachment of flood channels have been cited as a primary factors that caused extensive damage and losses to human life during floods of September 2014. Similarly, the City of Guwahati is cushioned from devastating floods of River Bramhaputra by Deepor Beel and associated wetlands (Gogoi, 2007), Kathiresan and Thakur (2008) present extensive accounts of role of mangrove marshes in guarding against the impacts of tropical storms and cyclones.

Wetlands have deep connections with Indian culture and traditions. Loktak Lake (Manipur) is revered as 'Ima' (meaning Mother) by the inhabitants of Manipur valley, whereas Khecheopalri Lake (Sikkim) is popular as the 'wish fulfilling lake'. North Indian festival of Chhath is one of the most unique expressions of the association of people, culture, water and wetlands (WISA, 2015). Dal Lake (Jammu & Kashmir), Khajjiar Lake (Himachal Pradesh), Nainital Lake (Uttarakhand) and Kodaikanal (Tamil Nadu) are popular tourism destinations of the country, contributing significantly to local economy. Fisheries and tourism in Lake Chilika (Odisha) support livelihoods of over 0.2 million people living around the lagoon (Kumar and Pattnaik, 2012).

Wetlands serve as habitats for numerous plant and animal species, including several of high conservation value. Existing records indicate presence of nearly 1,200 floristic (Prasad et al., 2002) and 18,000 faunal (Alfred et al., 1998; Alfred and Nandi, 2000) species in these ecosystems. The Zoological Survey of India (ZSI) has also recorded presence of 3,022 fish species in the nation's aquatic environment (MoEF, 2014). These are important parts of food chain as well as components of food and nutritional security of a large human population. For 276 recorded water bird species (Gopi et al., 2014), wetlands provide critical resting, roosting, feeding and foraging habitats.

Indian wetlands harbour a number of globally threatened species requiring urgent conservation action. The 646 threatened faunal species in India include 213 fish and 74 amphibians. Twenty one of the 28 species of freshwater turtles found in the country's wetlands are assessed as being globally threatened (MoEF, 2014). Similarly, of the water bird species recorded in Indian wetlands, 49 species are classed in threatened category (4 as critically endangered, 7 endangered, 16 vulnerable and 22 near threatened) (Gopi et al., 2014).

Several wetlands are habitats of charismatic species. Chilika maintains a healthy population of, and is one of the only two lagoons in the world inhabited by Irrawaddy Dolphin (*Orcaella brevirostris*). Keibul Lamjao, a floating National Park on the south of Loktak Lake is the only known natural habitat of globally endangered swamp deer commonly known as Brow-antlered Deer (*Rucervus eldii*). The largest remaining populations of critically endangered Gharial (*Gavialis gangeticus*) are concentrated around riverine wetlands of River Son, Girwa and Chambal of Central India. The spectacular wetlands of Ladakh are the only known breeding grounds of globally vulnerable Black-necked Crane (*Grus nigricollis*) in India (Chandan et al., 2005). Over 70 per cent of the global population of Great Indian Rhinoceros (*Rhinoceros unicornis*) is largely confined within the grasslands and swamps of Kaziranga National Park in Assam.

The mangrove species diversity in India represents nearly 60 per cent of the known global diversity (Bhatt et al., 2013), supporting over 920 plant and over 3,100 animal species (Bhatt et al., 2011). The 39 true mangrove species recorded from Indian mangrove marshes include the world's largest block of halophytic mangroves (Sundarbans which straddles India and Bangladesh), including two globally threatened species *Sonneratia griffithii* and *Heritiera fomes*. Similarly, the coralline diversity in the country, constituted by 478 species of 89 genera, forms 60 per cent of the global hermatypic genera (Bhatt et al., 2011).

Placed geographically in the core region of the Central Asian Flyway (CAF), Indian wetlands are of high significance for migrating water bird species within a large intracontinental territory between the Arctic and the Indian Ocean. Indian wetlands are host to 81 extralimital seasonal immigrants from Palaearctic Region beyond the Himalayas – in Central and Northern Asia, and Eastern and Northern Europe (CMS, 2005). Of these, Baer's Pochard (*Aythya baeri*), Spoon-billed Sandpiper (*Calidris pygmaea*) and Sociable Lapwing (*Vanellus gregarious*) are classed as being critically endangered.

Status and trends

Several wetland types exhibit large seasonal and inter-annual variations in inundation regimes and vegetation, rendering comprehensive assessment of status and trends difficult. Nonetheless, efforts to create an inventory of wetlands and assess their extent in the country have been made since the 1980s, wherein an All India Wetland Survey was initiated by the Government of India. The Directory of Asian Wetlands of 1989 reported the wetland area in the country to be 58.3 million ha, which included 40.9 million ha under paddy cultivation (Scott, 1989). Efforts to map wetlands at national scale using remote sensing techniques began in the nineties (see Garg, 2015 for an overview). The first remote sensing based National Inventory of Wetlands was published in 1998 by Space Application Centre (Garg et al., 1998) using post and pre monsoon imageries of 1992-93 (IRS LISS I and II data). Subsequently, the national inventory was updated at a uniform scale (1:250,000) using 2004 – 05 Resourcesat AWiFS (8 m spatial data), as per which the national wetland extent was assessed to be 8.83 million ha, excluding paddy area. The inventory, however, was not published (Garg et al., 1998). In 2004, the Salim Ali Center for Ornithology (SACON) under a UNDP sponsored project, carried out a mapping of inland wetlands using 23.5 m resolution data of IRS LISS III mostly of 2001 (Vijayan et al., 2004). The assessment also included data on select species groups for analyzing conservation significance.

The MoEFCC (the then MoEF) commissioned a nation-wide wetland mapping project entitled 'National Wetland Inventory and Assessment' to the Space Application Centre (SAC) in 2007. The project used a 19 wetland type classification (including natural as well as human-made), derived from analysis of RESOURCESAT I LISS III data of 2006 – 07 at 1:50,000 scale (with 23.5 m resolution) for pre-monsoon and post-monsoon periods (SAC, 2011). The atlas, for the first time, included a separate category of high altitude wetlands (wetlands located at 3,000 m amsl). A summary of wetland inventory information resulting from remote sensing methods is presented in Table 2.1. As can be noted, the variation in wetland extent reported in these assessments is largely due to use of data of different resolutions and mapping scales, and does not necessarily depict trends of change.

The most recent of remote sensing based assessment, the 2011 National Wetland Atlas, places the national extent of wetlands as 15.26 million ha, equivalent to 4.63 per cent of the country's geographical area (SAC, 2011). Inland wetlands (including wetlands below the minimum mapping unit of 2.25 ha) constitute 69 per cent (10.56 million ha) of the total wetland area. High altitude wetlands have been assessed to extend

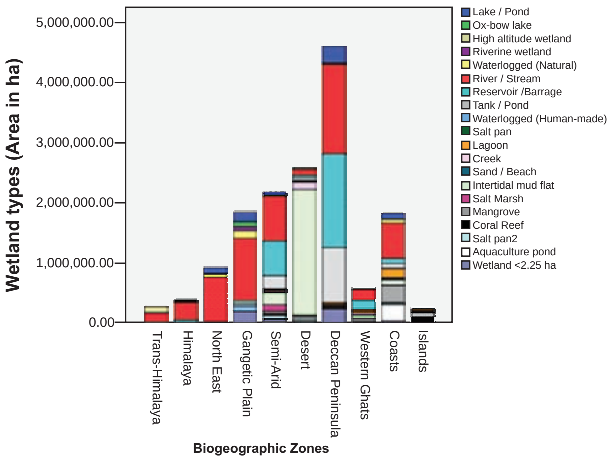


Fig 2.1: Distribution of wetlands in different biogeographic zones of India (Source: Authors's estimate based on data from SAC, 2011)

126,249 ha. The state of Gujarat has the maximum wetland area (3.47 million ha).

A distribution of wetlands in the 10 biogeographic zones of the country is presented in Fig 2.1. The Deccan Peninsula and desert – semi arid region account for nearly 30 per cent each of the total extent, Gangetic plains and coasts each account for 12 per cent of the wetland extent. North-East region and Western Ghats have 6 per cent and 4 per cent of the total wetland extent respectively. The Himalayan region (including Trans-Himalayas) has 4 per cent of the total extent, whereas the islands constitute the balance 1.5 per cent.

Predominance of wetlands also varies across the biogeographic zones. Rivers and riverine wetlands constitute 35 per cent of the total wetland area in the country, and are the predominant wetland types in Gangetic plains (56%), Himalayas (74%), Trans-Himalayas (59%), North-East (79%), Semi-arid (34%) and Western Ghats (30%) biogeographic regions. Within Deccan Peninsula, 33 per cent of wetland area is constituted by reservoirs and barrages. Within the desert, intertidal mudflats account for 81 per cent of its wetland area. Coral reefs constitute 45 per cent of the total wetland area in the islands.

Discerning trends in wetlands extent is rendered difficult due to differences in resolution of data, and comprehensiveness of assessments. In fact, periodic assessments, since 1987, have been conducted only for mangroves as a part of the biennial forest area assessment by the Forest Survey of India. The 1987 assessment was done at 1:1,000,000 scale, which was subsequently refined to 1:250,000 from 1989 to 1999 and 1:50,000 from 2001 onwards. Vijayan et al. (2004), using remote sensing based change analysis data from 71 districts, surmised a loss of 38 per cent inland wetlands during 1992-2001.

Table 2.1 Summary of remote sensing based inventories of Indian wetlands

Title	Agency	Year of Publication	Base Data	Assessment Scale	Coverage	Wetland classes (number)	Inventory results (million ha)		
							Total	Inland	Coastal
Nation-wide Wetland Mapping Project	SAC	1998	1992-93	Mix of 1:250,000 and 1:50,000	National	24	7.58	3.55	4.02
	SAC	Unpublished	2004–05	1:250,000	National	NA	8.83	NA	NA
Inland Wetlands of India – Conservation Priorities	SACON	2004	1999-2001	1: 50,000	National; Inland Wetlands	9		7	
National Wetland Inventory and Assessment	SAC	2011	2006-7	1:50,000	National; Inland and Coastal Wetlands	19	15.26*	11.12	4.14

*includes 0.56 million ha wetlands under the minimum mapping unit of 2.25 ha, NA = Not Available

This report endeavours a statistical trend analysis of change in wetland area based for the period 1940-2010, and projected for 2050. Rivers have been excluded from analysis as no spatial extent change records could be derived from the literature search. Records of change in wetland area were derived from published journal papers, reports and datasets, and each record allocated to one of the seven decades between 1941-2010. For consistency, annual percentage change in wetland area was calculated as arithmetic mean between the start and end year of the record. Trends in area under natural inland wetlands were derived from records for rural and urban lakes. These were estimated separately, and projected into a cumulative estimate using the proportion of urban to rural areas. Data on areas of large reservoirs was used to estimate change in area under barrages/ reservoirs. Change in area under tanks in Tamil Nadu and Andhra Pradesh have been used to derive trends for tanks. Trends in area under mangroves were derived from FAO and Forest Survey of India datasets. For lagoons, the data pertains to three major wetlands, namely Chilika, Ashtamudi and Vembanad. Rate of change for all other coastal wetlands were imputed as the average of rates of change of mangroves and lagoons. All rates of change were converted into area projections using 2007 data presented in SAC (2011). Projections for 2050 have been made by extrapolating the rates of change in area during 2001-2010 decade. The analysis indicates that since 1940, atleast 30 per cent of natural wetland area has been lost (Fig 2.2).

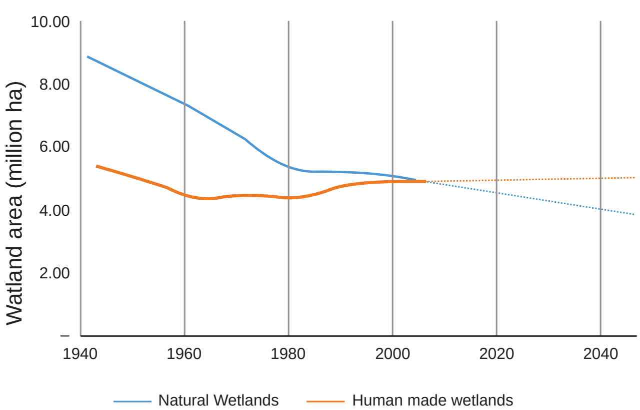


Fig 2.2: Trend analysis of area under wetland

Wetlands are globally one of the most rapidly degrading ecosystems (Davidson, 2014; Gardner et al., 2015), and these trends are also reflected in the status of Indian wetlands. The major direct and indirect threats impacting wetland biodiversity and ecosystem services include alteration of natural hydrological regimes, catchment degradation, nutrient enrichment, pollution, over-harvesting of resources, unregulated tourism, and climate change.

Alteration of natural hydrological regimes: Water regimes structure biodiversity and ecosystem services of wetlands. Alteration of natural hydrological regimes often leads to reduced or enhanced water availability, altered hydro-period, loss of connectivity with biodiversity habitats, impeded nutrient exchange and other processes which significantly enhance their degradation (Parikh et al., 2012).

Until 2007, about 1000 medium and 276 major irrigation projects with a total water storage capacity of 222 billion cubic metres were constructed in India (CWC, 2010). These projects have played a critical role in providing water for economic usage such as hydro-power and agriculture, but in several instances, lack of consideration of the functioning of wetland ecosystem services has created adverse impacts on the integrity of aquatic habitats. Diversion of water for hydropower generation through construction of Ithai Barrage downstream of Loktak Lake has converted a natural floodplain lake into reservoir, critically affecting the habitat of the Manipur Brow-antlered Deer and nearly complete obstruction of migratory pathways of fishes from Chindwin-Irrawaddy system (WISA, 2005). In Kashmir valley, conversion of marshes associated with Wular Lake for agriculture, has reduced the capacity of the wetland complex in regulating flow regimes, and thereby, leading to increased floods and droughts (WISA, 2007).

Catchment degradation: The water holding capacity of wetlands plays a crucial role in determining its ability to regulate flow regimes, cycle nutrients and support biodiversity. Being depositional in nature, wetlands act as sediment traps, which in the long run play a key role in their succession. However, catchment degradation accelerates sedimentation rates, thereby, risking sustenance of ecosystem processes and services.

The 2010 bathymetric surveys of Harike Lake (Punjab) have indicated a loss of 86 per cent of water holding capacity since 1954 due to excessive silt accumulation from Shivalik catchments. The resulting decline in inundation has reduced hydrological regime moderation capability of this wetland, and coupled with high levels of nutrient enrichment, promoted infestation of invasive species *Eichhornia crassipes*. Surajkund and Badhkal Lakes, tourist hotspots of Haryana in the vicinity of Delhi, frequently run dry on account of excessive mining in the catchments, which prevents inflow of rainwater and recharge of groundwater critical to the maintenance of the hydrological regimes of these wetlands (Parikh et al., 2012).

Pollution: Increasing urbanization without development of adequate waste management infrastructure has led to increased pollution in wetlands located within urban and the peri–urban areas. Agricultural intensification and the increased use of chemical fertilizers have resulted in negative impacts on the water quality within rural wetlands. For instance, most of the Gangetic floodplain wetlands are in advanced state of eutrophication due to discharge of untreated sewage and sewerage as well as runoff from agricultural fields (Kumar, 2015).

Invasive alien species: Most of the inland wetlands of India have been invaded by exotic species, which have acquired nuisance proportions considerably influencing the native biota and habitat conditions. The list is topped by the water hyacinth, which was introduced into India about a century ago and now occurs almost throughout India. The other major species that have gradually infested several wetlands are *Salvinia molesta, Ipomoea carnea* and *Alternanthera philoxeroides*. Highly adverse impacts of fish invasive on local biodiversity have been noted in the case of Tilapia (*Oreochromis mossambicus*) (Parikh et al., 2012).

Over–harvesting of resources: Owing to high livelihood dependence, wetlands are often subjected to over–harvesting of resources and modification for enhancing provisioning services such as wood, fish, and water at the cost of regulating and cultural services. Uses of detrimental fishing practices, such as small mesh size nets, are prevalent in a majority of inland wetlands. Often sustainable yield for a particular wetland is not known and at times ignored by stakeholders. Wetland biodiversity and wider food webs are also put under stress by loss through by-catch. Varying inundation regimes are often modified to suit agricultural and aquaculture uses (MoEFCC & GIZ, 2014). For example, livelihoods of over 15,000 fishers living around Kanwar Jheel in North Bihar have been disrupted as dynamic inundation patterns in Kanwar Jheel have been transformed for promoting permanent agriculture (WISA, 2015). Agriculture in turn has been impacted by lowering of ground water levels and flooding attributed to shrinkages in wetland regimes (WISA, 2015).

Unregulated tourism: Tourism contributes nearly six per cent to the national Gross Domestic Product (GDP) and generates nine per cent of the total employment, making it an important driver of growth. Wetlands, an important part of tourism experience, are likely to see an increase in touristic pressure in the times to come. For example, the backwaters of Kerala are visited by nearly 0.7 million tourists annually. Accordingly, tourism industry ensures livelihood of over 85,000 households (WISA, 2013). Often, the habitat characteristics or functioning of wetlands are not taken into account while developing tourism infrastructure and recreation facilities. For instance, increase in houseboats in Dal Lake (Jammu & Kashmir) and Vembanad-Kol backwaters (Kerala) have converted tourism from a livelihood opportunity to threat to these fragile ecosystems.

Climate change: Global climate change is fast emerging as an important driver of loss and change in wetlands, especially high altitude and coastal wetlands, which face high risks of adverse changes in ecological character. Climate change induced melting of glaciers has led to increased water levels of Tsomoriri (Ladakh), submerging habitats utilised by endangered migratory birds such as the Black-necked Crane and Bar-headed Geese (Chandan et al., 2008). Modelling simulations indicate that about 84 per cent of coastal wetlands are at risk due to a one metre sea level rise (Blankespoor et al., 2012). Inland wetlands are at risk from alteration in hydrological regimes and eutrophication, and algal blooms that are likely to result from increasing temperatures (Gopal, 2013).

Conservation and management efforts

Wetland conservation draws strength from India's rich legacy of environmental conservation enshrined in various policies, legislations and regulatory regimes. The Indian Constitution encapsulates this spirit, notably in its Article 51–A (g) stating that "it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures."

Wetland conservation and their sustainable management is placed within the mandate of MoEFCC. Wetlands were initially conserved primarily for their biodiversity values, and several predominantly wetland landscapes such as Keoladeo, Harike, Kaziranga and Manas were declared as Wildlife Sanctuaries and National Parks (IUCN Category II protected area). With India becoming a party to the Ramsar Convention in 1982, and MoEFCC (the then MoEF) being established in 1985, a national programing framework for wetlands was institutionalized. MoEFCC established the National Wetland Conservation Plan (NWCP) in 1986 to provide overarching national policy framework and financial assistance to the state governments for implementation of site management plans. In 2001, the National Lake Conservation Programme (NLCP) was introduced to address pollution issues in urban and semi-urban water bodies through interception, diversion and treatment of pollution load. As of December 2013, the network of sites of national and international significance included 170 wetlands. India has also designated 26 wetlands as Ramsar Sites.

The National Conservation Strategy and Policy Statement on Environment and Development (1992) identified pollution and over-exploitation of wetlands as an area of concern. Conservation of wetlands was emphasized as a strategy for sustainable use of land and water resources as well as biodiversity conservation. Subsequently, the National Environment Policy (2006) laid down specific policy elements for wetlands. Wetlands have been identified as components of 'freshwater resources' and the recommended policy actions for wetlands conservation include integration in developmental planning, management based on prudent use strategies, promotion of ecotourism, and implementation of a regulatory framework. Integration of wetlands in river basin management has been identified as a strategy for management of river systems.

In 2010, in line with recommended policy actions, a regulatory framework for wetlands was introduced by MoEFCC in the form of Wetland (Conservation and Management) Rules, 2010 under the provisions of the Environment (Protection) Act, 1986. The Rules stipulate prohibition and regulation of a range of developmental activities within a wetland notified under provisions by the state governments. A Central Wetlands Regulatory Authority (CWRA) has been constituted for the purpose of enforcing the rules, to evaluate proposals for wetland notification sent by the state governments, and to set thresholds for activities to be regulated. However, implementation of the framework has not been as desired. The MoEFCC is therefore contemplating revision of these rules in order to provide for a decentralized framework, while taking into account site specific characteristics and ecosystem services. A revised draft of the Wetlands Rules was under public consultation at the time of writing this report.

Provisions of the Indian Forest Act, 1927 and the Indian Wildlife (Protection) Act, 1972 define the regulatory framework for wetlands located within forests and designated protected areas. Similarly, coastal wetlands are protected under the Coastal Regulation Zone (CRZ) Notification (2011) and the Island Protection Zone (IPZ) Notification (2011). These Notifications recognize coral reefs, mangroves, mudflats, and salt marshes as ecologically sensitive and categorize them as CRZ-I, which implies that these areas are accorded protection of the highest order. The Indian Fisheries Act, 1897, The Water (Prevention and Control of Pollution) Act, 1974, The Environment (Protection) Act, 1986 and The Biological Diversity Act, 2002 provide substantive legal and regulatory framework for conservation of Indian wetlands. The Coastal Aquaculture Authority Act, 2005 prohibits conversion of natural coastal wetlands such as mangroves, salt pans, estuaries and lagoons for aquaculture.

In line with the CBD Strategic Plan 2011–2020, India has formulated 12 National Biodiversity Targets. Wetlands find direct reference under Target

3 (strategies for reducing rate of degradation, fragmentation and loss of natural habitats are finalized and actions put in place by 2020), Target 6 (ecologically representative areas on land and in inland waters, as well as coastal and marine zones, especially those of particular importance for species, biodiversity and ecosystem services, are conserved effectively and equitably), and Target 8 (by 2020, ecosystem services, especially those related to water, human health and livelihoods and well-being are enumerated and measures to safeguard them are identified).

Wetlands also find place in sectoral policies for water and climate change. The National Water Policy (2012) provides an important policy framework for linking wetlands to water resources management. The policy recommends adoption of a basin approach for water resources management, and identifies conservation of river corridors, water bodies and associated ecosystems as an important action area. Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWRRD) has several programmes that contribute to wetland conservation. The MoWRRD also coordinates implementation of pilot scheme for "National Project for Repair, Renovation & Restoration (RRR) of Water Bodies directly linked to Agriculture" since January, 2005. The scheme supports restoration and augmentation of storage capacities of water bodies, including recovery and extension of their lost irrigation potential. In 2013, the Ministry of Urban Development (MoUD) issued an advisory on conservation and restoration of waterbodies in urban areas, identifying funding streams of the MoUD and MoWRRD for urban wetlands (MoUD, 2013).

The National Action Plan for Climate Change has identified eight missions which form the core intervention strategy for climate change mitigation and adaptation. Wetland conservation and sustainable management is included in the National Water Mission. Similarly, the National Mission for Green India has a target of 0.1 Mha for wetlands conservation and an additional 0.1 Mha for mangroves.

Several state governments (notably West Bengal, Odisha, Kerala, Manipur and Assam) have also enacted their own legislations pertaining to wetlands. The Government of Manipur notified the Manipur Loktak Lake (Protection) Act, 2006 and Manipur Loktak Lake (Protection) Rules, 2008, which define a core zone and buffer zone, and stipulate specific activities that can be permitted within these designated areas. Similarly, the East Kolkata Wetlands (Conservation and Management) Act, 2006 recognizes use of sewage as one of the core ecological characteristics of the East Kolkata Wetlands. In Kerala, the Conservation of Paddy Land and Wetland Act, 2008, bans conversion of wetlands. In 2015, the state governments of Karnataka and Rajasthan have enacted legislations for conservation of wetlands.

Some state governments have constituted dedicated wetland authorities to address the need for coordinated efforts in implementation of management plans by multiple departments and stakeholders. Loktak Lake is one of the largest freshwater lakes in the North-East. The Lake was seeing rapid degradation due to invasive species, shrinkage in area and reduction in water holding capacity, particularly after the commissioning of Loktak Hydro-electric Project in 1983. Accordingly, the Loktak Development Authority (LDA) was constituted in 1986, making it one of the first wetland development authorities established in the country. In 1991, the Government of Odisha constituted the Chilika Development Authority to address the pressures on Chilika Lake, the largest brackish water lagoon on the east coast. The lake was threatened by increasing silt load, declining fisheries and expansion of shrimp aquaculture.

In 1997, the Government of Jammu and Kashmir, under the aegis of the Housing and Urban Development Department, constituted the Lakes and Waterways Development Authority for restoration of Dal and Nigeen Lakes. Since 2000, separate wetland authorities have been created for waterbodies of Madhya Pradesh, lakes within Bengaluru City (Karnataka), and East Kolkata Wetlands. The Lake Conservation Authority of Madhya Pradesh initially focused on Bhoj Wetlands, but in 2004 was entrusted with the mandate of conserving all waterbodies of the state. Odisha and Bihar constituted a State Level Wetland Authority in 2012 and 2014 respectively. Till date, eight states have constituted Wetland Authorities as the nodal policy and regulation enforcing institutions at the state level.

The core of management interventions for Indian wetlands has been based on a mix of ecosystem service approach and prioritisation based on biodiversity values. Successes as reflected in ecological restoration of Chilika, and its transformation from a Ramsar Site enlisted within Montreux Record to an award winning site, namely Ramsar Wetland Conservation Award and Evian Special Prize in 2002, are indicative of the significance attached to conservation of wetlands in the country.

Gaps and challenges

Evidences of continued degradation of natural wetlands are an indication that the required scale of integration of their values and benefits in broader developmental programming is yet to be fully achieved. The following gaps and challenges limit effectiveness of policy and programmatic measures for wetlands in the country:

Sectoral approaches: The full ranges of ecosystem services and biological diversity values of wetlands are rarely integrated in sectoral developmental plans. This impedes the ecological and hydrological functioning of aquatic ecosystems and leads to stakeholder conflicts. In several instances, interventions for increasing food production and water supply (e.g. through construction of hydraulic structures and expansion of irrigated area) have led to reduced ability of wetlands to recharge groundwater, and buffer floods. In most states, wetlands are often clubbed within 'wastelands' meant to be used for alternate developmental purposes and are not recognized as a distinct land use category. Within sectoral policies, there is considerable scope of enhancing recognition of various wetland ecosystem services. The National Water Policy (2012), while recommending allocation of water for maintaining ecosystems, does not allude to wetlands as a solution in achieving water management objectives such as flood control, groundwater recharge and increasing overall freshwater availability. The National Action Plan for Climate Change needs to acknowledge the contribution of wetlands towards climate change adaptation, and also addressing the risks imposed on these ecosystems due to maladaptation. Wetlands also need to be included within National Agriculture Policy and National Marine Fisheries Policy, as lack of consideration of wetland functioning within prevailing agriculture practices and food production programmes continues to be a significant driver of wetland degradation.

Ineffective governance mechanisms: Implementing restoration plans for wetlands requires cross-sectoral institutional arrangements. This was envisaged to be achieved through creation of dedicated authorities responsible for developing management plans, implementation through line departments, monitoring and evaluation. However, only few states have been able to establish distinct authorities. Further, many of these authorities do not have any form of regulatory backing.

Ad-hoc approach to implementation of management plans: The management plans for most wetlands are not based on landscape-level planning. These plans, therefore, are prescriptive by nature, and do not address the root causes of degradation (for example fragmentation in hydrological regimes or pollution). Post project sustainability strategies are also not worked out. Very few states have included allocation for wetlands within their budgets. Moreover, wherever included, it is mostly for establishment expenses and not for supporting restoration.

Insufficient capacity for integrated management: A review of management plans indicates that there is lack of capacity in drafting of plans that address the full range of drivers of ecosystem degradation. Equally significant is the lack of training and capacity building opportunities for site managers implementing the management plans.

Limited research management interface: To be able to address the diverse drivers of change, management of wetlands would require continuous research inputs. However, this has failed to happen for most sites. Much of the research is focused on structural elements of wetlands (limnology, biodiversity) with very limited emphasis on functional aspects (for example studies elucidating relationship of hydrological regimes with ecosystem services).

3. Recognizing economic values of wetland biodiversity and ecosystem services

WISA Photo Library

Fisher in Mahanadi River, Odisha

- The wise use approach for managing wetlands recognizes human sustainable use of these ecosystems, on the basis of their value ascription, as compatible with conservation. It encourages engagement with stakeholders and transparency in negotiating value trade–offs and determining equitable outcomes for conservation.
- Economic valuation improves the possibility of achieving sound decisions for wetland wise use by acting as a feedback mechanism alerting the society on the consequences of sectoral developmental pathways for wetland functioning.
- Application of economics based approaches for wetland conservation and management in India is a growing research area. Much of the emphasis still is on valuation of benefits from provisioning and cultural ecosystem services. There is a pressing need to contextualize valuation within policy and decision-making frameworks and processes.

Economic values and wise use

The 'wise use' approach of Ramsar Convention is globally recognized as the central tenet of wetland management. The approach recognizes that restricting wetland loss and degradation requires incorporation of linkages between people and wetlands, and thereby emphasizes that human use of these ecosystems on sustainable basis is compatible with conservation (Finlayson et al., 2011). This approach aligns well with the fact that a certain level of natural variation and disturbance is important to maintain resilience within wetland ecosystems.

The Ramsar Convention on Wetlands defines wise use as "the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development". Ecological character is "the combination of ecosystem components, processes and benefits/services that typify the wetland at a given point in time". Ecosystem services framework has been drawn into the definition of ecological character as a means of bridging wetland ecosystem functioning and their human use for well-being (Finlayson et al., 2011). Ecosystems approach requires consideration of the complex relationship between various ecosystem elements and promotion of integrated management of land, water and living resources. Wise use, through emphasis on sustainable development, calls for resource use patterns which can ensure that human dependence on wetlands can be maintained not only in the present, but also in the future. Seen in totality, wise use is about maintaining wetland values and functions in order to ensure maintenance of flow of benefits from wetlands (their ecosystem services) from inter-generational equity point of view.

The term-value of ecosystem services and biodiversity-can be interpreted as importance, preference or a measure thereof. However, value can also mean a principle or core belief underlying the preferences. The way nature is valued can relate to diverse ontologies and epistemologies, which have an influence on constitution and conceptualization of value, and changes brought in across various decision-making contexts. Valuation is "the process of expressing a value for a particular good or service… in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology and so on)" (Farber et al., 2002). Costanza (1991) and North (1994) highlight that valuation involves assigning relative weights to various aspects of individual and social decision problems, with the weights being reflections of the goals and world views of the community, society and cultures of which individuals are parts. Economic valuation, which is the core focus of TII, is an attempt to express these weights in monetary terms, making them comparable with alternate uses, which often have benefits and cost flows defined in similar units. It is essentially an anthropocentric way of considering nature, wherein values are consigned to the extent that these fulfil and directly or indirectly contribute to human well-being (positive change in well-being, hereinafter termed as benefits after TEEB, 2010).

Wise use requires addressing trade-offs between two competing values people hold for wetlands. In the context of wider developmental programing, functioning wetlands produce multiple provisioning, regulating and cultural services, which being interlinked, are affected positively or adversely in response to wetland use. In several circumstances, ecosystem services co-vary negatively (use of wetlands for permanent agriculture may reduce capability of wetlands to moderate water regimes), whereas some services may co-vary positively (for example, improving flood buffering capacity of wetlands can support increased groundwater recharge and help maintain productive fisheries). Unfortunately, being public goods, public policy making may not consider and internalize a large category of wetland ecosystem services. Economic values may make explicit the impact of public policy or private decisions on ecosystem service values, and enable expression of these value changes in units that allow for their incorporation in public decision-making (Mooney et al., 2005). It is a means of communicating the value of wetland ecosystem services to different groups of people using a language that communicates with dominant economic and political viewpoints across the world.

Wise use of wetlands necessitates stakeholder engagement and transparency in negotiating ecosystem services trade-offs associated with various forms of wetland use in order to determine equitable conservation outcomes (Finlayson et al., 2011). Economic valuation increases the possibility of achieving sound decisions on wetland use and management, by acting as a societal feedback mechanism, alerting the society on the consequences of consumption choices and behaviour (Zavestoski, 2004).

Economic valuation of wetland ecosystem services: State-of-the-art

Theoretical frameworks

Ecosystem services concept encapsulates people-environment interactions, a coinage believed to have been introduced by Ehrlich and Ehrlich (1981), building on the earlier literature on nature's functioning to describe a framework for structuring and synthesizing biophysical understanding of ecosystem processes in terms of human well-being (Brauman et al., 2007). The foundational construct of the ecosystem services is appreciation of the nature-human well-being interlinkages as an intertwined stock-flow relationship, wherein the ecosystem (including its components and processes) is perceived as a "stock of natural capital" and the "ecosystem services" as the flows which emanate from the stock of ecosystem assets (Barbier, 2009; Mäler et al., 2009). The continuing decline and degradation of natural capital stock has raised concerns on the capacity of economic systems to ensure maintenance of the natural capital stock for sustained provision of ecosystem services recognizing limits to substitution by human or manufactured capital (Barbier, 1994; Daily, 1997). In the following decades, ecologists and economists have further elaborated the on notion of ecosystems as life support systems, and providers of ecosystem services and economic benefits (Ehrlich and Mooney, 1983; de Groot, 1987; Folke et al., 1991). Publications of Costanza et al. (1997); Daily (1997), the Millennium Ecosystem Assessment (MEA) and TEEB have played an important role in placing ecosystem services on the global policy agenda.

Notably, one of the key outputs of the MEA was a Water and Wetlands Synthesis, prepared with an objective of informing the Contracting Parties of the Ramsar Convention and those involved in the implementation of the Convention, on the key assessment findings related to water and wetlands (MEA, 2005). The assessment concluded that the degradation and loss of wetlands was more rapid than that of other ecosystems, and so was the status of wetland dependent species. A key recommendation was to ensure that information on full range of benefits provided by wetland ecosystem services is considered in decision-making.

The term ecosystem services was implicitly contained as 'wetland product, functions and attributes' within the initial definition of ecological character situating ecosystem services as an outcome of wetland functioning. In 2005, concurrent with the publication of MEA findings, a proposal for replacing the terms 'products, functions and attributes' within the ecological character definition, with 'services' was made by the Scientific and Technical Review Panel (STRP) of the Convention, which was accepted by the Contracting Parties in their 9th Conference of Parties meeting. Thus, after nearly 35 years of Convention's existence, the core concepts of 'wise use' and 'ecological character' were linked and 'ecosystem services/benefits' (hereinafter ecosystem services) were brought into the implementation processes (Finlayson et al., 2011).

Economic values of wetlands can be recognized and assessed using the existing framework for natural resources valuation. As per the tenets of neoclassical economics, the willingness to pay for the benefits, or willingness to accept a compensation for being denied the benefit derived from wetland ecosystem services, is an economic measure of its value. They reflect the choice pattern, considering the socio-economic, technological and institutional conditions prevailing while the consumption decisions are made (Barbier et al., 2009). The neoclassical framework has its underpinning in being utilitarian (things count to the extent people want them), anthropocentric (humans impute the values) and instrumentalist (various components of natural world are instruments for human satisfaction) (Randall, 1988).

The economic values of benefits derived from wetland ecosystem services can be assessed using biophysical or preference-based approaches. Biophysical approaches involve estimation of intrinsic properties of wetland ecosystems (for example material flows, primary productivity), which are treated as a 'cost of production' of these ecosystem services (examples include energy analysis (Costanza, 1980 and Odum, 1996)). On the other hand, preference-based approaches use subjective preferences held by individuals as a basis of valuation.

The economic value comprises output value (benefit arising from ecosystem service provision within a given ecosystem state) and insurance value (capacity of ecosystems to maintain the output values through their resilience and reorganization capacity (Holling, 1973; Walker et al., 2004)).

The Total Economic Value (TEV) provides a conceptual framework for assessing output value of wetland ecosystem services. Under the TEV framework, the benefits derived from ecosystem services can be broadly classified into two categories: use value (resulting from direct or indirect use of ecosystem services) and non-use value (resulting from reasons other than direct or indirect use, for example due to satisfaction associated with the fact that a well-managed wetland can be an asset for future generations).

Economic values for wetland ecosystem services can be estimated based on information directly derived from market transaction or through transactions in related markets. Direct market valuation methods use data from actual markets to derive economic values of ecosystem services. These can be broadly classified into three: a) market prices based methods, which derive values based on quantity and prices traded in a perfect market; b) cost-based methods which, are based on estimation of costs incurred if the ecosystem services were to be recreated using alternate means; and c) production function based methods, wherein values are derived from the knowledge of ecosystem services' contribution to an economic activity.

Valuation methods based on revealed preferences derive values based on "preferences revealed" through the purchases of goods and services bundles at different income and price circumstances. Travel cost and hedonic pricing methods are two main methods based on revealed preference. Stated preference methods derive willingness to pay or accept through choices made in hypothetical or constructed situations. Stated preference based methods are more suited for assessing non-use values of wetland ecosystems, and broadly include two methods: a) contingent valuation, and b) choice modelling. Each of these techniques has its own assumptions, merits and shortcomings. While neoclassical methods assume existence of preferences which are discovered, deliberative methods are being increasingly applied to support emergence of values from a communicative social process (Zografos and Paavola, 2008).

Given the differences in site characteristics, ideally a detailed value assessment for each site of interest would be commissioned. However, there are practical limitations of various sorts, key being cost and time implications. The benefit transfer method addresses the lack of information on values for a particular site by transferring an existing valuation estimate from a similar ecosystem. If care is taken to adjust for important differences between the two, benefit transfer provides a cost and time saving approach for estimation of economic value of ecosystem services (Smith et al., 2002). There are, however, methodological issues related to differences in spatial scales at which ecosystem services are supplied and demanded, and non-constant marginal values (Spash and Vatn, 2006). Economic valuation is also associated with uncertainty of various forms and levels, which need to be understood for a meaningful application in policy (e.g. Ready et al., 1995; Akter et al., 2008; Kontoleon et al., 2002).

While economic valuation has its intrinsic appeal in terms of highlighting the consequences of production and consumption choices on wetlands, there are critiques of the science and practice of valuation as well. The complexity of ecosystems coupled with nature of various ecosystem services, renders their individual classification impossible (Costanza and Folke, 1997). The legitimacy of foundational constructs of neoclassical valuation economics, namely individual rationality and choice and preference relationships, have been extensively questioned (Bromley and Paavola, 2002; Sagoff, 1994). The other line of critique stems from the scientific objectivity associated with values, as these are mainly contextual and therefore cannot be meaningfully reduced in terms of single number or even a range (Sagoff, 2011). Such critique suggests that economic valuation of wetlands, and natural resources in general, is an evolving field and needs to be continually enriched with better understanding of ecosystem functioning and plurality of values, so as to meaningfully support conservation and wise use of these ecosystems.

Evidence base

In India, economic valuation of wetlands has received attention as a major research area only since the last decade and a half. One of the early attempts was under the then MoEF's Eco-development Programme, wherein an application of valuation techniques was done on Keoladeo National Park (Bharatpur, Rajasthan) with an aim to provide possible policy options for improving people-park relationships. Subsequently, the World Bank supported 'Environmental Management Capacity Building Technical Assistance' (EMCaB) Project, implemented during 1996 – 2004 by the then MoEF with Indira Gandhi Institute of Development Research (IGIDR, Mumbai), Institute of Economic Growth (IEG, Delhi), Madras School of Economics (MSE, Chennai) and other agencies put significant focus on promoting research using economic valuation tools, of which wetlands were one of the priority areas. Since then, the subject matter has been accorded high priority within research programmes of MoEFCC and several universities.

An early example of application of economic valuation techniques to wetlands was use of Travel Cost Method to assess the consumer surplus for Keoladeo National Park (Chopra, 1998). James and Murty (1998) applied Contingent Valuation Method for measuring non-user benefits from cleaning Ganga. James (1998) applied opportunity cost methods for assessing the economic values of the Vembanad-Kol system. Verma et al. (2001) demonstrated use of contingent valuation method to assess the willingness to pay for Bhoj Wetlands in Madhya Pradesh. Kumar et al. (2001) used a mix of revealed and stated preference approaches, including production function approach, to assess the benefits from River Yamuna floodplains in Delhi. Applying contingent valuation method in the case of Pallikarnai marshlands in Chennai, Venkatachalam and Janyanthi (2016) concluded that the residents were willing to pay ₹ 2,096 per annum for improvement in ecological status of the wetland.

Anoop et al. (2008) imputed use value of ₹ 1,924 million to Ashtamudi Estuary, using a mix of direct market and value transfer based methods for fisheries, husk retting, inland navigation, recreation, and carbon sequestration. Hirway and Goswami (2007) estimated direct and indirect use values of Gujarat mangroves to be ₹ 1,603 million and ₹ 2,858 million per year (2003 prices) respectively. Guha and Ghosh (2009) used a zonal travel cost method to estimate annual recreational value of Indian citizens visiting Indian Sundarbans. The value was estimated to be US$ 377,000 (in 2006). Das and Vincent (2009) estimated the opportunity cost of saving a life by retaining mangroves was ₹ 11.7 million per life saved. Hussain and Badola (2010) provided estimates of livelihood support from mangroves in Bhitarkanika conservation area, concluding that each household derived US$107 worth benefits from fishery and forest products, which was approximately one-fifth of their annual income.

Dixit et al. (2010, 2012) used value transfer method to estimate fisheries, recreation, protection of coastal aquifers from salinity ingress, erosion control and biodiversity related values of coral reefs of Gulf of Kachchh in Gujarat. The value of ecosystem services emanating from reefs was estimated to be ₹ 2200.24 million (at 2007 prices).

Singh and Gopal (2002) in their analysis of recreational values of Nainital Lake have used Participatory Rural Appraisal methods to cover perception of a range of stakeholders, such as boatmen, horsemen, coolies and professionals and linked them to the value attributes. An analysis of net and gross values added in fisheries of Chilika Lake has been linked to analysis of livelihood systems to validate distributional consequences of increase in fish landing from Chilika in the study of Kumar (2012).

Trade-offs emerging from policy decisions form a useful application area of economic valuation tools. The study of Yamuna floodplains involved assessing the opportunity cost of converting the floodplains for development and concluded that the same could not be justified on the grounds of economic efficiency (Kumar et al., 2001). Economic valuation was used as a tool to assess the impacts of freshwater flow regulation on ecosystem services of Chilika Lake. The assessment highlighted the positive benefits of floods to floodplain agriculture as well as downstream wetland fisheries. It also indicated that the possibility of policy decisions leading to reduced freshwater flows were likely to lead to negative economic consequences in terms of values of fisheries, flooding and waterlogging (WISA, 2004).

Only two studies have attempted extrapolation of economic values of wetlands or impacts of change in wetland extent to state or national level aggregates. Pandey et al. (2004) have computed state-level aggregated values of wetland wealth using the data on wetland extent (from Directory of Wetlands, 1990) and economic values from Costanza et al. (1997) and Mitsch and Gosselink (2000). The study ranks Karnataka, Gujarat, and Andhra Pradesh as the states having the highest wetland wealth, and Nagaland, Meghalaya and Sikkim with lowest wealth. More recently, a framework for accounting inland wetland ecosystems for selected Indian states has been proposed by Kumar (2012). The study uses benefit transfer method to determine the impacts of physical area losses of wetlands in Gujarat, Jammu and Kashmir, Kerala, Rajasthan and West Bengal. Value estimates from 18 wetlands have been used to develop a meta-regression model to finally compute the loss of per capita wetland wealth for 1991 – 2001. The study concludes that the State of Jammu and Kashmir had the maximum wealth loss per capita (US$ 211.83 or ₹ 9532 at 2010 exchange rate), and an average loss of ₹ 520 (US$ 11.57 at 2010 exchange rate) in the other identified states. A study on ecosystem degradation and biodiversity loss in Indian Sunderbans assessed the damage to be worth ₹ 6.2 billion (US$ 0.14 billion) annually at 2009 prices, equivalent to 4.8 per cent of the region's GDP (World Bank, 2014).

An analysis of aforementioned studies indicates that economic valuation of wetlands in India is an emerging field and is gradually evolving towards addressing management and policy related issues. Some of the trends that can be discerned are as follows:

- The number of wetlands wherein economic valuation studies have been conducted is small considering the overall wetland extent in the country. In terms of wetland types, high altitude wetlands of Himalayas, human-made tanks, salt pans, reefs and mudflats have been underemphasized. The Deccan Peninsular region and the west coast have limited studies as compared to other regions.
- A majority of the studies have focused on assessing monetary values of wetland ecosystem services with an objective of demonstrating their contribution to the local or regional economy. There is limited use of economic valuation studies in decision-making contexts.
- In terms of ecosystem services, one can infer an emphasis on provisioning services followed by cultural services. Regulating services have received almost limited attention. Valuation of hydrological functions of wetlands, in particular (for example, flood control, water regime regulation) needs to be taken up on a priority.
- There is a distinct preference for revealed preference based approaches (market prices, shadow prices). This is commensurate with the focus on provisioning services, as most of the wetland products can be linked to prices in some form. Contingent valuation follows next in terms of application; however, the theoretical rigour varies across the studies. A good emphasis can also be seen on use of Travel Cost Methods to assess the recreational benefits derived from wetlands. Methodologies which require validation of ecological relationships for determining ecosystem services (e.g. production function, damage cost and replacement cost) in general have been underemphasized. Again, this finding is related to the observation of lesser emphasis placed on valuation of regulating services of wetlands. Very few valuation studies involve assessment of trade-offs.
- Limited effort has been applied to extrapolate the values to obtain national scale implications of loss of wetland biodiversity and ecosystem services values.

Gaps and challenges

Application of economics based approaches for wetland conservation and management in India is a growing research field. Much of the emphasis still is on valuation of provisioning and cultural services of wetlands, with relatively lesser effort placed on regulating services. There is also a pressing need to graduate to application end of the research spectrum, wherein valuation of wetland ecosystem services can be contextualized within a policy or decision-making framework.

Valuation of wetlands needs to take into account a number of ecological and socio-economic considerations. Ecological considerations with respect to valuation include reference to systems dynamics, complexities and resilience characteristics. Wetland ecosystems being complex, highly interconnected with non-linear interactions between variables, coupled with stochastic influences, indicate that it is nearly impossible to classify ecosystem services into independent conditions and processes for valuation (Costanza and Folke, 1997). Focusing on valuation of single elements or functions may obscure synergistic properties (Vatn, 2000). Identification of ecosystem services is also confounded by at least two key system properties related to scale and system dynamics. Not all wetland ecosystem services are important at the same scale. For example, provisioning services of wetlands are important at the wetland site scale, whereas the regulation function may emerge significant at a river basin scale. Habitats for waterbirds mostly emerge at flyway scales which link various sites. Taking into account the scale at which service delivery takes place is a practical challenge.

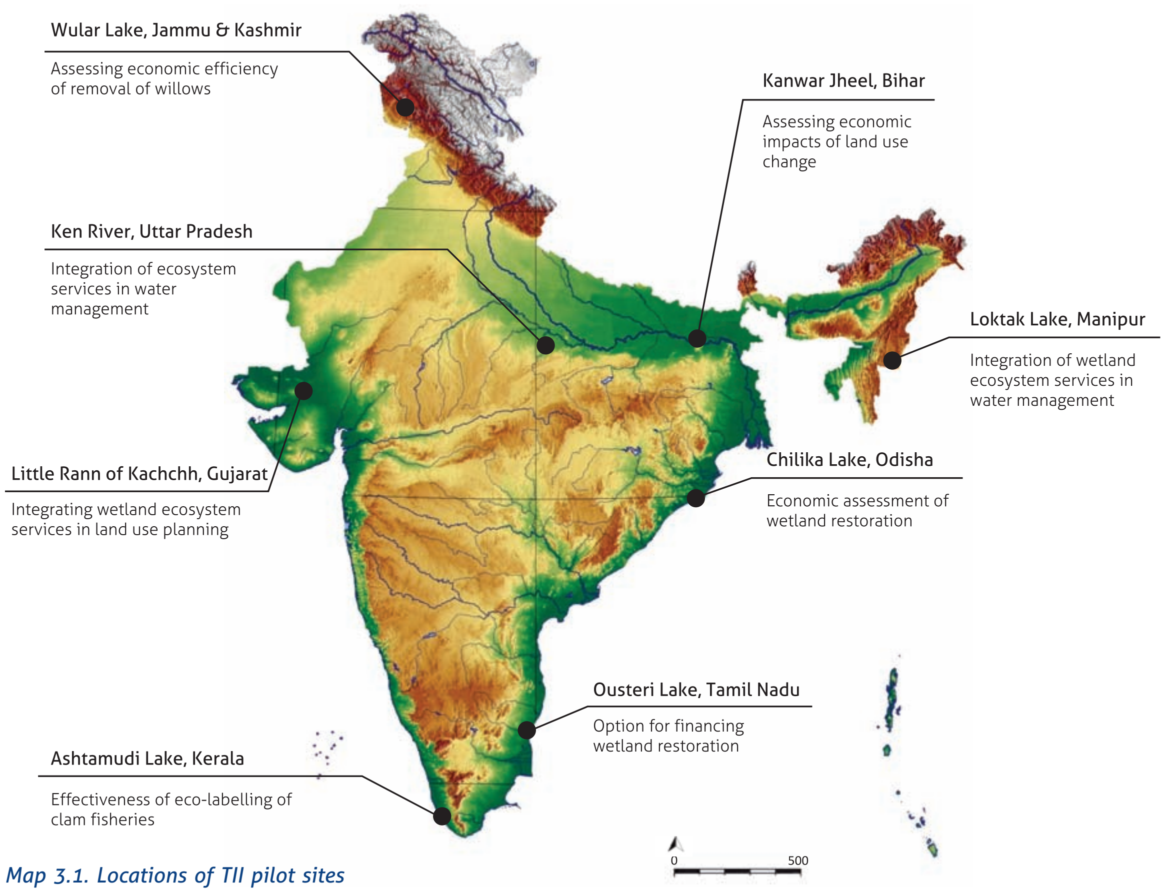
Based on sociological considerations, there is a need to build in participation and deliberation in valuation of wetlands. Values, in whatever units, emerge from interactions with systems, both people with nature as well as nature with people and value formation therefore is an ongoing process. This perspective yields challenges to commensurability as well as static view of ecosystems as existing in equilibrium state. Institutions serve to enhance the relationship with environment through enabling collective decision-making rather than reducing them to individual, independently optimizing units. Enriching valuation methods with institutional approaches and deliberations will make assessment outcomes more relevant from management and decision-making perspectives.

Rigorous assessment of the effects of ecosystem changes on ecosystem services calls for application of integrated ecological-economic modelling, which can capture various systemic attributes and their socio-economic linkages and can lead to solutions that can balance the conservation-development trade-offs. Addressing threshold effects in wetland ecosystems which can stimulate health and well-being consequences remains an area for future development.

Relevance of TII for wetland management

The analysis presented in the previous sections reinforces that mainstreaming wetlands in sectoral developmental programming has been a major challenge in India, limiting the effectiveness of management efforts taken for conservation and wise use of these ecosystems till date. A narrow appreciation of wetland functioning often leads to their use for a limited set of ecosystem services, mostly provisioning services, while impairing their ability to provide regulating and cultural services.

The TEEB framework is a structured approach to make values of wetlands visible to society to aid informed decision-making and mainstreaming (TEEB, 2010). The first step, recognizing ecosystem services values, involves making stakeholders aware of the values in the first place. In places where policy decisions and investments impact, or are likely to impact wetlands functioning, demonstrating values helps in decision-making that takes into account the full range of ecosystem services and biodiversity values, rather than a smaller subset which is considered by markets as private goods. The third stage, capturing ecosystem values, refers to use of mechanisms to incorporate values of wetlands ecosystems through



Map 3.1. Locations of TII pilot sites

altered price signals or incentive mechanisms. The framework can be used to improve awareness of ecosystem service values, consequences of sectoral programming, and options that exist to address conservation – development trade-offs. The framework is particularly useful in demonstrating the inter-relationship between wetland 'values' and societal objectives of water, food and climate security, to propagate the idea of wetlands as 'natural capital' (Russi et al., 2012).

The following policy and decision-making contexts were identified as suited for application of economic approaches to assessment of ecosystem services values of Indian wetlands:

- Economic case for investment in wetland restoration.
- Integration of wetlands in land use planning and regulation.
- Wetlands and integrated water resources management.
- Property rights and improving distribution of costs and benefits.
- Use of market based instruments for supporting wetland wise use.
- Financing wetland conservation and management.

Following screening of project proposals from an open call, nine wetlands and wetland complexes were identified as pilot sites wherein the aforementioned themes were being addressed. An overview of wetland types, ecosystem services assessed and decision-making contexts is presented in Table 3.1 and locations depicted in Map 3.1 (see page 19). The following chapter highlights the lessons learnt from the pilot projects for each of these policy and decision making contexts.

Table 3.1: Features of TII pilot sites

Wetland	Wetland type		Ecosystem Services Assessed											Policy and decision making context					
	Inland	Coastal	Food	Fibre and Fuel	Freshwater	Moderation of water regimes	Erosion prevention	Inland navigation	Pollution control and detoxification	Erosion protection	Groundwater Recharge	Recreation	Species habitat	Wetland restoration	Land use planning and regulation	Wetlands and integrated water resources management	Property rights	Use of market based instruments	Financing
Chilika, Odisha		•	•	•				•				•	•	•			•		•
Loktak, Manipur	•		•	•	•				•							•			•
Kanwar, Bihar	•		•	•							•				•		•		•
Little Rann of Kachchh, Gujarat	•		•									•			•				
Ashtamudi, Kerala		•	•						•									•	•
Ousteri, Puducherry and Tamil Nadu	•		•									•	•					•	
Wular Lake, Jammu & Kashmir	•		•			•						•		•					•
Ken, Uttar Pradesh	•		•									•				•			
Mangroves of Gujarat		•	•				•							•					•

4. Integrating value of wetlands in planning and decision-making

Late Ashwin Pomal

Flamingo nests, Flamingo City, Kachchh, Gujarat

- The benefits of wetland restoration outweigh its costs even when a sub-set of ecosystem services and biodiversity values are taken into account.
- Managing wetlands for a narrow range of ecosystem services is an economically inefficient decision. The full range of biodiversity and ecosystem service values of wetlands should be considered in water and land use planning.
- For ecological restoration to translate into livelihood benefits, dimensions of social equity and fairness in distribution of costs and benefits need to be factored in planning processes.
- Incentive based mechanisms can complement regulatory approaches for achieving wetland conservation and wise use.
- Resource gaps for funding wetland management can be substantially reduced if convergence opportunities with development sector investments are effectively utilized.

Wetland restoration

Wise use and removing the pressures leading to adverse change in wetland ecological character are best practices for ensuring that these ecosystems continue to provide their wide ranging biodiversity and ecosystem services values. However, in situations wherein wetland structure and functioning have been adversely affected, restoration is an important opportunity for the society to recover and enhance benefits from these ecosystems. Wetland restoration involves implementing actions that promote a return to previous state, or improve ecosystem functioning, without necessarily seeking return to a pre-disturbance stage. Successful wetland restoration involves three principal dimensions, namely utilization of native wetland species in characteristic assemblages, integration of wetland functioning within wider landscape scale planning, and reduction or elimination of drivers of wetland degradation (SER, 2004).

Restoration costs, its effectiveness and ecological and socio-economic outcomes, are ecosystem and site-specific. Available evidences indicate that the cost of restoration of coastal wetlands such as coral reefs is substantially higher than other wetlands. Restoration can be achieved through 'passive interventions', which remove adverse pressures (for example, by banning unsustainable fishing practices), or through 'active interventions' (as restoring hydrological regimes). In several instances, it is difficult to restore biodiversity and ecosystem services values associated with natural ecosystems as thresholds of irreversibility may have already been breached.

Restoration entails financial resources. Costs of restoration and its potential benefits are important considerations for allocating finances for restoration projects. TII included three studies wherein costs and benefits of wetland restoration were assessed. In all these studies, despite taking into account only a sub-set of ecosystem services, the benefits of restoration outweigh the restoration costs.

Case 1: Restoration of Lake Chilika, Odisha

Chilika is a brackish water lagoon spanning 1,165 km^2 along the east coastline of the state of Odisha. The diverse and dynamic assemblage of fish, invertebrate and crustacean species provides the basis of rich fishery, which generates over 6 per cent of the state's foreign exchange earnings and supports livelihoods of 0.2 million fishers. In 1981, considering its rich biodiversity value and socio-economic significance, Chilika was designated as a Wetland of International Importance (Ramsar Site under the Convention on Wetlands) by the Government of India.

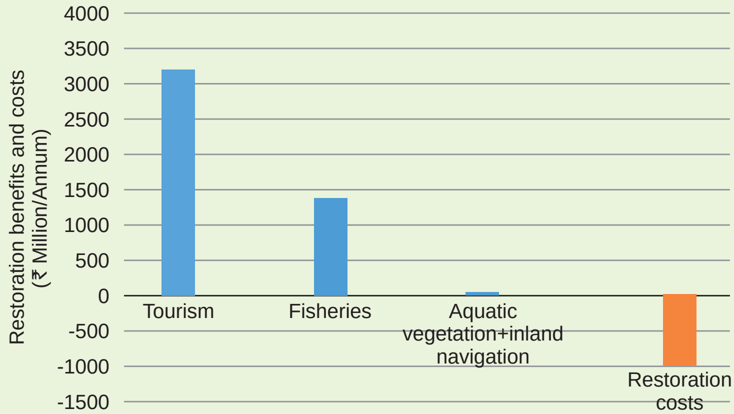
During 1950 – 2000, Chilika rapidly degraded due to increasing siltation from catchments and a variety of anthropogenic activities, which choked the lagoon's connection with the Bay of Bengal. Between 1985/86 and 1998/99, the annual fish landings crashed from 8600 MT to 1702 MT. Proliferation of shrimp culture led to gradual breakdown of traditional resource management systems and increased livelihood conflicts. In 1993, Chilika was ultimately placed under the Ramsar Convention's Montreux Record.

The Government of Odisha created the Chilika Development Authority (CDA) in 1991 as the nodal agency to undertake measures for ecological restoration. The Authority is chaired by the Chief Minister, Government of Odisha, and has membership of Secretaries of all concerned departments, political representatives as well as representatives of fisher communities. In 2000, a new mouth to the Bay of Bengal was cut open following recommendations from modelling studies and stakeholder consultations. A comprehensive lake basin management programme is being implemented since then, incorporating components of catchment revegetation, maintaining hydrological regimes, sustainable fisheries, livelihood improvement and communication and outreach. Wetland monitoring programme has been put in place to comprehensively assess the state of ecological character, and recommend necessary adaptation measures.

WISA Photo Library

Lake Chilika

Restoration measures have led to several positive changes in Chilika's biodiversity and ecosystem services. A salinity gradient within the lagoon has been re-established. The average fish landing during 2001 – 14 was nearly 13,000 MT. The Irrawaddy Dolphin population has increased from 89 to 158 individuals between 2003 and 2014, along with an increase in habitat use, improved breeding and dispersal, and decline in mortality rates. The sea grass meadows have expanded from 20 km^2 in 2000 to 80 km^2 at present. Improvement of Chilika habitat, in particular the increase in dolphins, has led to a resurgence of wetland tourism. The annual number of tourists visiting the wetland during 2000 – 2014 averaged 0.3 million – an increase of over 60 per cent as compared to arrivals during 1994 – 1999. Based on the positive changes in ecological character, Chilika was delisted from Montreux Record of the Ramsar Convention and the intervention recognized with the Ramsar Wetland Conservation Award.

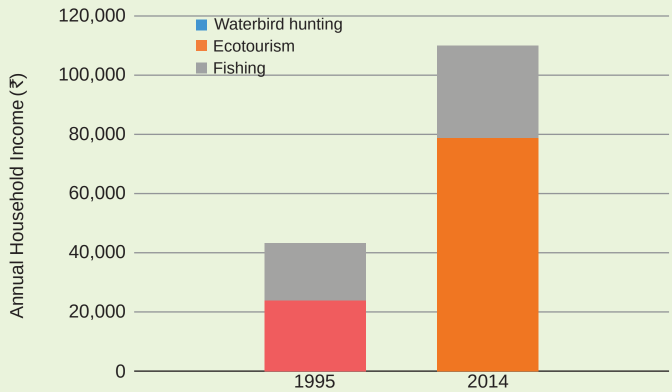


Of the current bundle of ecosystem services, fisheries, inland navigation and use of aquatic vegetation were valued using available market prices. The annual flows of benefits from these were assessed to be worth ₹ 1463 million, ₹ 34 million and ₹ 14 million respectively. The annual economic value of wetland tourism, derived using individual travel cost method, was estimated to be ₹ 3,379 million. Non-use benefits were estimated to be ₹ 167 million per annum.

To sustain these benefits, since its inception in 1991, CDA has incurred programmatic expenses of ₹ 1608 million. This translates into an average annual investment (adjusted at 5% rate of interest) of ₹ 1028.9 million. Using a select set of ecosystem services, namely increase in fish landings and recreational benefits, the benefit cost ratio was assessed to 15.44. The role of CDA as an institution to coordinate restoration with participation of stakeholders is also underscored.

Ecological restoration of Chilika has also promoted local-level transformation in attitudes towards wetlands. The case of ecotourism at Manglajodi stands out as a community initiative for creating win-win opportunities for wetland conservation as well as securing livelihoods of dependent communities. Manglajodi village fringes the marshy environment of wetland's northern shorelines. Shallow depth, plentiful of food and varied vegetation makes this area an ideal habitat for migrating water birds. The fishers of Manglajodi, once deriving livelihood from illegal water bird hunting, presently sustain themselves on community managed wetland ecotourism venture under the aegis of their society, 'Sri Sri Mahavir Pakshi Surakshya Samiti (SSMPSS)'. Water bird hunting in Manglajodi flourished in the 1980s and 90s. However, in 1999, when the contours of Chilika restoration were being laid out, controlling illegal hunting of water birds was identified as a major issue. CDA, with the support of local NGO 'Wild Orissa', initiated a community-based ecotourism programme in order to promote ecotourism as an alternate livelihood option. As a part of these efforts, establishment of SSMPSS was facilitated in 1999. CDA provided support for construction of an office space and watchtowers, provided three boats and other bird watching equipment to cater to the tourists, and undertook training of local guides in bird identification and natural history.

As the number of tourists visiting Chilika soared after the hydrological restoration, the number of footfalls to Manglajodi (which next only to Nalabana, consistently supports large water bird congregation numbers) also increased. The community has since been making much higher and steady income from tourists interested in bird watching, than the income levels and risks associated with illegal water bird hunting. Presently, the area is visited by 5,000 tourists each year and stands out as one of the popular destinations for watching migratory water birds within a serene and scenic environment. Apart from direct economic benefits, the initiative has resulted in improved habitat quality of migratory water birds. Over 50 species of water birds have been recorded in this area, of which over 30 are migratory. Community members provide protection to nests and eggs, and promptly report any damage to the society members. The use of manual paddle boats helps maintain serenity of environment, and enriches nature-watching experience of the tourists.



Analysis of income patterns validates the direct benefits accrued to the communities. As per assessments carried under TII, annual household incomes have increased over 2.5 times in the last two decades (from ₹ 44,952 in 1995 to ₹ 1,12,460 at present), also bringing dignity in profession. Awards such as Pakshi Bandhu Puraskar (2001) and Biju Patnaik Pakshi Mitra (2007) have instilled confidence in the society members to pursue and strengthen their conservation efforts. The TII study at Manglajodi recommends integrating such local solutions into the wider integrated management planning process to ensure that the communities continue to benefit from an improved environment, and to prevent their incremental gains being crowded out due to adverse anthropogenic impacts.

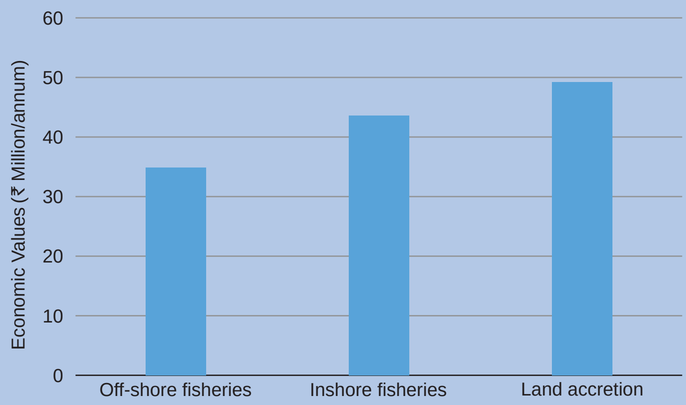
TII Study Title: Economics of Ecosystem Services and Biodiversity for Conservation and Sustainable Management of Inland Wetlands

Authors: Ritesh Kumar and Anita Chakraborty, Wetlands International South Asia, New Delhi

Case 2: Mangrove restoration in Gujarat

The State of Gujarat has more than doubled its mangrove cover since the 1930s (from 854 km² to 1,107 km² in 2013) owing to government's efforts in restoring degraded mangrove patches along its 1,650 km coastline. The TII study valued the contribution regenerated mangroves make towards inshore fisheries and prevention of coastal erosion.

When compared with creeks with no mangroves, the daily catch of artisanal fishers was found to be 4.23 kg higher in creeks with natural mangroves, 3.96 kg higher in creeks having enriched plantation and 0.94 kg higher in creeks wherein mudflats have been planted with mangroves. Analysis of 26 years of data on off-shore commercial fisheries also indicates significant increase in catch of mangrove-dependent species. The annual contribution of mangrove plantation to commercial fishery was estimated to be 51 tons of demersal, 45 tons of crustaceans and 11.5 tons of mollusks. Coastal areas planted with mangroves also exhibited higher rates of accretion leading to net increase in land area by 2,206 ha during 1990 – 2013.



The annual monetary value of the two ecosystem services was assessed to be ₹ 95.5 million. When mangroves were planted using direct sowing method, the two ecosystem services benefits were estimated to fully cover plantation costs within 15 years even with 5 per cent rate of discount. The study recommends taking a long-term view on mangrove restoration projects, and adopting low-cost plantation techniques.

TII Study Title: Accounting for Regenerated Forests: Evaluating the Flow of Ecosystem Services from Regenerated Mangroves Compared to Original Mangrove Forests

Author: Saudamini Das, Institute of Economic Growth, New Delhi

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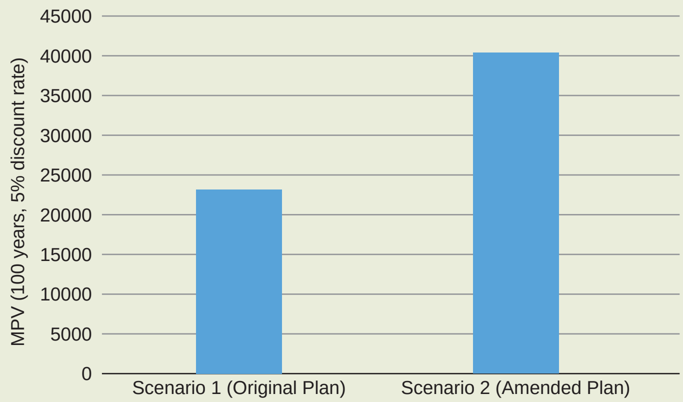
Mangroves in Gulf of Khambhat, Gujarat

Case 3: Willow removal for restoration of Wular Lake, Jammu & Kashmir



Located 34 km northwest of Srinagar City, Wular is the largest wetland in Kashmir Valley, spanning 160 km^2 with 18 km^2 as associated marshes. Wular and its marshes moderate hydrological regimes of the valley by absorbing high summer flows and gradually releasing water during winters. Migrating water birds of the Central Asian Flyway use the wetland as habitat for feeding and roosting. Communities living around the wetland harvest fish, water chestnut, and lotus rhizomes for their livelihoods. In 1990, Wular was designated as a Ramsar Site.

Wular has witnessed a massive shrinkage in area over the last century, reducing from 213 km^2 in 1911 to 130 km^2 in 2011, mainly due to drainage of marshes, siltation and plantation of willows to meet the fuelwood needs of the local people. This has impaired natural functioning of the wetland, particularly its ability to moderate water regimes and support livelihoods of dependent communities.

A management plan for wetland restoration formulated in 2007 by Wetlands International, recommended augmentation of water holding capacity by removal of willows from the wetland fringes and selective dredging of heavily silted upper areas. The TII study looked into economic feasibility of the proposal to remove willows. Benefit and cost flows were estimated for major stakeholder categories. Two management scenarios: S1 (reduction in areas under willows in wetland's southern fringes by 27%) and S2 (complete removal of willows from wetland's southern fringes) were compared with business as usual course of action (no removal). Impacts of interventions on hydropower production, aquatic vegetation, fisheries, floods, carbon sequestration, and wood for business processes were considered.

The study found Net Percent Value (NPV) of willow removal to be substantial for the two intervention scenarios as compared with business as usual. At 8 per cent discount rate, the NPV for scenarios S1 and S2 were ₹ 15,104.27 million and ₹ 26,211.2 million respectively, thus validating the need to restore water holding capacity of Wular from an economic efficiency perspective. A need to progress wetland restoration in a time bound manner is recommended by the study.

Wular Lake, Kashmir

TII Study Title: Economic Feasibility of Willow Removal from Wular Lake, Jammu and Kashmir, India

Author: Rahul Kaul, Wildlife Trust of India, New Delhi

Land use planning and regulation

Anthropogenic land use is a critical driver of terrestrial conditions that affect structure and functioning of wetlands. Wetlands are expressions of geophysical, ecological and social histories of the landscapes in which they are situated. The terrestrial and aquatic components of landscapes are intricately linked through exchange of water, nutrients and species. Thus, the objective of securing wetland biodiversity and ecosystem services values can only be met if management of wetlands is embedded within the management of broader landscape.

Wetlands are often managed to deliver provisioning services (for example, using wetlands for food production and water supply) to meet landscape scale food and water security needs. However, such management compromises the ability of these ecosystems to deliver regulating services (as flood buffers, groundwater recharge zones), cultural services (religious and aesthetic values related to wetlands) and provide habitats to biodiversity. It is increasingly recognized that full range of biodiversity and ecosystem services values provided naturally by wetlands should be considered in landscape scale development programming to ensure that multiple management objectives are met and their ecological character maintained. The Wetland (Conservation and Management) Rules, 2010 require that the zone of influence of wetlands is defined and measures taken to ensure that land use change within this zone does not adversely affect wetland functioning.

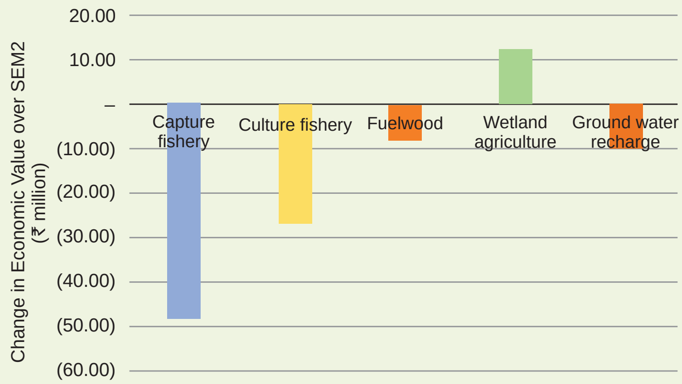
TII looked into economic dimensions of land use change and wetland functioning in the case of Kanwar Jheel (Bihar) and Little Rann of Kachchh (Gujarat). The studies indicate that managing wetlands for a narrow range of ecosystem services is economically inefficient. Pathways for factoring in wetland ecosystem services and biodiversity values in landscape planning have been suggested.

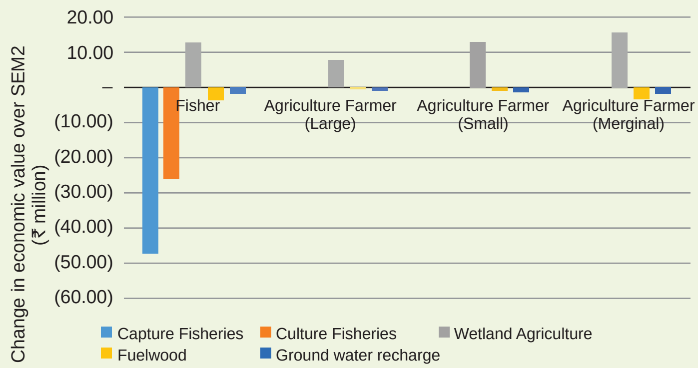
Case 4: Balancing multiple uses in Kanwar Jheel, Bihar

Kanwar Jheel is part of an extensive floodplain complex formed in the lower reaches of Gandak-Kosi interfan in North Bihar. Located at a distance of 21 km from Begusarai town, Kanwar is the largest of several shallow permanent and ephemeral wetlands formed between River Burhi Gandak and paleo-channel of River Bagmati. The wetland complex has a highly variable inundation regime, expanding to nearly 6700 ha during monsoon and shrinking to 600 ha during summers, exposing nearly 2600 ha of grasslands, large parts of which are used for agriculture.

Kanwar is the mainstay of livelihoods of 22,000 farmer and fisher households. High soil moisture, better water availability and the highly fertile silt received from the riverine inundations underpin resource productivity. Kanwar helps reduce flood risks for the adjoining settlements by acting as buffer and accommodating significant proportion of local runoff and bank flows of River Burhi Gandak. The wetland teems with water birds in the winters, and is one of the important congregation areas in North Bihar, particularly for migrating ducks and coots. The island of Jaimangalagarh located in its southern part has high archaeological significance. Considering its high water bird diversity, since 1989, Kanwar has been designated as a Sanctuary by the name of 'Kanwar Lake Bird Sanctuary' under the provisions of Indian Wildlife (Protection) Act, 1972.

Despite such high ecological and socio-economic significance, management of Kanwar has received little attention in the regional developmental programming. The wetland complex has been subject to extensive hydrological regime fragmentation and conversion for permanent agriculture. This has resulted in near-complete decimation of fisheries, reduced biodiversity habitats, especially of migratory water birds and impaired ability of wetland complex to moderate hydrological regimes. Shrinking resource base has accentuated conflicts between farmers and fishers.





TII study at Kanwar aimed at economic analysis of trade-offs associated with land use transformation and its distributional impacts. Three land use scenarios, corresponding to business as usual with peak inundation covering only 50 per cent of wetland area (BAU), situation in 1980s wherein 70 per cent area is inundated (SEM 1), and 1970s situation with the entire wetland inundation (SEM2) were modelled for four ecosystem services, namely capture and culture fisheries, wetland agriculture and groundwater recharge. Economic analysis indicated that when compared with SEM2, BAU scenario corresponded with a benefit of ₹ 12.7 million worth wetland agriculture, but at a loss of ₹ 47.8 million worth capture fisheries, ₹ 26.3 million worth culture fisheries, ₹ 8 million worth aquatic vegetation and ₹ 9.6 million worth groundwater recharge value. Thus, conversion of a multifunctional wetland to a predominantly agriculture landscape was an economically inefficient decision.

In terms of distributional equity, restoration to SEM1 and SEM2 scenario is likely to impose significant opportunity costs for farming community. Keeping in view the overall technical feasibility and costs of achieving each of the scenarios, the study recommends restoration of wetland regime towards SEM1 condition, while building in alternate livelihoods options for marginal and small farmers.

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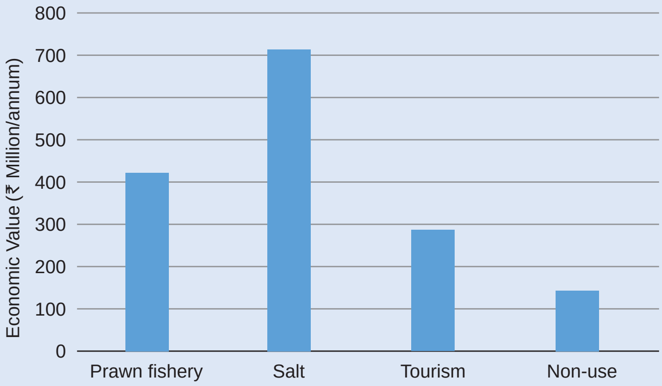
Kanwar Jheel, Bihar

TII Study Title: Economics of Ecosystem Services and Biodiversity for Conservation and Sustainable Management of Inland Wetlands

Authors: Ritesh Kumar and Kalpana Ambastha, Wetlands International South Asia, New Delhi

Case 5: Little Rann of Kachchh, Gujarat

The Little Rann of Kachchh (LRK) is an extensive salt marsh in the state of Gujarat, spanning 3,570 km^2 between the Great Rann and the Gulf of Kachchh. Over 30 per cent of country's inland salt is produced here. The region is also the main source of export of Ginger prawn (*Metapaeneus kutchensis*) and abounds with spectacular biological diversity. LRK is a notified protected area.



TII study on LRK focused on assessing its key production systems (salt production, prawn fishery and tourism) and eliciting economic estimates of use and non-use values. The annual flow of economic benefits from LRK were assessed to be ₹ 1,517 million. These include ₹ 410 million worth prawn fishery, ₹ 694 million worth salt production, and ₹ 276 million worth recreational tourism, and the rest resulting from non-use values. The direct use values sustain livelihoods of over 12,000 households.

The economic values are contingent on LRK's dynamic hydrological regime created by its three principal sources of water inflows, namely catchment runoff (21%), rainfall (52%) and seawater (27%). Increasing upstream storages and blocking of creeks impose high risk to maintenance of this variable water regime, thereby threatening ecosystem services and biodiversity values. The study calls for balancing upstream land uses with ecological and hydrological functioning of LRK.

TII Study Title: Economic Valuation of Landscape Level Wetland Ecosystem and its Services in Little Rann of Kachchh, Gujarat

Author: A.M. Dixit, Centre for Environment and Social Concerns, Ahmedabad, Gujarat

A. M. Dixit

Pelicans in Little Rann of Kachchh

Wetlands and integrated water resources management

The presence of water, permanently or seasonally, provides the conditions for development of soil, microorganisms and plant and animal communities, which differentiate wetland characteristics from terrestrial or pure aquatic habitats. For most wetland types, precipitation accounts for a small fraction of the overall water regime, the majority being the surface and groundwater exchange from rivers and streams and sea in the case of coastal wetlands. Wetland functioning is therefore predicated on the extent to which water of right quantity, timing and quality is allocated for these ecosystems within wider basin and coastal zone level planning.

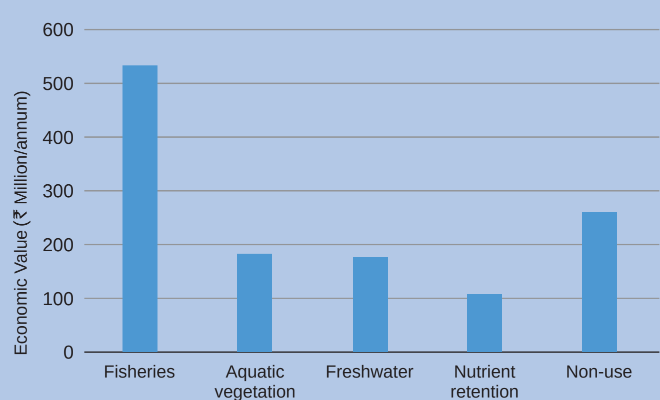
Integrated Water Resources Management (IWRM), a process which promotes coordinated development of land, water and related resources for maximizing economic and social welfare in an equitable manner without compromising ecosystem sustainability, is recognized within India's national water policy as framework for managing water resources. Implementation, however, is limited to protecting wetlands of high biodiversity or provisioning services value through building in an allocation of water for ecosystem functioning.

A more meaningful integration can be achieved by taking into account water-related ecosystem services (such as buffer for extreme events, water recharge and purification, silt and nutrient traps) while considering options for various water management objectives targeted through IWRM. Ecosystem services need to be factored in as 'natural solutions' for water management planning and decision-making. Equally important is to consider implication of water management on wetland functioning through assessment of hydrological regime linkages between various parts of river basins and coastal zones. It is vital that wetlands are recognized as sources of water rather than as competing users.

Within TII, the aspect of integration of wetland ecosystem service values in water management was the focus of studies in Loktak Lake, Manipur and Ken River, Madhya Pradesh. The case of Loktak demonstrates ways in which trade-offs resulting from modification of natural water regimes can be addressed by considering full range of wetland biodiversity and ecosystem service values. Similarly, the study on River Ken underlines the need to consider interconnectedness of flow regimes with ecosystem services values in river basin scale planning and decision-making.

Case 6: Water allocation policy for Loktak Lake, Manipur

The floodplain wetlands of Manipur River known as Loktak Lake complex, encompassing Loktak, Pumlen, Ikop, Kharung, Khoidum and other satellite wetlands, are lifeline of the North-Eastern state of Manipur. Spanning over 469 km² in Bishnupur and Thoubal Districts, these wetlands are the largest source of fish, edible plants and freshwater; underpinning water and food security for a large population dependent on wetland resources for sustenance. *Phumdi-*



floating masses of vegetation-are characteristic features of the wetland complex. Keibul Lamjao in the southern part of Loktak has a single contiguous mass of *phumdi* area spanning around 40 km^2, which serves as the only known natural habitat of the globally endangered deer *Rucervus eldii* (Manipur Brow–antlered Deer, locally called Sangai), and has been notified as a National Park since 1975. In 1990, Loktak was designated by Government of India as a Wetland of International Importance under the Ramsar Convention.

Seasonal fluctuations in water levels and variable inundation regime enable flood attenuation, sediment flushing and nutrient uptake by *phumdi*. The natural hydrological regimes have, however, been transformed over last decades by water resources development projects. Construction of Ithai barrage in 1984 entailing regulation of lake levels for hydropower generation converted a naturally fluctuating wetland into a reservoir leading to inundation of peripheral areas, loss of migratory fisheries, reduction and degradation of National Park habitat, and decline in water quality. Of particular concern has been rapid proliferation of phumdi in the central sector, which prior to 1984 was very limited. Loktak Development Authority, constituted by the state government in 1986 for lake management has recently implemented a partial restoration programme, particularly aimed at restoration of open water area and reduce siltation. The core issue of balancing water allocation for hydropower and irrigation with ecological needs of wetland functioning is yet unaddressed. TII included Loktak Lake as a case study for identifying pathways for integrating wetland functioning in water resources planning and decision-making.

The benefits derived from fisheries, aquatic vegetation, supply of water for hydropower generation and nutrient retention by phumdi were assessed to be worth ₹ 1,277 million annually. The current pricing mechanism for hydropower does not factor in Loktak waters as an input to production processes and thereby does not provide efficient resource scarcity signals. The impacts of inefficient water management are ultimately realized in terms of livelihood consequences for wetland communities and restoration costs borne by state exchequer.

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Loktak Lake, Manipur

A scenario analysis was conducted to meet various ecological and human objectives of water management. The analysis indicated that prioritizing water for hydropower would lead to impacts on park habitat, whereas mimicking natural regimes would lead to considerable reduction in hydropower. A multiple objective led water management performed the best towards meeting ecological and social objectives, however, water allocation for hydropower production would need to be reduced during winters. The economic assessment indicates the possibility of narrowing water resources conflict by basin-scale water management, and supplementing hydropower deficit during winters through alternate sources.

TII Study Title: Economics of Ecosystem Services and Biodiversity for Conservation and Sustainable Management of Inland Wetlands

Authors: Ritesh Kumar and Akoijam Yaiphaba Meetei, Wetlands International South Asia, New Delhi

Case 7: Ecosystem services of River Ken

River Ken, a major north-flowing tributary of River Yamuna, is an inter-state river between Madhya Pradesh and Uttar Pradesh. The river has relatively low anthropogenic pressure on account of limited urban and industrial development within its basin. The river hosts the Panna Tiger Reserve (PTR) and a gharial (*Gavialis gangeticus*) sanctuary, and supports high fish diversity.

Under TII, a rapid assessment of Ken River was taken up to highlight ecosystem service values for a flow dependent ecosystem. A sub-set of values provisioning and cultural values were assessed using tools of market and non-market valuation.


Brij Gopal

Ken River, Madhya Pradesh

High quality sand extracted from Ken River, is preferred and extensively used in many districts of Uttar Pradesh. As per the study, ₹ 25,000 million worth of sand is extracted from leased mines in downstream reaches. An additional ₹750 million accrues to communities living in the adjacent villages from this activity. The river also supports high fish diversity of which nine species are rare, endangered and vulnerable, and some restricted only to upstream reaches. Contribution from fisheries has been estimated at about ₹ 0.2–1.7 million in four different downstream stretches from Banda to Chilla Ghat. The river also plays an important role in sustaining ecosystem services and biodiversity value of Panna Tiger Reserve, assessed to be worth ₹ 3,690 million per annum.

Ecosystem services of rivers, as Ken, are intricately linked to flow regimes. The study recommends careful consideration of these interlinkages in planning for river resources development.

TII Study Title: Integrating the Economics of Wetland Biodiversity and Ecosystem Services in Management of Water Resources of River Ken

Authors: Brij Gopal and D.K. Marothia, Centre for Inland Waters in South Asia, Jaipur, Rajasthan

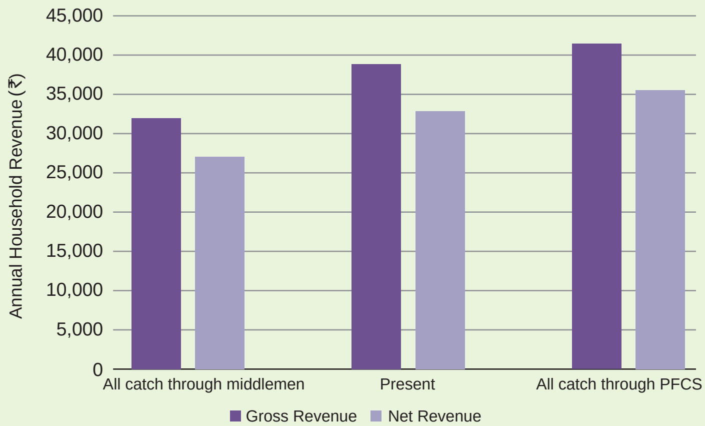
Property rights and improving distribution of costs and benefits

Wetlands, owing to their inherent complex characteristics as multiplicity and joint production of several ecosystem services benefits, are influenced by a range of property rights held by communities as well as the state. These have a significant bearing on access, use and management of wetlands. The rights also underpin and determine the motivations and institutional structures under which stakeholders value and utilize ecosystem services and biodiversity, ultimately influencing the possibility of achieving wise use. Lack of clearly defined property rights and institutional fit with ecosystem functioning can accentuate wetland degradation by limiting management effectiveness. The coexistence of contrasting individual and communal rights to wetlands has led to resource use conflicts in several circumstances.

Including social fairness and improvement of community livelihoods as objectives of wetland management, along with those related to ecological features, is a key step towards improved sharing of costs and benefits related to policy decisions linked with water and wetlands. Mapping stakeholders and institutions with ecosystem services and eliciting stakeholder differentiated benefit and cost sharing, provides the analytical framework for assessing social fairness dimensions, particularly ecosystem services trade-offs.

TII included assessment of distributive aspects of wetland ecosystem services and biodiversity values in the case studies on Lake Chilika and Kanwar Jheel (results summarized in Case 4). The studies indicate that management plans aimed at ecological restoration are likely to have limited impact on livelihoods and stakeholder engagement, if explicit consideration of property rights and restoration costs and benefits is not factored within planning processes.

Case 8: Improving livelihoods of fishers of Chilika, Odisha



For generations, the fishers of Chilika managed lagoon fisheries by putting in place an informal but nuanced management regime designed on their indigenous understanding of fishing grounds, fish recruitment and migration patterns and crafts and gear specialization of various sub-castes. Introduction of capital intensive prawn culture in 1984 – 85 prompted entry of non-fishers in the lagoon, gradually edging out the primary fishers and ultimately leading to near complete disruption of community managed fisheries. The Primary Fisher Cooperative Societies (PFCS) put in place to protect the interests of fishers were moribund by mid-1990s due to weak capacities and economic non-viability. A majority of fishers fell in debt trap of the scrupulous money lenders who used their power to buy the fish catch at rates substantially lower than the markets.

While the hydrological intervention of 2000 was able to restore the necessary ecological conditions for rejuvenation of fisheries, the key to its sustenance lies in the design of institutional arrangements and mechanisms through which various stakeholders gain access and control over the resource base. Socio-economic surveys conducted in 2008 indicated that despite a near seven-fold increase in fish catch, the per capita income of fishers increased by only one-third, a majority (85%) continued to be in debt and there was nearly no change in access to basic amenities. With over 90 per cent of the fish catch of over 33,000 fishers traded through 1,300 middlemen, a coercive market structure continued to prevail in Chilika.

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Fishing in Chilika, Odisha

CDA responded to the situation by developing a Fisheries Resource Management Plan, focused on strengthening the role of PFCS in managing the catch. Investments were made in improving the condition of landing centres, training cooperative members in sustainable fisheries management, providing ice boxes to fishers to prevent distress sales and infusing capital so that the members could source loan from their own institutions rather than depending on middlemen.

TII looked into the impact of such intervention on livelihoods of fishers. Data from a sub-set of 106 cooperatives indicated that strengthening the role of PFCS had increased gross annual value realization of fisher households by 21 per cent. The annual interest outgo on debt also reduced by 13 per cent as over one-fifth of the fishers were able to source loan from these societies instead of middlemen. If the cooperatives are able to manage the entire fish trade, the gross revenue to each of the fisher household is likely to be over 30 per cent higher than the situation in 2008, when the entire trade was controlled by middlemen. The case of Chilika fisheries underlines the need to bring in the goals related to distributional equity within the framework of ecological restoration so as to ensure that livelihoods of the dependent communities are improved as an incentive for resource stewardship.

TII Study Title: Economics of Ecosystem Services and Biodiversity for Conservation and Sustainable Management of Inland Wetlands

Authors: Ritesh Kumar, Satish Kumar and Anita Chakraborty, Wetlands International South Asia, New Delhi

Market-based instruments and wise use

Based on the values people hold for their environment, important repercussions for ecosystem services could result just by making the link between the economy and environment more explicit. Markets influence individual and societal production and consumption choices through prices. Market-based instruments can be used as support for wetland wise use by altering incentives related to various sectors which influence ecosystem functioning. Experience has shown that well designed market-based instruments can achieve environmental goals at less cost than conventional "command and control" approaches, while creating positive incentives for continual innovation and improvement.

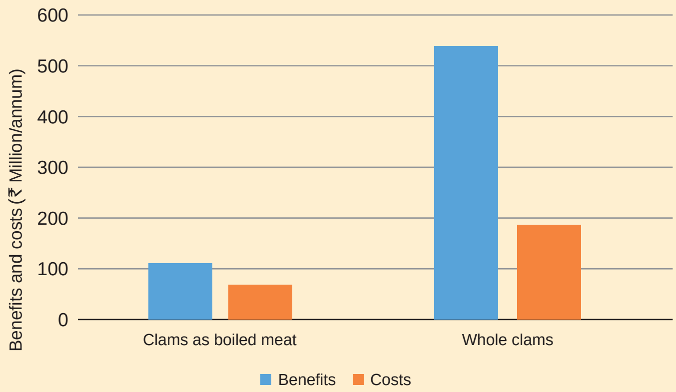
Market-based instruments are being increasingly used to achieve environmental policy outcomes through use of efficient market signals, which internalize costs and benefits associated with policy decisions impacting environment. Taxes, fees and charges raise the cost of environmentally damaging actions, whereas subsidies reduce the costs of environment-friendly activities. Quantity based instruments set limit on use of resource and often lead to development of markets wherein user rights can be traded. Liability-based instruments assign responsibility for preventing and remediating environmental damages to the responsible agents. Payment for ecosystem services has attracted increasing interest as a mechanism for translating external, non-market values of the environment into real financial incentives for local actors for services provision. Wetland banking and water quality trading permits (United States), salinity credits (Australia), and PES schemes (in Latin America, China and Japan) indicate the possibility of using market-based instruments for wetland management.

Indian environment policy has predominantly built on regulatory approaches. Use of market-based instruments has been largely limited to pollution control, and more recently it has been branched into forest policy (Compensatory Afforestation Programme) and management of marine fisheries (incentives for seasonal fishing ban). The continued loss and degradation of wetlands indicate the need to complement regulatory approaches with innovative market-based instruments to incentivize wise use. PES schemes in particular should be considered within the range of wetland management tools to create incentives for sustainable use of wetland resources. Market-based instruments can also serve as information raising instruments, creating important signalling and awareness effect. However, these instruments are relevant only when the underlying cause of environmental degradation is 'economic', and internalization of environmental externalities, the likely solution.

Within TII, use of market-based instruments was included in the design of studies on Ashtamudi (Kerala) and Ousteri (shared between Puducherry and Tamil Nadu). Assessments in Ashtamudi indicate possibilities of enhancing incentive to wetland dependent communities by eco-labelling tools, whereas the need for PES based instrument is highlighted in the case of Ousteri.

Case 9: Eco-labelling clam fisheries of Ashtamudi, Kerala

Short-necked clams form an important constituent of fisheries in Ashtamudi, a palm-shaped estuary on the west coast of Kerala. Over half of the fisheries economy of Ashtamudi is attributed to clams alone. Besides contributing significantly to the livelihoods of over 3,000 clam fishers, clams also constitute an important component of lake ecology, acting as effective biofilters and increasing nutrient supply in the aquatic environment.



Ashtamudi clam harvest underwent a decline in the 1990s mainly due to use of indiscriminate fishing practices. This promoted government agencies to enforce regulation of use of gear and imposing a fishery ban from December to February – the peak breeding season of the species. These measures helped revive the resource considerably, yet economic value realization to fishers remained low. To assist communities in realizing higher value from a sustainably managed resource, a novel initiative to seek Marine Stewardship Council (MSC) Certification for the short-neck clam fishery of Ashtamudi was taken up in 2013. A study on economics of certification was taken up under TII to assess the extent to which this intervention has benefitted the local communities, and assess potential for replication.

Economic assessments indicated that the benefit from certification was at least 1.8 times higher than its cost. It was also indicated that changing clam processing techniques (from selling clams in the form of boiled meat to whole clams) could yield an additional 75 per cent increase in revenue, bringing in substantial tangible benefits to the communities.

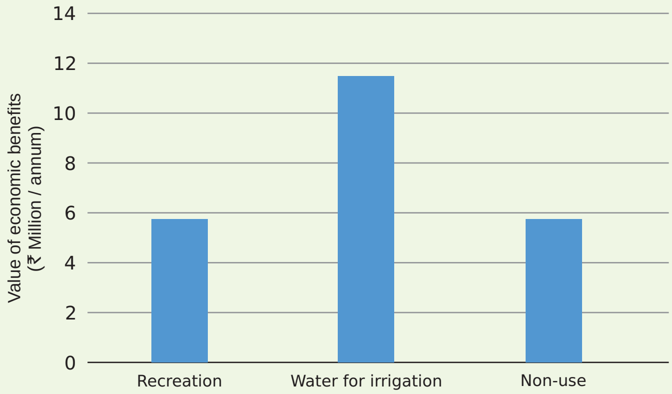
K. Sunil Mohamed

Yellow Clams of Ashtamudi, Kerala

TII Study Title: Assessment of Eco-labelling as Tool for Conservation and Sustainable Use of Biodiversity in Ashtamudi Lake, Kerala (Southwest coast of India)

Author: K. Sunil Mohamed, Central Marine Fisheries Research Institute, Kochi, Kerala

Case 10: Using market-based instruments for management of Ousteri



Ousteri, spanning about 800 hectares across the Union Territory of Puducherry and state of Tamil Nadu is the single largest freshwater resource in the region. The diverse habitats found here attract a number of migratory water birds, earning it the designation of a Bird Sanctuary by Puducherry and Tamil Nadu governments in 2008 and 2014 respectively. This protected area status is intended to secure the wetland habitat from anthropogenic pressures of encroachment, dumping of solid waste and increased human activity in a fragile area. However, such management has curtailed harvest of wetland resources for meeting livelihood needs. TII study used economic valuation methods to assess the benefits of restoration and identify financing options for supporting integrated site management.

When use values of Ousteri (from irrigation benefits and recreation) and non-use values are considered, the natural capital worth of the wetland is assessed to be ₹ 2.44 million per annum. Most of the people living around are willing to pay for the conservation of this wetland, considering this an opportunity to enhance their individual and societal welfare. The study recommends capturing

Ritesh Sharma

Ousteri Lake, Puducherry

this value for supporting wetland management through use of 'Payment for Ecosystem Services', which embeds incentives for the stakeholders to protect the wetland in an efficient, equitable and sustainable basis in the coming years. Management approaches which incorporate stakeholder participation can minimize the transaction costs (such as monitoring cost) of wetland management.

The study recommends stakeholder involvement in wetland management, such as upstream industries (which are willing to participate in reducing the effluent discharge into the wetland) and neighbouring communities who can collectively act in curbing illegal fishing and poaching of wild animals and birds by outsiders in lieu of access to certain important ecosystem benefits.

TII Study Title: Economic Valuation of Ecosystem Services: A Case Study of Ousteri Wetland, Puducherry

Authors: L. Venkatachalam and Zareena Begum, Madras Institute of Development Studies and Madras School of Economics, Chennai

Financing

Wetland conservation and management in India is primarily financed as a part of broader environment sector public investments. A major share of this is made by Union Government. Consideration of the full range of wetland biodiversity and ecosystem services values, supports the case of including wetland conservation and management as a part of broader sectoral development programming both at the level of union government as well as within states and union territories. Wetland restoration can be suitably prioritized to meet the societal water, food and climate security objectives, and included within the financing streams for these objectives.

All of the pilot studies indicate the role of wetlands as 'societal capital', supporting human well-being through their range of provisioning, regulating, cultural and supporting services. Presently, only small fraction of resources required to manage priority wetlands is available within the environment sector budgets. The available resources can be substantially increased if wetland management is financed on the 'principles of convergence' with development sector investments. Resources from private sector can also be tapped to finance wetland restoration as an effort towards building natural capital.

5. Conclusions and Recommendations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A fisher in Loktak Lake, Manipur

An understanding and appreciation of values and benefits of wetlands is central to development of inclusive management approach which secures wise use of these ecosystems. Systematic recognition, valuation and capture of wetland biodiversity and ecosystem services values are the building blocks of such an approach.

The implications for an ecosystem services and biodiversity values led approach for design and implementation of wetlands conservation programmes are significant and multiscalar. Investment is required to broaden dimensions of wetland research, in particular building a better understanding of the criticality of ecosystem processes (particularly hydrological processes), which underpin delivery of ecosystem services. Ecosystem services need to be built into the existing inventory and assessment protocols. Criteria for designating wetlands of national and international importance need to be broadened, from consideration of biodiversity values to include ecosystem services as well. Management planning for the prioritized wetlands should consider ecosystem services related objectives while defining objectives and implementation strategies. The interaction of ecosystem services with livelihood capitals also needs to be addressed with special focus on equity and social fairness related outcomes of wetland management.

Following are specific recommendations for stakeholders to respond to the values of wetland biodiversity and ecosystem services:

Managers of pilot study sites

Lake Chilika, Odisha	• Implementation of lake basin management should be continued to ensure that biodiversity and ecosystem services values are maintained on long-term basis. Ecosystem services and biodiversity values should be integrated into wetland assessment and monitoring system as one of the indicators of management effectiveness. • Primary Fisher Cooperative Societies should be sufficiently capitalized and capacitated to ensure that Chilika fishers are incentivized for sustainable fisheries. • Models of community managed ecotourism should be incorporated into wetland management so that communities gain livelihood benefits from ecological restoration. Such models should form an integral part of wetland management plan, so as to ensure that the benefits are not crowded out due to competing investments and infrastructure development. • Experiences of Lake Chilika ecological restoration should be used to promote integrated and adaptive management of other coastal wetlands, such as Pulicat, Ashtamudi and Vembanad-Kol.
Loktak Lake, Manipur	• Management of water regimes should take into account ecological needs of wetland functioning. Alternate sources for power should be used during winter season to ensure that ecosystem processes are maintained. • Integrated wetland management should be pursued to ensure that ecosystem services and biodiversity can be maintained on long-term basis.
Kanwar Jheel, Bihar	• Management of Kanwar Jheel should aim to restore the hydrological regime to 1980s status, wherein nearly two-thirds of the wetland was inundated for at least 6 months. • Zoning principles should be used to maximize ecosystem services and biodiversity benefits. The core of wetland should be maintained for biodiversity, whereas a mix of capture fisheries and subsistence level wetland agriculture should be permitted in the rest of the wetland to address livelihood needs. • A management authority may be constituted for restoration with representation of all stakeholders and sectors.
Ousteri, Puducherry	• Given the positive willingness to pay for recreational benefits, a user charge may be levied to fund wetland management costs. • Villages located around the wetland should be allowed access to bundle of wetland ecosystem services in return for participation in maintaining wetland biodiversity values.
Little Rann of Kachchh, Gujarat	• Dynamic hydrological regimes which underpin delivery of ecosystem service values of LRK, need to be maintained and integrated in upstream water resources management decisions. • An optimal mix of livelihood systems (salt manufacturing, prawn farming, tourism) should be assessed to ensure that biodiversity values are maintained.
Mangroves of Gujarat	• Mangroves should be considered as long-term assets, and not in terms of short-term gains. • Less costly and participatory methods of mangrove plantation should be preferred for economic efficiency.

River Ken, Uttar Pradesh	• Impacts of river flow diversion on downstream areas in terms of groundwater recharge, sand, fish, riparian vegetation and water quality need to be incorporated in water management decisions. • A detailed policy should be formulated to regulate sand extraction based on its annual availability. • Interdependence of forests, wildlife and riverine ecosystems should be incorporated in accounting framework for river ecosystem services.
Wular Lake, Jammu & Kashmir	• Willows should be removed from Wular fringes to restore hydrological functioning of the wetland complex. • Funds realized from sale of willow wood should be ploughed back into wetland management. • Willow removal may increase spread of invasive species such as alligator weed and azolla. A strategy to mitigate this threat should be part of the existing management plan.
Ashtamudi Lake, Kerala	• Value realization from eco-labelling of clams can be increased substantially if whole clams are marketed and exported instead of current practice of meat processing. • The experiences of Ashtamudi can be replicated in other small-scale fisheries and fisherfolk made aware of eco-labelling as a tool for resource management. The Central Marine Fisheries Research Institute, in tandem with WWF, should identify similar small-scale fisheries wherein eco-labelling may be introduced. • Seafood trade promotion agencies such as The Marine Products Exports Development Authority could take the results of this study to processors and exporters to reap the benefits of consumer preferences and target new markets.

National network of wetland managers

- Assess status and trends in wetland ecosystem services through use of suitable indicators applied within an integrated wetland inventory, assessment and monitoring system.
- Assess wetland ecosystem services-livelihood linkages while developing site management plans, and include distributional equity related management objectives within implementation strategies.
- Formulate integrated management plans using diagnostic approaches for securing full range of ecosystem services and biodiversity values.
- Use valuation of ecosystem services and biodiversity as a tool to communicate role of wetlands in local and regional economies, raise resources, and inform decision-makers on trade-offs associated with implementation of sectoral policies and programmes.
- Wherever possible and feasible, integrate market-based instruments to internalize externalities associated with wetland ecosystem services, and provide incentives for natural resource stewardship.
- Integrate indigenous and local knowledge within design and implementation of site management plans.

State level policy makers

- Constitute state wetland authorities as nodal institutions for coordinating sectoral programmes and ensuring consideration of full range of wetland biodiversity and ecosystem services values in developmental programming.
- Safeguard and restore wetland resources to ensure sustained delivery of wetland ecosystem services and biodiversity values.

- Ensure that wetland based options are fully considered within land and water resources planning and decision-making.
- Conduct systematic inventory and prioritize restoration of wetlands with due consideration of ecosystem services and biodiversity values.
- Provide adequate financial resources within state budgets to periodically monitor wetlands and support formulation of integrated management plans.
- Promote awareness and outreach on wetland ecosystem services and biodiversity values.
- Support achievement of national biodiversity targets, particularly those related to water and wetlands.

National Wetland Programme

- Build capacity of state-level policy makers and wetland managers in inventorying wetland ecosystem services and biodiversity values and their integration in site management plans.
- Include indicators based on ecosystem services and biodiversity values for assessing management effectiveness.
- Include assessment of ecosystem services values within environmental impact assessment protocols related to wetlands, and for developmental projects taking place within zone of influence of wetlands, especially those adversely impacting hydrological regimes.
- Strengthen research on wetland ecosystem services, particularly on regulating services
- Promote integration of wetland ecosystem services values within national policies and sectoral developmental programming (related to water management, agriculture, fisheries and aquaculture, rural and urban development, disaster management, health and others).
- Introduce guidelines for recognizing wetlands as a distinct land use category in land use classification systems, and in collaboration with state governments ensure that these ecosystems are appropriately demarcated and incorporated within land use records.
- Strengthen implementation of National Biodiversity Action Plan, particularly on targets related to water and wetlands.
- Introduce text on wetlands, and their ecosystem services and biodiversity values in school curriculum to enhance awareness.

Academia

- Improve research on wetland functioning and delivery of ecosystem services.
- Address knowledge gaps on values of wetland ecosystem services, particularly related to regulating and cultural services.
- Promote multi-disciplinary research to assess ecosystem services trade-offs related to wetland management.

Development cooperation community

- Integrate appreciation of wetland biodiversity and ecosystem service values within development cooperation objectives.
- Build wetland restoration and integrated management within investment portfolios.

Civil Society organizations

- Understand, demonstrate and communicate wetland biodiversity and ecosystem services values.
- Promote application of integrated approaches for safeguarding wetland biodiversity and ecosystem service values.
- Improve stakeholder engagement in wetland management.

Businesses

- Proactively include wetland restoration within Corporate Social Responsibility (CSR) activities.
- Consider direct and indirect impacts on wetlands within business processes and include adequate sustainability measures.
- Assess risks associated with direct and indirect impacts on wetlands and improve disclosures through use of corporate ecosystem valuation tools.
- Reduce water footprint in order to safeguard water and wetland resources for posterity.

References

Akter, S., Bennett, J. and Akhter, S., 2008. Preference Uncertainty in Contingent Valuation. *Ecological Economics*, 67(3), pp.345–351.

Alfred, J. R. B. and Nandi, N. C., 2000. Faunal Diversity in Indian Wetlands. *ENVIS Newsletter*. 6(2).

Alfred, J. R. B., Das, A. K. and Sanyal, A. K. eds., 1998. *Faunal Diversity in India*. Calcutta: ENVIS Centre, Zoological Survey of India.

Anoop, P., Suryaprakash, S., Umesh, K. B. and Amjath Babu, T. S., 2008. Economic Valuation of Use Benefits of Ashtamudi Estuary in South India. In: Sengupta, M. and Dalwani, R. eds., 2008. *Proceedings of Taal 2007: The 12th World Lake Conference*. Jaipur, India, 28 October–2 November 2007. New Delhi: Ministry of Environment and Forests, Government of India. pp. 1822–1826.

Barbier, E. B., 1994. Valuing Environmental Functions: Tropical Wetlands. *Land Economics*, 70, pp.155–173.

Barbier, E. B., 2009. Ecosystems as Natural Assets. *Foundations and Trends in Microeconomics*, 4(8), pp.611–681.

Barbier, E. B., Baumgartner, S., Chopra, K., Costello, C., Duraiappah, A., Hassan, R., Kinzig, A., Lehman, M., Pascual, U., Polasky, S. and Perrings, C., 2009. The Valuation of Ecosystem Services. In: Naeem, S., Bunker, D. E., Hector, A., Loreau, M. and Perrings, C. eds., 2009. *Biodiversity Ecosystem Functioning and Human Wellbeing: An Ecological and Economic Perspective*. Oxford: Oxford University Press. Ch.18.

Bhatt, J. R. and Kathiresan, K., 2011. Biodiversity of Mangrove Ecosystems in India. In: Bhatt, J. R., Macintosh, D. J., Nayar, T. S., Pandey, C. N. and Nilaratna, B. P. eds., 2011. *Towards Conservation and Management of Mangrove Ecosystems in India*. New Delhi: IUCN India.

Bhatt, J. R., Kumar, R. and Kathiresan, K., 2013. Conservation and Management of Mangroves in India: An Overview. In: Bhatt, J. R., Ramakrishna, Sanjappa, M., Remadevi, O. K., Nilaratna, B. P. and Venkataraman, K. eds., 2013. *Mangroves of India: Their Biology and Uses*. Kolkata: Zoological Survey of India.

Blankespoor, B., Dasgupta, S. and Laplante, B., 2012. *Sea–level Rise and Coastal Wetlands: Impacts and Costs*. [Policy Research Working Paper 6277]. Washington, DC: The World Bank.

Brauman, K. A., Daily, G. C., Duarte, T. K. and Mooney, H. A., 2007. The Nature and Value of Ecosystem Services: An Overview Highlighting Hydrologic Services. *Annual Review of the Environment and Resources*, 32, pp.67–98.

Bromley, D. W. and Paavola, J., 2002. Economics, Ethics and Environmental Policy. In: Bromley, D. W. and Paavola, J. eds., 2002. *Economics, Ethics, and Environmental Policy: Contested Choices*. Malden, MA: Blackwell. Ch.16.

Central Water Commission (CWC), 2010. *Financial Aspects of Irrigation Projects in India*. New Delhi: Central Water Commission.

Chandan, P., Chatterjee, A., Gautam, P., Seth, C. M., Takpa, J., Haq, S., Tashi, P. and Vidya, S., 2005. *Black–necked Crane–Status, Breeding Productivity and Conservation in Ladakh, India* 2000–2004. WWF–India and Department of Wildlife Protection, Government of Jammu and Kashmir.

Chandan, P., Chatterjee, A. and Gautam, P., 2008. Management Planning of Himalayan High Altitude Wetlands: A Case Study of Tsomoriri and Tsokar Wetlands in Ladakh, India. In: Sengupta, M. and Dalwani, R. eds., 2008. *Proceedings of Taal 2007: The 12th World Lake Conference*. Jaipur, India, 28 October–2 November 2007. New Delhi: Ministry of Environment and Forests, Government of India.

Chopra, K., 1998. *The valuation of biodiversity within protected areas: Alternative approaches and case study*. New Delhi: Institute of Economic Growth.

Convention on Migratory Species (CMS), 2005. *Central Asian Flyway Action Plan for Waterbirds and their Habitat*. [Country Report–India]. Bonn, Germany: Convention on Migratory Species.

Costanza, R., 1980. Embodied Energy and Economic Valuation. *Science*, 210, pp.1219–1224.

Costanza, R. ed., 1991. *Ecological Economics: The Science and Management of Sustainability*. New York: Columbia University Press.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Naeem, S., Limburg, K., Paruelo, J., O'Neill, R. V., Raskin, R., Sutton, P. and van den Belt, M., 1997. The Value of the World's Ecosystem Services and Natural Capital. *Nature*, 387, pp.253–260.

Costanza, R. and Folke, C., 1997. Valuing Ecosystem Services with Efficiency, Fairness and Sustainability as Goals. In: Daily, G. ed., 1997. *Nature's Services: Societal Dependence on Natural Ecosystems*. Washington, DC: Island Press. pp. 49–70.

Daily, G. ed., 1997. *Nature's Services: Societal Dependence on Natural Ecosystems*. Washington, DC: Island Press.

Das, S. and Vincent, R. V., 2009. Mangroves Protected Villages and Reduced Death Toll during Indian Super Cyclone. *Proceedings of the National Academy of Sciences*, 106(18), pp.7357–7360.

Davidson, N. C., 2014. How much Wetland has the World Lost? Long–term and Recent Trends in Global Wetland Area. *Marine and Freshwater Research*, 65, pp.934–941.

de Groot, R. S., 1987. Environmental Functions as a Unifying Concept for Ecology and Economics. *The Environmentalist*, 7(2), pp.105–109.

Dehadrai, P.V. and Yadava, Y.S., 2004. *State of Indian Farmer: Fisheries Development* (Volume -13). New Delhi: Academic Foundation.

Dixit, A. M., Kumar, P., Kumar, L., Pathak, K. and Patel, M. I., 2010. *Economic Valuation of Coral Reef Systems in Gulf of Kachchh*. [Final Report]. World Bank aided Integrated Coastal Zone Management (ICZM) Project. Gandhinagar: Gujarat Ecology Commission.

Dixit, A. M., Kumar, L., Kumar, P. and Pathak, K., 2012. Valuing the Services of Coral Reef Systems for Sustainable Coastal Management: A Case Study of the Gulf of Kachchh, India. In: Kumar, P. and Wood, M. D. eds. *Valuation of Regulating Services of Ecosystems: Methodology and Applications*. London: Routledge, pp.175–198.

Ehrlich, P. R. and Ehrlich, A. H., 1981. *Extinction: The Causes and Consequences of the Disappearance of Species*. New York: Random House.

Ehrlich, P. R. and Mooney, H. A., 1983. Extinction, Substitution, and Ecosystem Services. *Biosciences*, 33, pp.248–254.

Farber, S. C., Costanza, R. and Wilson, M. A., 2002. Economics and Ecological Concepts for Valuing Ecosystem Services. *Ecological Economics*, 41(3), pp.375–392.

Finlayson, C. M., Davidson, N., Pritchard, D., Milton, G. R. and MacKay, H., 2011. The Ramsar Convention and Ecosystem–Based Approaches to the Wise Use and Sustainable Development of Wetlands. *Journal of International Wildlife Law and Policy*, 14(3–4), pp.176–198.

Folke, C., Hammer, M. and Jansson, A. M., 1991. Life–Support Value of Ecosystems: A Case Study of the Baltic Region. *Ecological Economics*, 3(2), pp.123–137.

Gardner, R. C., Barchiesi, S., Beltrame, C., Finlayson, C. M., Galewski, T., Harrison, I., Paganini, M., Perennou, C., Pritchard, D. E., Rosenqvist, A. and Walpole, M., 2015. *State of the World's Wetlands and their Services to People: A compilation of recent analyses*. [Ramsar Briefing Note no. 7]. Gland, Switzerland: Ramsar Convention Secretariat.

Garg, J. K., 2015. Wetland Assessment, Monitoring and Management in India using Geospatial Techniques.*Journal of Environmental Management*, 148, pp.112–123.

Garg, J. K., Singh, T. S. and Murthy, T. V. R., 1998. *Wetlands of India*. [Project Report]. RSAM/SAC/RESA/PR/01/98. Ahmedabad: Space Application Centre (ISRO). p.239.

Gogoi, R., 2007. Conserving Deepor Beel–Ramsar Site, Assam. *Current Science*, 93(4), pp.445–446.

Gopal, B., 2013. Future of Wetlands in Tropical and Subtropical Asia, Especially in the Face of Climate Change. *Aquatic Sciences*, 75, pp.39–61.

Gopi, G. V., Arya, S. and Hussain, S. A., 2014. Waterbirds of India: An Introduction. In: Gopi, G. V. and Hussain, S. A. eds., 2014. *Waterbirds of India, ENVIS Bulletin: Wildlife and Protected Areas*, 16. Dehradun: Wildlife Institute of India. pp. 10–23.

Guha, I. and Ghosh, S., 2009. *A Glimpse of the Tiger: How Much are Indians Willing to Pay for It?* [SANDEE Working Paper No. 39–09]. Kathmandu, Nepal: South Asian Network for Development and Environmental Economics (SANDEE).

Hirway, I. and Goswami, S., 2007. *Valuation of Coastal Resources: The Case of Mangroves in Gujarat*. Ahmedabad, Gujarat: Academic Foundation.

Holling, C. S., 1973. Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematic*, 4, pp.1–23.

Hussain, S. A. and Badola, R., 2010. Valuing Mangrove Benefits: Contribution of Mangrove Forests to Local Livelihoods in Bhitarkanika Conservation Area, East Coast of India. *Wetlands Ecology and Management*, 18(3), pp.321–331.

James, A. J. and Murty, M. N., 1998. *Measuring Non–User Benefits from Cleaning Ganges*. [Working Paper E/202/99]. New Delhi: Institute of Economic Growth.

James, E. J., 1998. *The Wise Use of Vembanad Kol Wetland System and Its Drainage Basins*. [Report]. Kerala: Centre for Water Resources Development and Management (CWRDM).

Kathiresan, K. and Thakur, S., 2008. *Mangroves for the Future: National Strategy and Action Plan, India*. [Revised Draft]. New Delhi: Ministry of Environment and Forests.

Kontoleon, A., Macrory, R. and Swanson, T., 2002. Individual Preference–Based Values and Environmental Decision Making: Should Valuation have its Day in Court? *Research in Law and Economics*, 20, pp.179–216.

Kumar, P., 2012. Measuring Natural Capital: Accounting of Inland Wetland Ecosystems from Selected States of India. *Economic and Political Weekly*, 47, pp.77–84.

Kumar, P., Babu, C. R., Sharma, S. R., Love, A. and Prasad, L., 2001. *Valuation of Ecosystem Services: A Case Study of Yamuna Floodplain in the Corridors of Delhi*. Under the World Bank Aided Environmental Management Capacity Building Programme. New Delhi: Mimeograph, Institute of Economic Growth (IEG).

Kumar, R., 2015. *Integrated Management of Wetland Biodiversity and Ecosystem Services (IMWBES)* Project proposal submitted to United Nations Environment Programme. Wetlands International South Asia, New Delhi. (unpublished)

Kumar, R. and Pattnaik, A. K., 2012. *Chilika–An Integrated Management Planning Framework for Conservation and Wise Use*. New Delhi: Wetlands International South Asia and Bhubaneswar: Chilika Development Authority.

Kumar, R., Singh, R. D. and Sharma, K. D., 2005. Water Resources of India. *Current Science*, 89(5), pp.794–811.

Kundu, N., Pal, M. and Saha, S., 2008. East Kolkata Wetlands: A Resource Recovery System through Productive Activities. In: Sengupta, M. and Dalwani, R. eds., 2008. *Proceedings of Taal 2007: The 12th World Lake Conference*. Jaipur, India, 28 October–2 November 2007. New Delhi: Ministry of Environment and Forests, Government of India. pp. 868–881.

Mäler, K. G., Aniyar, S. and Jansson, A., 2009. Accounting for Ecosystems. *Environmental and Resource Economics*, 42, pp.39–51.

Millennium Ecosystem Assessment (MEA), 2005. *Ecosystems and Human Well–being: Wetlands and Water Synthesis*. Washington, DC: World Resources Institute.

Ministry of Environment and Forests (MoEF), 2014. *India's Fifth National Report (NR5) to the Convention on Biological Diversity (CBD)*. New Delhi: Ministry of Environment and Forests, Government of India.

MoEFCC & GIZ. 2014. *The Economics of Ecosystems and Biodiversity TEEB India Initiative*: Interim Report - Working Document. 96p

Ministry of Urban Development, (MoUD), 2013. *Advisory on Conservation and Restoration of Water Bodies in Urban Areas*. New Delhi: Central Public Health and Environmental Engineering Organization (CPHEEO), Ministry of Urban Development, Government of India.

Mitsch, W. J. and Gosselink, J. G., 2000. The Value of Wetlands: Importance of Scale and Landscape Setting. [Special Issue]. *Ecological Economics*, 35, pp.25–33.

Mooney, H., Cropper, A. and Reid, W., 2005. Confronting the Human Dilemma: How can Ecosystems provide Sustainable Services to benefit Society? *Nature*, 434, pp.561–562.

North, D. C., 1994. Economic performance through time. *American Economic Review*, 8(2), pp.359–368.

Odum, H. T., 1996. *Environmental Accounting: Energy and Environmental Decision Making*. New York: John Wiley, p.370.

Palanisami, K., Meinzen–Dick, R. and Giordano, M., 2010. Climate Change and Water Supplies: Options for Sustaining Tank Irrigation Potential in India. *Economic & Political Weekly*, 45(26–27), pp.183–190.

Pandey, J. S., Joseph, V. and Kaul, S. N., 2004. A Zone–Wise Ecological Economic Analysis of Indian Wetlands. *Environmental Monitoring and Assessment*, 98, pp.261–273.

Parikh KS, Ravindranath NH, Murthy IK, Mehra S, Kumar R, James EJ, Vivekanandan E, Mukhopadhyay P. 2012. *The Economics of Ecosystems and Biodiversity - India*: Initial Assessment and Scoping Report. Working Document. GIZ. New Delhi. 157pp.

Prasad, S. N., Ramachandra, T. V., Ahalya, N., Sengupta, T., Kumar, A., Tiwari, A. K., Vijayan, V. S. and Vijayan, L., 2002. *Conservation of Wetlands of India–A Review*. Tropical Ecology, 43(1), pp.173–186.

Ramsar, 2002. *Information Sheet on Ramsar Wetlands (RIS): Sasthamkotta Lake*. Gland, Switzerland: Ramsar Convention Secretariat.

Randall, A., 1988. What Mainstream Economists have to Say about the Value of Biodiversity. In: Wilson, E. O. ed. *Biodiversity*. Washington, DC: National Academy Press. pp. 217–223.

Ready, R. C., Whitehead, J. C. and Blomquist, G. C, 1995. Contingent Valuation when Respondents are Ambivalent. *Journal of Environmental Economics and Management*, 29, pp.181–196.

Russi, D., ten Brink, P., Farmer, A., Badura, T., Coates, D., Förster, J., Kumar, R. and Davidson, N., 2012. *The Economics of Ecosystems and Biodiversity for Water and Wetlands*. [Final Consultation Draft].

Sagoff, M., 1994. Should Preferences Count? *Land Economics*, 70(2), pp.127–144.

Sagoff, M., 2011. The Quantification and Valuation of Ecosystem Services. *Ecological Economics*, 70, pp.497–502.

Scott, D. A., 1989. *A Directory of Asian Wetlands*. Gland, Switzerland: IUCN.

Singh, S. P. and Gopal, B., 2002. *Integrated Management of Water Resources of Lake Nainital and its Watershed: An Environmental Economics Approach*. [EERC Working Paper Series: WB–8]. Mumbai: Environmental Economics Research Committee (EERC), Indira Gandhi Institute for Developmental Research.

Society for Ecological Restoration International Science and Policy Working Group (SER), 2004. *The SER International Primer on Ecological Restoration*. www.ser.org and Tucson: Society for Ecological Restoration International.

Space Application Centre (SAC), 2011. *National Wetland Atlas. SAC/EPSA/ABHG/NWIA/ATLAS/34/2011*. Ahmedabad: Space Applications Centre (ISRO). p.310.

Spash, C. L. and Vatn, A., 2006. Transferring Environmental Value Estimates: Issues and Alternatives. *Ecological Economics*, 60, pp.379–388.

Smith, V. K., Van Houtveen, G. and Pattanayaak, S. K., 2002. Benefit Transfer via Preference Calibration: "Prudential algebra" for Policy. *Land Economics,* 78, pp.132–152.

TEEB, 2010. *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*. Abingdon and New York: Routledge.

Trisal, C. L. and Kumar, R., 2008. *Integration of High Altitude Wetlands into River Basin Management in the Hindu Kush Himalayas: Capacity Building Needs Assessment for Policy and Technical Support*. New Delhi: Wetlands International South Asia.

Trisal, C. L., Tabassum, T. and Kumar, R., 2008. Water Quality of the River Yamuna in the Delhi Stretch: Key Determinants and Management Issues. *Clean*, 36(3), pp.306–314.

Vatn, A., 2000. The Environment as a Commodity. *Environmental Values*, 9, pp.493–509.

Venkatachalam, L. and Jayanthi, M., 2016. *Estimating the Economic Value of Ecosystem Services of Pallikaranai Marsh in Chennai City: A Contingent Valuation Approach*. [MIDS Working Paper No. 220]. Chennai, India: Madras Institute of Development Studies (MIDS)

Verma, M., Bakshi, N. and Nair, R. P. K., 2001. *Economic Valuation of Bhoj Wetlands for Sustainable Use*. Bhopal: Indian Institute of Forest Management.
Under World Bank Aided India: Environmental Management Capacity Building Technical Assistance Project.

Vijayan, V. S., Prasad, S. N., Vijayan, L. and Muralidharan, S., 2004. *Inland Wetlands of India–Conservation Priorities*. Coimbatore: Salim Ali Centre for Ornithology and Natural History.

Walker, B. H., Holling, C. S., Carpenter, S. R. and Kinzig, A. P., 2004. Resilience, Adaptability and Transformability. *Ecology and Society*, 9(2), p.5.

Wetlands International South Asia (WISA), 2004. *Socio–economic Assessment of Environmental Flow Scenarios of Chilika*. [Final Report]. New Delhi: Wetlands International South Asia.

Wetlands International South Asia (WISA), 2005. *Conservation and Management of Loktak and Associated Wetlands Integrating Manipur River Basin*. [Detailed Project Report]. New Delhi: Wetlands International South Asia.

Wetlands International South Asia (WISA), 2007. *Comprehensive Management Action Plan for Wular Lake, Kashmir*. [Final Report]. New Delhi: Wetlands International South Asia.

Wetlands International South Asia (WISA), 2013. *Conservation and Wise use of Vembanad–Kol: An Integrated Management Planning Framework*. New Delhi: Wetlands International South Asia.

Wetlands International South Asia (WISA), 2015. *Kanwar Jheel: An Integrated Management Action Plan for Conservation and Wise Use*. New Delhi: Wetlands International South Asia.

World Bank, 2014. *Building Resilience for Sustainable Development of the Sunderbans – Strategy Report (Report No.88061–IN)*. Sustainable Development Department, Environment & Water Resources Management Unit, Washington DC: The World Bank.

Zavestoski, S., 2004. Constructing and Maintaining Ecological Identities: The Strategies of Deep Ecologists. In: Clayton, S. and Opotow, S. eds., 2004. *Identity and the Natural Environment: The Psychological Significance of Nature*. Cambridge, MA: The MIT Press. pp. 297–316.

Zografos, C. and Paavola, J., 2008. Critical Perspectives on Human Action and Deliberative Ecological Economics. In: Zografos, C. and Howarth, R. B. eds. *Deliberative ecological economics*. Delhi: Oxford University Press.

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