# Capacity Building in the Assessment of Biodiversity and Ecosystem Services for Conserving Wetlands for the Future

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## HIGHLIGHTS

- Wetlands, their biodiversity and ecosystem services are degraded and lost because they are neither assessed nor valued by projects related to land and water resources development or management.
- Most stakeholders are unaware of the wetland ecosystem services other than those related to direct consumptive use.
- Conflicting interests of various stakeholders can be resolved by promoting awareness and capacity building.
- The future of wetlands can be ensured by effective policies and legislation rooted in the understanding of their biodiversity and ecosystem services together with the factors that sustain them.

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**ABSTRACT** Wetlands support a significantly large proportion of biodiversity. Their ecosystem services range from provision of water, food (fish and rice) and other resources to the regulation of water regimes, water quality and climate. They enhance the aesthetics and are hubs of cultural and recreational activities. Wetlands are threatened most by changes in land use/land cover and inappropriate water resources management because of poor understanding of their biodiversity and ecosystem services and lack of capacity for their assessment and valuation. To improve the capacity of various stakeholders, we prepared guidelines for rapid assessment (sampling, identification and enumeration) of biodiversity and major ecosystem services of wetlands. These guidelines were tested briefly in three different wetlands in Kolkata, Guwahati and Kathmandu by demonstration in the field and discussion with over 230 researchers, scientists, managers, policy makers and NGOs representatives besides about 100 members of the local wetland-dependent community. It generated interest and helped improve their understanding of the wetland benefits. The guidelines (available online) may be elaborated and adapted for assessment of biodiversity and ecosystem services and capacity building in different regions. A policy brief (also available online) highlighting the ecosystem services of wetlands and their relationships with biodiversity was prepared and discussed at another workshop for managers and policy makers. Extensive capacity building effort is recommended for the necessary change in wetland related policies.

**KEYWORDS** *wetland biodiversity; ecosystem services; rapid assessment; deepor beel; kholsi beel; Nagdaha lake*

## 1. Introduction

Wetlands include periodically shallow flooded areas such as floodplains along large rivers and littoral zones of lakes and reservoirs, seasonal or perennial shallow water bodies (fresh, brackish or saline, with or without vegetation) and mangroves (dominated by woody vegetation) along the estuarine coastal areas in the tropics. Paddy fields and fish ponds are among the most important human-made and managed wetlands. Other wetlands include peatlands where organic matter produced by the plants has accumulated over many centuries, and coastal salt marshes. Wetlands occur in all climatic zones—from trop-

ical deserts to cold tundra, and at all altitudes—from below the sea level to about 6000 m elevation in the Himalayas.

Wetlands, especially the riverine floodplains, gave birth to human civilisations across the globe and were an integral part of the socio-cultural ethos of the people in South Asia where they were held sacred and even bestowed with divinity. Humans depended on wetlands for water, fish and plants such as reeds, papyrus and lotus. Rice which was domesticated serves half of the humanity today.

Wetlands, however, were extensively drained and over-exploited for their plant and animal resources as well as peat, particularly in Europe and North America (see Williams, 1990). Concerns were raised first, less than a century ago, for their protection in view of the large populations of migratory birds visiting them. They became the subject of an international agreement—the Ramsar Convention (signed on 2 February 1971 in Ramsar, Iran), under which practically all countries have committed themselves to the wise use and maintenance of the ecological character of wetlands. The Ramsar Convention has gradually widened its scope to bring all aquatic ecosystems, except oceans, under the banner of wetlands (see Ramsar Convention Secretariat, 2013).

Here we discuss the importance of capacity building in the assessment of biodiversity and ecosystem services of wetlands that will help integrating wetlands into land and water management policies. We draw upon our experience from an APN-funded project where we developed the rapid assessment guidelines and tested them briefly in three different wetlands. Some recommendations are made for further work.

## 2. Wetland Biodiversity, Functions and Ecosystem Services

### 2.1 Biodiversity in Wetlands

Wetlands are best known for their very high biodiversity including microorganisms (Gopal, 2009). The diversity and abundance of macrophytes as well as the fauna are governed by the water regime (depth and duration, frequency and amplitude of change and the time of the year as well as flow velocity) which controls their various life processes. Macrophytes play a major role in enhancing the biodiversity by providing food both directly and indirectly (through detritus) as well as habitat, shelter, nesting and breeding sites. Numerous birds, fish, amphibia, reptiles and invertebrates seasonally migrate between wetlands and other open water or terrestrial habitats as they require different water regimes and food sources at different times of their life cycle. Wetland fauna includes various residents, regular migrants, occasional visitors and those indirectly dependent on wetland biota.

### 2.2 Functions and Ecosystem Services

Similar to other ecosystems, wetland functions include capture and transfer of energy through plants to food webs and biogeochemical cycling (including water cycle). Wetlands are among the most productive systems and capture large amounts of energy and carbon dioxide. They play a major role in the hydrological cycle by regulating the flux of water at every stage (see Gopal, 2016).

Humans derive many direct and indirect benefits from these wetland functions. Such benefits have recently been termed as “ecosystem services”, which are categorised into provisioning, regulating, cultural and supporting services (MEA, 2005; Finlayson & D’Cruz, 2005). High rates of organic matter production by wetland plants and animals means that a large diversity of biological resources is available for direct use as food, fibre, fuel, fodder, medicine, etc. (i.e., provisioning service). At the same time, high organic production and its relatively slow decomposition and mineralisation results in significant carbon sequestration. Wetlands therefore contribute to regulating climate change. Under certain conditions, wetlands also release methane and nitrous oxide which contribute to global warming. Recent studies however show that wetlands may be a source for greenhouse gases only on a time scale of decades; over long-term (100 to 300 years), most wetlands become net carbon sinks (Mitsch et al., 2012).

Humans benefit from wetlands indirectly as they regulate the water regimes. Wetlands receive water from the catchments, retain it for varying periods of time, retard its flow, transfer it downstream and facilitate its infiltration below ground but may also enhance losses in evapotranspiration. The evapotranspiration through the macrophytes moderates the microclimate of the surrounding areas (see Gopal, 2016). Humans benefit directly in terms of water availability for different uses over a longer time and space as well as through protection against the hazards of floods and drought.

A suite of physical, chemical and biological processes involved in the cycling of nutrients and other elements help improve the water quality by stripping the nutrients and pollutants. Floodplains and littoral zones help maintain the water quality in rivers and lakes by intercepting and transforming the nutrients and various pollutants from non-point sources.

Wetland habitats are also preferred for recreational and socio-cultural activities such as bird watching, boating, angling, swimming etc or just relaxing in aesthetically pleasant, serene places. Many wetlands have high spiritual and religious values and are held sacred. Further, the livelihoods of many communities and social groups depend almost exclusively upon wetlands.

### 2.3 Linkages between Biodiversity and Ecosystem Services

All ecosystem services noted above are linked with some components of biodiversity because different plants, animals and micro-organisms are involved in various processes of energy capture and transfer, water cycle, uptake and transformation of nutrients, and development of habitats. These linkages are discussed in detail by MEA (2005), Duffy (2009) and Mace, Norris, and Fitter (2012). In wetlands, the ecosystem services of fish, macroinvertebrates and microbes, birds and macrophytes have been discussed by Holmlund and Hammer (1999), Covich et al. (2004), Green and Elmberg (2014) and Gopal, 2016 respectively.

### 2.4 Wetland Threats and Ecosystem Services Assessment

The ecosystem services of wetlands have been assessed to have very high economic value at global scales (Costanza,

Farber, & Maxwell, 1989; Costanza et al., 1997; Ghermandi et al., 2010). Yet in most of the developing countries, wetlands continue to be considered as unproductive wastelands—a perception transplanted from Europe, and therefore, are being lost to urbanisation or degraded by domestic and/or industrial wastewaters. Important factors responsible for this state are (a) inadequate assessment of their biodiversity, (b) failure to recognise the ecosystem services, particularly the intangible and non-use benefits and those related to the livelihoods local communities, and link them with the biodiversity, and (c) ignoring the valuation of ecosystem services for factoring them in the cost-benefit analysis of land and water resources management projects (see Kumar et al., 2011, Kumar & James, 2012). This in turn stems from a general lack of the capacity to assess and valuate the wetland biodiversity and ecosystem services.

## 3. The Capacity Building Project

The Ramsar Convention chose the theme "Wetlands for Our Future" for the 2015 World Wetland Day. We believe that our future is closely linked with the future of wetlands, which in turn depends upon our capacity to understand and assess the benefits we derive from them and to integrate that understanding into policy and action. This motivated us to initiate activities for capacity building on wetlands among a wide range of stakeholders, from students and young researchers to wetland managers and policy makers, with support from the Asia Pacific Network for Global Change Research (APN) under its Capacity Building programme. We focused on the wetlands in the Ganga-Brahmaputra river basin, particularly those in the Eastern Himalayan region. This area lies within the Himalaya and Indo–Burma global biodiversity hotspot (Allen, Molur, & Daniel, 2010). It is also a distinct freshwater ecoregion (Abell et al., 2008) and differs significantly from the Western Ghats (another biodiversity hotspot) in its freshwater biodiversity (see Molur, Smith, Daniel, & Darwall, 2011). The area has thousands of large floodplain wetlands which include Ramsar sites like Deepor Beel and World Heritages like Kaziranga and Manas National Parks. These wetlands are threatened by numerous hydropower projects (Das, 2013) and climate change (Gopal, Shilpakar, & Sharma, 2010).

The project focused on (i) preparing the Guidelines for rapid assessment of wetland biodiversity and ecosystem services, (ii) communicating and testing these Guidelines by bringing together a range of stakeholders in workshops, and (iii) preparing a policy brief for wetland managers and policy makers.

### 3.1. The Guidelines

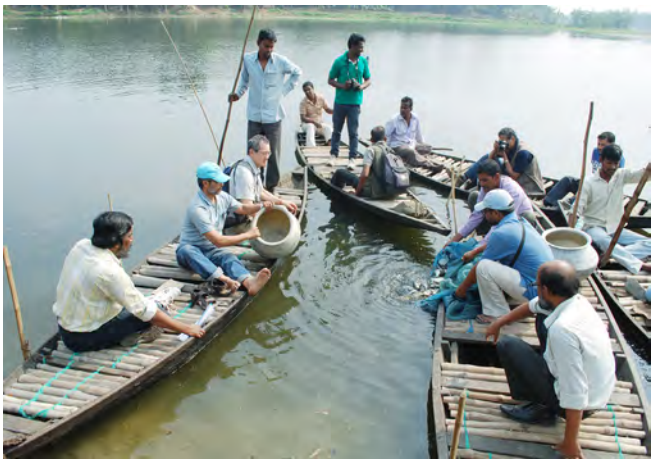
The Guidelines were prepared by experts in different biota to facilitate quick assessment of biodiversity and ecosystem services (Gopal, 2015a). The Guidelines for biodiversity assessment include an introduction, simple low cost methods for sampling, identification and quantification as far as possible in the field and with minimum laboratory requirement. The guidelines bring together the macrophytes, microphytes (phytoplankton and periphyton), zooplankton, macroinvertebrates, fish, waterfowl and herpetofauna along with notes on ecosystem services associated with them. Common taxa (other than birds) occurring in the East Himalayan region are illustrated in colour for easy identification. Five posters accompany the Guidelines to help identification in the field, especially by the local community. Microorganisms were not included because they necessarily require elaborate laboratory examination.


PICTURE 1. Wetland Biodiversity and Ecosystem Services Workshop: Kolkata, 19-21 February 2015

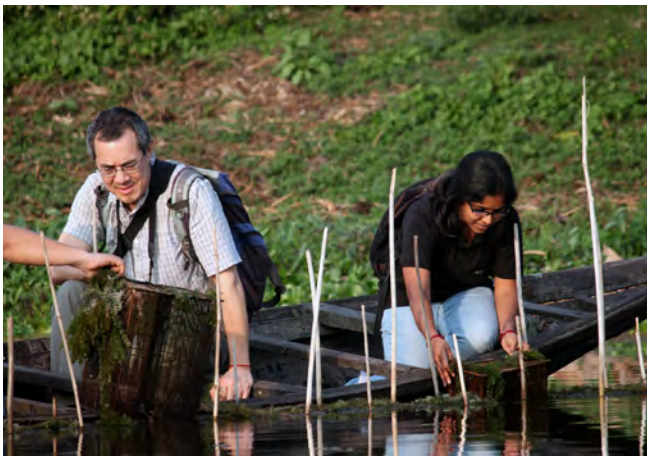
The Guidelines for rapid assessment of ecosystem services emphasise upon a participatory approach (also suggested by the Ramsar and Biodiversity Conventions; De Groot, Stuip, Finlayson, & Davidson, 2006). Starting with the identification of stakeholders, especially among the local communities, the Guidelines describe ecosystem functions and their indicators for selected ecosystem services followed by methods for their assessment. Ecosystem services related with water, biomass and water quality and the cultural/recreational services are covered briefly. We plan to revise and elaborate the Guidelines periodically.

### 3.2. Capacity Building Workshops

We organised three capacity building workshops in Kolkata, Guwahati (India) and Kathmandu (Nepal) in active collaboration with partner organisations. Participants included students, young researchers, scientists from universities and research institutes, wetland managers, government officers, NGO representatives and several policy makers. On the first day, after introduction and presentations on wetland issues in South Asia, the Guidelines were discussed. On the second day, the participants visited a wetland where a sizeable number of community members representing different sections were invited along with the wetland managers and other local officials for detailed interaction. Biodiversity assessment methods were demonstrated in the field, and the ecosystem services were assessed in consultation with the community stakeholders. The local community provided useful insights into their viewpoints on wetland benefits, traditional management practices as well as their problems (see below). Next day the information gathered during the field visit was analysed and discussed among the participants. Methods for economic valuation of identified ecosystem services were also discussed but not applied due to the lack of adequate data. The 3-day workshop was grossly inadequate for comprehensive discussion and demonstration.



PICTURE 2. Sampling on Khalsi Beel



PICTURE 4. Sampling macrophytes

### 3.2.1 Khalsi Beel, Kolkata

This wetland near Kolkata (West Bengal) is a 62-ha perennial oxbow lake surrounded by human settlements and intensively farmed agricultural land with a dependent fishing community. The fisher community was aware of the biodiversity other than fish and the role of submerged macrophytes as fish food. The community exotic and fisheries development officers were concerned at the loss of biodiversity (especially fish and birds) and habitat changes such as a reduction in water depth. They recognised siltation and loss of connectivity with the river together with the exotic species (water hyacinth and Chinese

PICTURE 3. Discussion with local community

carp) as major factors. The community also recognised other benefits such as flood control and groundwater recharge, water for jute retting, duck rearing, bathing and domestic use and local tourism.

### 3.2.2 Deepor Beel, Guwahati

This 4 sq km wetland near the Guwahati (Assam) airport is a Ramsar site in the floodplain of river Brahmaputra. A part of the wetland is a wildlife sanctuary though most of it supports the livelihood of fishing and farming community of the surrounding villages. The community is aware of the importance of Deepor beel for wildlife and birds as well as the issues of its degradation and shrinkage in area due to encroachment for housing and industries, solid wastes, sewage, and also the reduced connectivity with the river through a canal. The director of the wildlife sanctuary discussed on site the conservation problems, particularly the conflict between people and the wildlife.

### 3.2.3 Nagdaha Lake, Kathmandu

It is a relatively small shallow lake near Kathmandu (Nepal). A concrete wall along its margins restricts its area. It is visited by many people for recreation and for religious functions on specific days, as is affected by agricultural activity in the surrounding areas. The local community is concerned over erosion, water pollution due to uncontrolled washing, cleaning and bathing, aquatic weeds, exotic fishes and very low biodiversity as well as decline in water table. The local community have

PICTURE 5. Sampling in Nagadaha wetland-Kathmandu

formed Naghdaha Improvement Committee to conserve it for local people as a source of income from tourism and recreational fishing.

### 3.2.4 Wetland Network

We set up a web page (www.aquaticecosystems.org/network/) for an online networking of individuals and institu-

tions interested in wetlands, their biodiversity and ecosystem services, anywhere in Asia. This is expected to provide a useful database for exchange of information and communication among the wetland community. It can be searched by geographic regions, wetland types, groups of organisms, ecosystem processes and services.

### 3.3. Lessons Learned

Brief interaction with the local communities around the three wetlands revealed that the local communities, which depend upon wetlands for their subsistence and livelihoods, are fairly aware of many provisioning, regulating and cultural services of wetlands as well as the major causes of wetland degradation (including pollution and exotic species). Even the minor produce such as rhizomes of lotus, makhana (Euryale ferox) and the leafy shoots of Ipomoea aquatica were valued highly by the local community. The cultural services such as tourism and recreation were also recognised by the local communities. The field visits also confirmed that most of the impacts on wetlands arise from the catchment-based human activities of which the hydrological changes and conversion to other land uses were most significant.

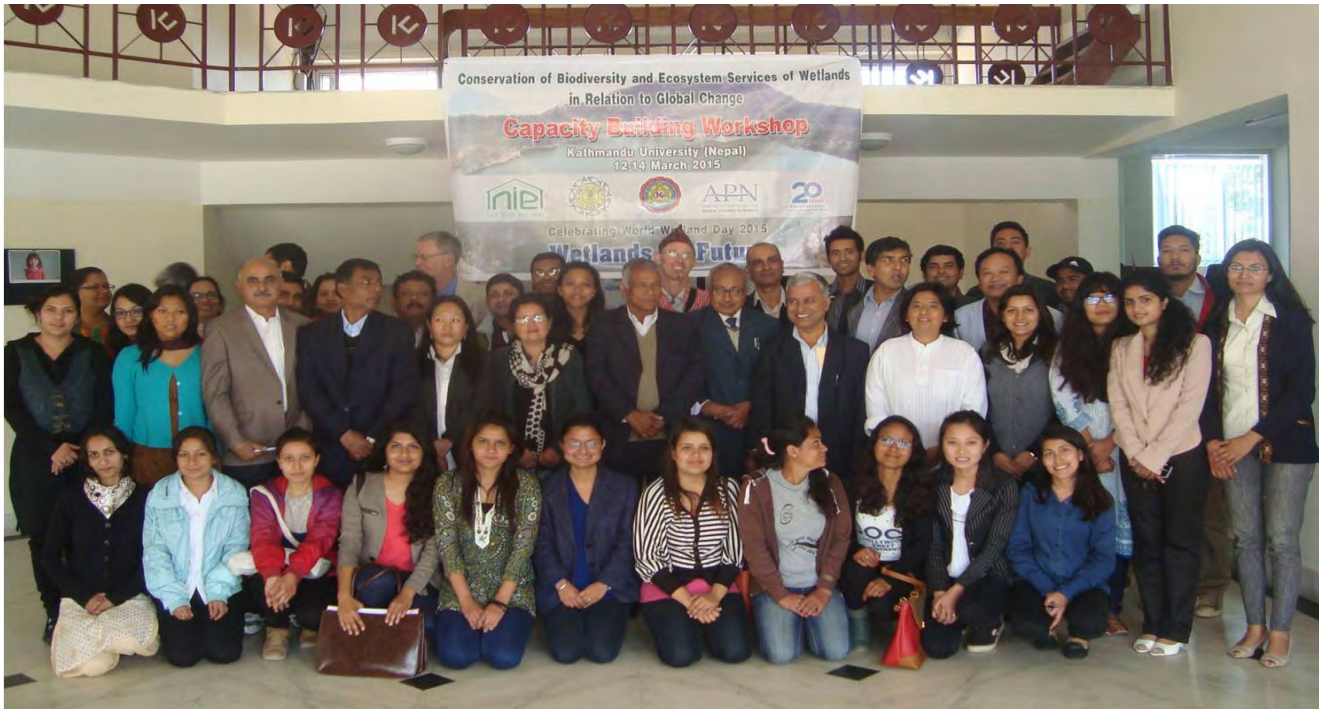
Discussions with stakeholders ranging from local communities to the policy makers made it clear that the biodiversity and ecosystem services of wetlands need to be assessed properly in a participatory manner by involving all sections of the local community and giving due weight to their livelihoods. Wetland managers and local communities tend to manage wetlands to maximise a few ecosystem services that result in the loss of other services providing indirect benefits. The capacity building needs greater emphasis on the assessment of the regulating and cultural services and the issues related to climate change.

### 3.4. Policy Workshop

We prepared a policy brief focusing on the biodiversity and ecosystem services of wetlands (Gopal, 2015b) and presented it together with the Guidelines at a workshop specifically targeted at policy makers and wetland managers. Our experiences from the three wetlands were discussed with policy makers from the Indian Government and several international organisations. It was emphasised that conservation requires a major shift in policies related to land and water use, and that both natural and human-made wetlands should be declared as specific land use category and their biophysical and hydrological characteristics should be documented and monitored regularly for any change. Further, all development projects such as those related to urban or industrial development, or those concerned with storage, diversion and abstraction of water from any source should consider all kinds of wetlands to be affected directly or indirectly, within the project area or far away from them. In the case of rivers, hydrological changes often cascade down to the entire river downstream (e.g., on floodplains). These projects should take into account especially the changes in biodiversity and the ecosystem services of wetlands, and their economic valuation should be integrated into the cost-benefit analysis of the project.

## 4. Conclusions

Capacity building requires far more effort than a one- or two-day interaction. Most of the biodiversity components which contribute to ecosystem services exhibit large seasonal




PICTURE 6. Capacity Building Workshop: "Conservation of Biodiversity and Ecosystem Services of Wetlands in Relation to Global Change", 12-14 March 2015, Kathmandu

variation in occurrence and abundance. Hence even the rapid assessments of biodiversity need more than a single visit of short duration for adequate sampling and analysis. Similarly, the assessments of ecosystem services require quantitative data and greater interaction with different groups of stakeholders. The project succeeded in preparing the guidelines and bringing the stakeholders together and generating interest in the ecosystem services and their assessment. Both the biodiversity and ecosystem services need to be assessed on an extensive scale to cover different kinds of wetlands and communities of different socio-economic status. The Guidelines will also require adaptation for different ecoclimatic regions and regular updating.

Wetland conservation meets the goals and objectives of several international conventions other than the Ramsar Convention; for example, the Conventions on Biodiversity, Climate Change and Migratory Species. Ecosystem services assessments followed by their economic valuation will help integrate wetlands into land and water management policies and help in ecosystem-based adaptation to climate change.

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