Wetland Conservation for Biodiversity and Ecosystem Services Needs a Shift in Land and Water Resources Policies

Historically wetlands were integrated into the socio-cultural ethos of the people of South and Southwest Asia. However, during the past century wetlands have been lost and degraded primarily because they were labelled as wastelands and did not receive attention in the development plans. Wetlands are treated as dustbins for wastewaters and solid wastes. Conservation of wetlands for protecting their biodiversity, speciÏc biophysical characteristics and obtaining optimum beneÏts (ecosystem goods and services) from them requires a major shift in policies related to land and water resources.

WHAT ARE WETLANDS?

Water is the most critical substance for the existence of life on the Earth. The highly uneven surface of the Earth has many areas where the land is saturated with or is submerged under the water that flows or remains standing for different duration - from days to centuries- before it returns to the oceans and the atmosphere. These watery areas were inhabited by a large diversity of plants and animals. The foundations of human civilisation were laid on these lands. Fish were harvested long before the humans learned to grow food on the floodplain of Tigris and Euphrates rivers in the Middle East, and discovered rice and domesticated it in Eastern Asia. Many plants (such as lotus and *Euryale ferox*) and animals such as turtles, crocodiles and swans became an integral part of the socio-cultural ethos of the people in South Asia. Jute was domesticated for fibre in India whereas in Egypt the giant sedge, *Cyperus papyrus*, led to the discovery of paper and was used to build boats that could be sailed across the ocean. In Europe, the reeds (*Phragmites australis*) were extensively used for thatching. In Asia, humans were not only attracted by the serene beauty of these watery areas that is reflected in their art, but developed such compassion for the wildlife that many species were bestowed with divinity, associated with gods. Lotus became a symbol of sacredness and purity in both Hinduism and Buddhism. In India, these watery vegetated habitats were called Anup (incomparable). Similar habitats elsewhere in the world were given many local names of which the most common in English were marsh, swamp, bog and mire which differed greatly in their characteristics and biota.

DEFINITIONS OF WETLANDS

U.S. Fish and Wildlife Service (Cowardin et al. 1979)

wetlands are "lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water" and

"must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year".

Ramsar Convention, 1971 (Ramsar Convention Secretariat 2013)

"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". and

"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".

Pittock et al. (2015)

"places where water is the primary factor controlling plant and animal life and the wider environment, where the water table is at or near the land surface, or where water covers the land".

By the early 20th century, these habitats which hosted thousands of migratory birds from distant parts of the globe, had turned into sport hunting grounds and soon concerns were raised in many countries for their protection. Around the middle of the 20th century, these habitats were named as 'wetlands' - signifying the land being wet. The term became internationally popular after the representatives of a few international organisations and national governments signed, on 2 February 1971 (in Ramsar, Iran) an agreement, called as the Ramsar Convention. The Convention which originally emphasized the conservation and wise use of wetlands primarily as habitats for waterfowl, has gradually extended its scope to larger array of aquatic ecosystems (except oceans). Thus, wetlands have turned into waters without requiring the role of 'land' in them.

DISTRIBUTION OF WETLANDS (Where wetlands occur today?)

Wetlands occur in all climatic zones - from tropical deserts to cold tundra, and at all altitudes - from below the sea level to about 6000 m elevation in the Himalaya. Wetlands occur wherever water accumulates for enough long periods that allow the establishment of plants and animals adapted to the aquatic environment. Water need not be present permanently and the depth may generally fluctuate. Thus, wetlands occur in or along all water bodies - from temporary ponds to shallow or deep lakes, springs, streams and rivers. Typically wetlands are recognised by the presence of aquatic plants (called macrophytes) other than microscopic algae (phytoplankton or filamentous algae). The macrophytes play

KINDS OF WETLANDS

Glacial Lakes: *A lake formed at the base of a glacier*

Peat bogs: *a thick mass of partly decomposed or undecomposed remains of plants (mostly Sphagnum mosses in norther latitudes*

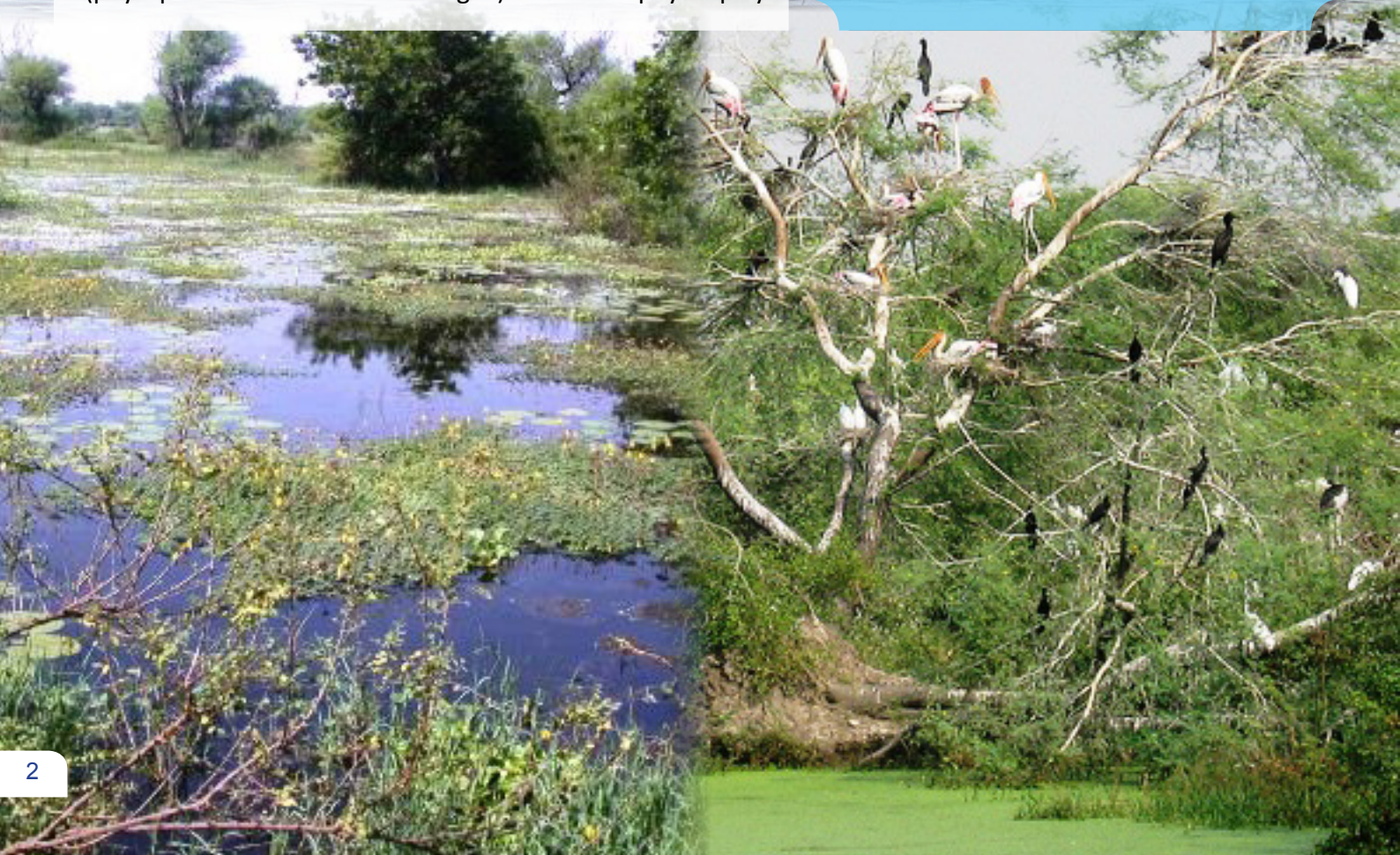
Shallow lakes: *Natural lakes with an average depth of about 3 meters which allows the abundant growth of macrophytes in its entire area*

Deep Lakes: *Lakes with water depths that prevent the growth of submerged macrophytes; may have a narrow peripheral littoral zone with macrophytic vegetation*

Flood-plains: *areas lying lateral to river channels and periodically flooded when the river flow exceeds the channels' carrying capacity*

Marshes: *habitats with waterlogged or water saturated substrate with herbaceous vegetation; may also have areas with shallow water; natural or incidental to human activity that causes water logging*

Swamps: *habitats with predominantly woody vegetation adapted to submerged or waterlogged substrates*



Ox-bows: *shallow water bodies created by the separation of meander loops of a river either by sediment deposition; may become periodically connected with the river at high flood time*

Lagoons: *a coastal water body that is connected to the sea by one or more small openings through which it exchanges water with the sea especially during the tide. The lagoons often receive freshwater runoff from their landward catchments.*

Reservoirs: *Any large water body created by constructing a dam over a stream or river*

Tanks: *Water bodies created generally by impounding the surface runoff from seasonal streams; Also those created by dredging*

Temple Tanks: *Natural or human made water bodies near the temples and used for cultural/ religious activities only*

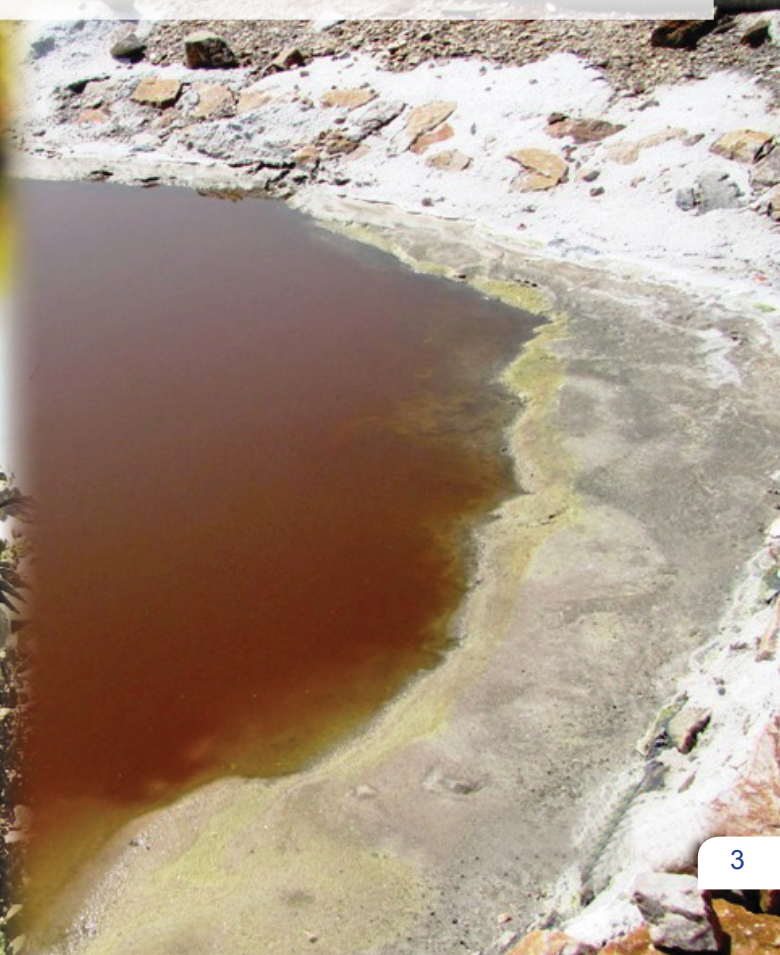
Fish ponds: *Natural or human made water bodies used mainly for fish culture (aquaculture)*

Paddy fields: *Agricultural fields for growing paddy*

Village ponds: *small shallow water bodies in the villages used for multiple purposes*

the most significant and predominant role in determining the functions of all wetlands. The growth and distribution of the macrophytes (other than the free-floating plants like duckweeds, Azolla, and water hyacinth) is determined among various factors by the water depth and is usually restricted to a depth of two metres. Submerged plants may occur under clear water conditions to a depth of about 4 metres. Therefore, only the shallow and usually the periodically flooded marginal areas of large rivers (called the floodplains) and lakes and reservoirs (called the littoral zones) are considered to be proper wetlands. A similar situation exists in case of another kind of wetlands - the mangroves- which also lie between higher land and the deep open waters of the sea.

Many wetlands have been modified and are managed by humans for specific purposes. For example, majority of the paddy fields and fish ponds have been created out of the natural wetlands by manipulating their vegetation and fauna. Similarly, innumerable tanks have been created in the arid and semi-arid regions by blocking the runoff of small seasonal streams to store water for irrigation and/ or domestic uses. Thousands of large and deep reservoirs have been created by constructing dams over the rivers. The water level in these human-made water bodies fluctuates considerably and owing to the morphology of their basins, they have large littoral zones which have gradually turned into wetlands with rich aquatic vegetation and other biota. Hundreds of thousands of human-made wetlands owe their existence to a wide range of human activities such as excavation of soil for making bricks or roads, stone quarrying, or due to waterlogging of low-lying lands along the canals.



According to the latest estimate of wetlands in India, the human-made inland wetlands cover about 37% area (3941,832 ha) and the remaining 63% are the natural wetlands (6623,067 ha). There are also 4140,116 ha of coastal wetlands (of which the intertidal mudflats of Kutchh alone contribute about 51%) and 555,557 ha of wetlands smaller than 2.25 ha each. It is noteworthy that the paddy fields were included as wetlands in this inventory.

WETLAND BIODIVERSITY (How wetlands support many species?)

Wetlands are characterised by the occurrence of macrophytes which include representatives of flowering plants, pteridophytes and bryophytes (mosses) and a few large algae (e.g., Chara, Nitella). Some of these plants float freely on the water surface or remain suspended in the water column. Majority of them are rooted in or attached to the substratum with their shoots being either wholly submerged or emergent above the water surface. Some plants have their shoots creeping and floating over the water surface and yet others have only their leaves floating on the surface. Numerous other plants occur rooted in waterlogged soils. The deep open water systems such as lakes, reservoirs and rivers are dominated by phytoplankton and some filamentous algae. These algae also occur commonly within the macrophyte dominated wetlands.

The diversity and abundance of macrophytes in a wetland is governed by its water regime. Five components of the water regime - the depth, duration, frequency and amplitude of change and the time of the year - control various life processes throughout the lifecycle of various macrophytes (as also the fauna). The water regimes are further influenced by the flow velocity and wave action in large water bodies.

Macrophytes provide substrate for a large diversity of periphyton which constitute the food of many grazing invertebrates and fish. Some macrophytes are utilised by the waterfowl for feeding, nesting material and roosting at different levels of the plant canopy. Submerged macrophytes provide food as well as refugia for many fauna. Most of the macrophyte production turns into detritus (decomposing organic matter) where microbes start complex food webs, enhance secondary production and enrich the biodiversity. In lakes, reservoirs and rivers the food chains are sustained by allochthonous inputs. It is important to note that most of the wetland fauna also require different water regimes and food sources at different times of their life cycle. Therefore, numerous fish, amphibia, reptiles and invertebrates seasonally migrate between macrophyte dominated wetlands and open water systems for breeding, feeding and other activities. Even the terrestrial insects depend upon shallow water habitats for their breeding and larval stages.

The faunal diversity of wetlands is grouped into six categories: (a) residents in the wetland proper; (b) regular migrants from deepwater habitats; (c) regular migrants from terrestrial uplands (particularly large herbivores); (d) regular migrants from other wetlands (e.g. waterfowl); (e) occasional visitors and (f) those indirectly dependent on wetland biota. Thus, wetlands are 'hotspots' of biodiversity and often support thousands of species, even if they appear to be dominated by one or two plant or animal species (e.g., *Phragmites*, *Typha* sp., *Cyperus* sp. or just flamingos or ducks).

WETLAND FUNCTIONS (What wetlands do and how?)

Functions of all natural ecosystems include transfer of energy through plants to food webs and the biogeochemical cycling (including water cycle). Wetlands also perform the same functions but differ among themselves in the magnitude and efficiency according to their hydrological regimes and climate which govern the biodiversity.

All macrophytes and various algae produce organic matter which is consumed directly or indirectly by the animals.do the same. Besides food, the macrophytes also provide habitats and support many other plants and animals. Submerged macrophytes oxygenate the water column whereas the emergent and rooted floating leaved plants help exchange of gases between the soils and the atmosphere. They transport oxygen to their root zones and carry methane and nitrous oxide to the atmosphere. All macrophytes sequester carbon in their biomass which

LOTUS (Nelumbo nucifera)

'Lotus Effect' leads to an Industry.

Lotus, a plant held sacred in Hinduism and Buddhism, symbolises purity and 'spontaneous' generation. The rhizomes are highly nutritious and the seeds have medicinal value.

The plant grows in muddy water but the leaves and flowers are always held above the water surface. The leaves and petals always remain clean and shining as dust never adheres to them. The self-cleaning and water repellent property of the leaves and flowers, has been termed as the 'lotus effect' and exploited for developing superhydrophobic surfaces of materials for different uses.

remains undecomposed under certain conditions for very long periods, and sometimes turns ino peat. Macrophytes transform nutrients through uptake, assimilation and storage but also also immobilise some heavy metals on their root surfaces or inside their belowground organs. Many macrophytes have the ability to take up and accumulate more nutrients than their requirements if the nutrient availability increases. Macrophytes function both as a source (from soils to water) and sink (from water to soils) of nutrients. Macrophytes influence also the hydrological cycle as they enhance or lower the loss of water to the atmosphere through evapotranspiration. Emergent macrophytes facilitate also the movement of water into the ground.

ECOSYSTEM SERVICES OF WETLANDS (How do we benefit from them?)

Humans use wetlands in several ways but also benefit from them indirectly. Various kinds of benefits derived from an ecosystem by the people and the society have recently been termed as ecosystem services. These benefits are often categorised into Provisioning (food, fiber, fodder, fuel, water, and other materials), Regulating (regulation of biogeochemical cycles including climate), Supporting (e.g., soil formation, supporting biodiversity) and Cultural (aesthetics, recreational and spiritual activities) services. These services accrue from the ecosystem functions and depend largely upon the biodiversity of that ecosystem.

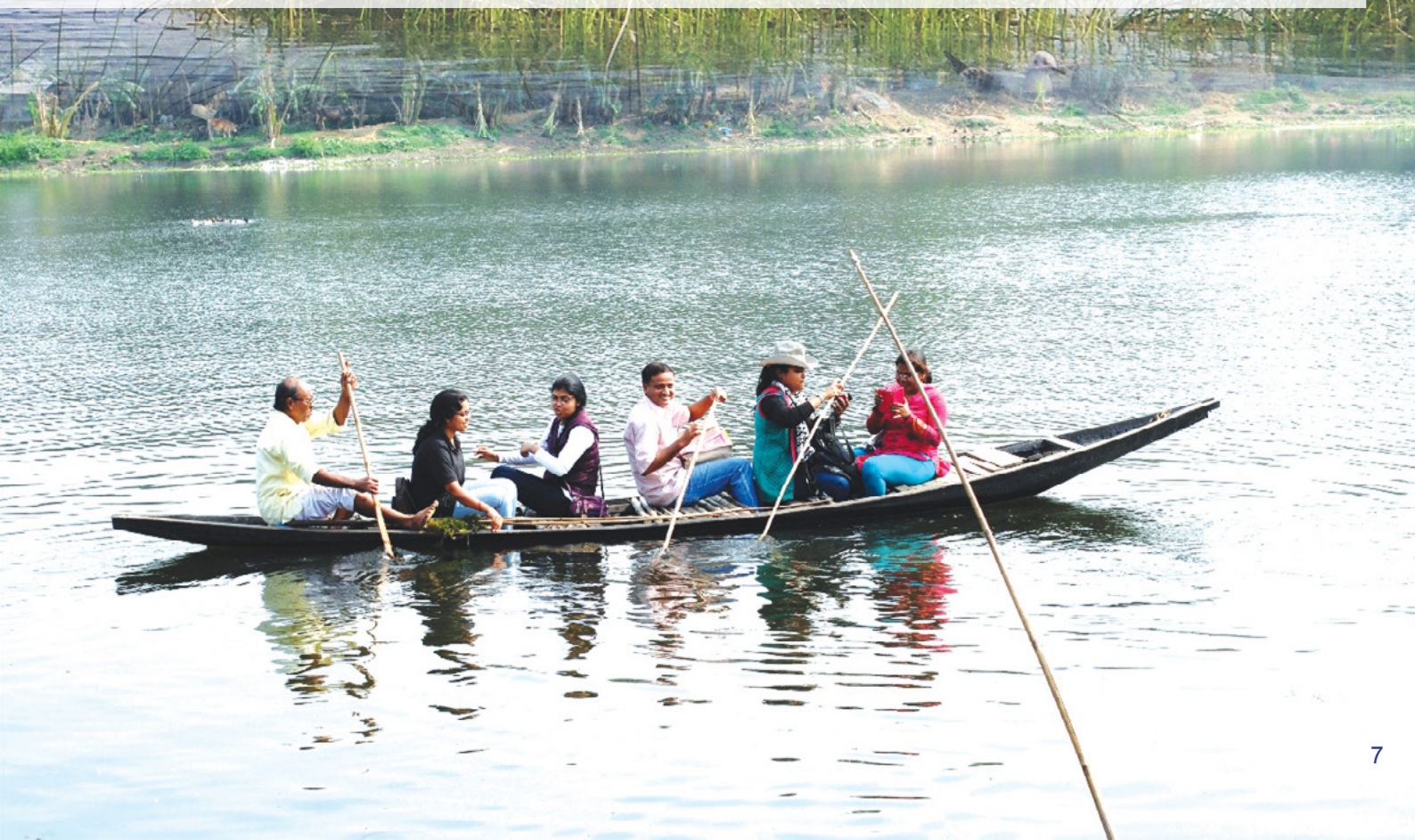
Among the direct and most important benefits from wetlands to humans are the production of rice and fish which are the staple food for more than half of the world's human population. Many other wetland plants are used for food e.g., *Trapa bispinosa*, *Nelumbo nucifera* (lotus), *Euryale ferox*, *Eleocharis dulcis*, *Colocasia* sp., species of *Cyperus, Scirpus, Echinochloa*, and *Ipomoea aquatica.* Jute, *Aeschynomene*, reeds, cattails (*Typha* sp.), *Calamus* and many grasses are used for fibre; woody plants such as *Tamarix* sp.are used for fuel, whereas species of *Echinochloa, Paspalum* and duckweeds are important animal feeds. Many plants e.g., *Acorus calamus, Bacopa monieri, Hygrophila spinosa, Eclipta alba*, *Cyperus rotundus*, etc. are used in medicines. Among the animals, fish, birds, amphibians, and large invertebrates (crustaceans and molluscs) are common in human food. Macrophytes are also used for extracting several vitamins and essential oils (e.g., *Vetiveria zizanioides*). Wetlands are known to be among the most productive systems and some macrophytes as *Arundo donax* may produce up to 20 tonnes per ha of biomass annually. Algae with very small biomass have only negligible direct use but several of them (e.g., *Chlorella, Spirulina*, *Scenedesmus, Dunaliella*). can be cultured for food and medicine.

Welands provide far more indirect benefits. High organic production in wetlands causes a reduction in the atmospheric carbon dioxide which

is sequestered in the plant or animal biomass or as organic matter in the soil. Thus wetlands contribute to regulating climate change. In permanent wetlands decomposition of organic matter is greatly reduced by the anoxic conditions, and results in peat formation under very low temperature (as in northern latitudes and at high altitudes) or acidic conditions that further reduce the microbial activity. However, wetlands are also known to release of methane and nitrous oxide which contribute o global warming. Recent studies have shown that wetlands may be regarded as a source for greenhouse gases on a short time scale (decades) only. Over long-term scales (100 to 300 years) methane emissions become unimportant and most wetlands become net carbon sinks.

All wetlands, through their nutrient cycling strategies, regulate water quality. Submerged macrophytes oxygenate the water column, lower the nutrient content and keep the water clean and transparent unless the systems are heavily human-impacted. Perennial macrophytes often accumulate large amounts of nutrients in their belowground organs. The rooted macrophytes actively transport oxygen to their rhizosphere where the greenhouse gases and other reduced ions such as sulphide, ammonium, ferrous and manganese etc are oxidised. These processes in the littoral zones and floodplains help maintain the water quality in open water areas by intercepting and transforming the nutrients and a wide range of pollutants, particularly from non-point sources. Wetland have indeed been called as 'Kidneys of the Earth'. The water quality improvement function of macrophytes has been utilised in developing the constructed wetland technology which is widely used in many countries. The flowing water systems also regulate water quality through their waste-assimilation capacity that is limited by the characteristics of their flow regimes, and is aided by the riparian and floodplain wetlands. Further, wetlands with perennial macrophytes and woody plans control soil erosion and stabilise shore lines. This is also helps improve water quality as sediments are trapped by the vegetation, thereby reducing or eliminating the turbidity. The fine sediments bring with them also the nutrients. In wetlands such as the floodplains humans benefit from this sediment trapping by way of renewed soil fertility and better crop yields.

The most important benefit from the wetlands (and all inland aquatic ecosystems) lies in their regulation of water regimes. All wetlands receive their water from the catchments, retain it for varying periods of time, transport it downstream and allow some of it to infiltrate into the ground. Some water also evaporates back finto the atmosphere. This regulation of water movement, according to their water holding or flow carrying capacity, benefits the humans by making it available over longer time and greater space (distance) as well as by protecting them from the hazards of floods and droughts caused by events of extreme precipitation. The macrophytes influence this function by reducing the water storing



RELATIVE EXTENT OF BIODIVERSITY AND ECOSYSTEM

	Glacial Lakes	Peat bogs	Shallow lakes	Deep Lakes	Flood-plains	Marshes
Biodiversity						
Microphyte	●	●	●	●	●	●
Macrophytes	●	●	●	●	●	●
Fish	●	●	●	●	●	●
Zooplankton	●	●	●	●	●	●
Benthos	●	●	●	●	●	●
Birds	●	●	●	●	●	●
Herpetofauna	●	●	●	●	●	●
Benefits to Humans						
Food	○	?	●	•	●	●
Fodder	○	•	•	○	●	●
Fuel	○	●	●	○	●	●
Fiber	○	○	●	○	●	●
Medicinal	○	•	●	○	●	●
Biochemicals	○	○	●	○	●	●
Genetic	?	•	●	○	•	●
Water Storage	●	•	●	●	●	●
Groundwater Recharge	?	○	●	•	●	●
Sediments	●	•	●	●	●	●
Nutrients	?	○	●	•	●	●
Heavy Metals	○	●	●	•	●	●
Toxics	○	●	●	•	●	●
C-sequestration	○	●	●	•	●	●
GHG emission	?	●	●	•	•	●
Erosion control	○	○	●	○	●	●
Disease vectors	○	○	●	○	●	●
Recreation	•	●	●	•	●	●
Aesthetics	•	•	●	•	●	●
Spiritual	•	•	●	○	•	•
Religious	•	○	●	○	•	•
Pollination	○	○	●	○	●	●
Soil Formation	○	•	●	○	●	●

Biodiversity: ● usually absent; ● low; ● Medium; ● High

SERVICES (BENEFITS) OF DIFFERENT KINDS OF WETLANDS

Ox-bows	Lagoons	Reservoirs	Tanks	Temple Tanks	Fish ponds	Paddy fields	Village ponds
●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●
●	●	•	○	○	●	●	•
●	●	○	○	○	○	•	○
•		○	○	○	○	○	○
●	•	○	○	○	○	•	○
•	•	○	○	○	○	•	○
•	•	○	○	○	○	●	○
○	●	○	○	○	○	○	○
●	●	●	●	•	●	○	●
●	●	•	•	•	•	•	●
●	●	●	●	●	•		•
●	●	•	•	•	•	•	•
•	●	○	○	○	○	○	•
•	●	○	○	○	○	○	•
•	●	•	○	○	•	•	○
•	•	●	○	○	○	●	○
•	•	○	○	○	○	○	○
●	•	○	•	○	•	•	●
●	●	•	●	•	○	○	•
•	●	•	•	•	•	○	•
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○	•	○	○	○	○	○	•

Benefits: ○ - no benefit; • - little, sometimes; ● -medium; ● - large

potential and obstructing the flow, but the emergent macrophytes also improve the hydraulic conductivity and help greater infiltration into the ground.

Humans benefit from the wetlands which are in general the most preferred sites for a variety of recreational and socio-cultural activities. Macrophyte dominated wetlands are highly valued for recreation involving bird watching, boating, angling, and resting or similar leisurely activities. Rivers, lakes and reservoirs are valued for recreational activities such as river rafting, diving, swimming, which require avoiding shallow areas with abundant submerged or floating macrophytes. Emergent macrophytes together with other wildlife (birds, mammals, and insecs) invariably enhance the aesthetic appeal of the landscape. Many rivers and lakes, especially the high altitude glacial lakes, in the Himalaya have very high spiritual and religious value; they are held sacred and attract numerous visitors. The benefits of such non-consumptive uses are difficult to quantify, and their value depends on individual and cultural assessments.

WETLAND LOSS AND DEGRADATION (What threatens wetlands?)

One would expect that in view of their large and varied benefits, the wetlands would be among the most desirable ecosystems. The fact that wetlands harbour high levels of biodiversity disproportionate to their areal extent would imply that these hotspots would receive top priority for the conservation of biodiversity. However, both wetland attributes fail to draw human interest in caring for them. The figures for the extent of wetlands in India noted earlier indicate that only 4.5% of India's land area is under wetlands against the global average of above 6 percent. If the rivers are excluded that make up 80% of the total natural wetlands, the total area of wetlands in India is reduced to less than 3 percent. An earlier study had estimated that about 38% of inland freshwater wetlands had been lost in recent decades only. Interestingly, human settlements continue to grow even today near wetlands and most often at their expense. The wetlands which come to lie within the urban limits are the most threatened for their existence. Several published studies and day to day experience shows a rapid loss of wetlands as has happened in Hyderabad, Bengaluru, Delhi, Kolkata and Guwahati where rapid urbanisation has spelt demise of the rich wetland ecosystems that were once created for the well-being of the people there. Wetlands are used as regular land fill sites or are gradually filled up by dumping solid wastes. The recent floods in Kashmir valley and Kedarnath valley are cruel testimony to the loss of floodplain wetlands and their encroachment by short-term economic interests.

This neglect or abuse of wetlands is not a recent phenomenon. It started with the arrival of the European colonialists who carried with them their own perceptions and approaches to these

watery habitats. The British considered all areas as wastelands if they did not yield revenue. In West Bengal and the present Bangladesh, the British encouraged conversion of the mangroves to paddy field by allowing onl the cultivators to settle there. The British tamed the rivers, creating embankments and barrages for canal irrigation that would generate revenue. Moreover, marshes were considered fit for drainage especially because they harboured mosquitoes and other disease vectors. We continue to follow the British in classifying wetlands as wastelands in our revenue records despite their having been recognised as common pool resources.

All remaining wetlands are victims of large scale widespread hydrological alteration. The sources and pathways of their water supply, whether surface runoff from the surrounding areas or inflow through channels or both, have been eliminated or blocked or their supply has been greatly altered. Many floodplain wetlands have been eliminated by embankments and in most cases, the flow storage and diversion structures upstream have greatly modified their flooding regimes. In lakes and other water bodies, water levels are regulated by withdrawal of water for different human uses. Whereas small annual changes do not matter much, the long term changes do adversely affect the wetlands.

Another major factor causing degradation of wetlands is the discharge of untreated domestic and industrial wastewaters in the wetland. It is not readily appreciated that the upstream wastewater discharges affect the wetlands downstream. Wastewaters also facilitate siltation and alter the hydrological regime besides bringing in various pollutants.

Numerous wetlands are also infested with the uncontrolled growth of exotic species, particularly water hyacinth. In recent years, there has been little effort to remove and destroy them because of the misplaced understanding that these plants can remove pollutants and help improve water quality. It is not realised that the - the weeds to be effective have to be selectively removed - young one left and allowed to multiply. death and decay returns the nutrients and pollutants back into water while huge quantities of undecomposed organic matter accumulate, fill in the water body, eliminate dissolved oxygen and cause mass fish kills.

REAL CAUSES OF WETLAND LOSS AND DEGRADATION

Thus, wetlands - both natural and human-made -are lost and degraded primarily because they do not receive attention in the development plans - whether they are concerned with land use changes or are related the development of water resources, and wetlands are treated as dustbins for the discharge of wastewaters as well as the disposal of solid wastes.

WHAT NEEDS TO BE DONE

Conservation of wetlands with the objective of protecting their biodiversity, specific biophysical

characteristics and obtaining optimum benefits from them requires a major shift in polcies related land and water use. Joining the Ramsar Convention is only being a part of the international community to express solidarity with its objectives. Designation of a few wetlands under the Ramsar Convention and enlisting a few other large ones as important wetlands does not ensure the conservation of all wetlands. Studies show that many small wetlands together support more biological diversity than one large wetland though some species may occur only in large wetland. Just as drops make an ocean, each small wetland has a bit to contribute. No two wetlands are entirely similar like a photocopy or identical twins.

We need to address the real causes of wetland loss and degradation.

- First and foremost, both natural and human-made wetlands should be declared as specific land use category and their hydrological characteristics (sources and regimes) should be identified.

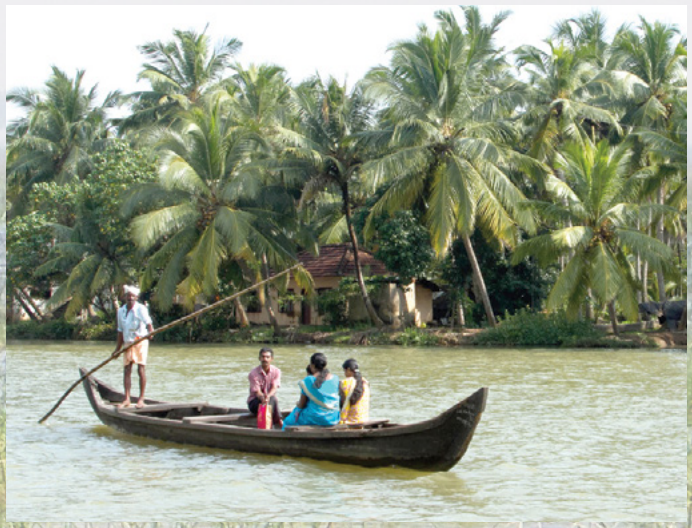
- Second, their conversion to any other land use or any reduction in their area or alteration in their water regime should be prohibited, except for strategic reasons after exploring other options and providing for compensatory measures.

- Third, the total biodiversity of all wetlands should be assessed and periodically monitored.

- Fourth, all ecosystem services of all wetlands should be assessed and valued in economic terms.

- 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 interventions on rivers, the hydrological changes may cascade down to the entire river course 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.

- The assessment of ecosystem services and their economic valuation should particularly address the benefits to the local community and their livelihoods. A few kilograms of rhizomes of lotus or the leafy shoots of *Ipomoes aquatica* may not be priced significantly but may have a high value for the local community in terms of vegetable use and nourishment a no cost to them.



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