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Wetlands: The living waters-A review

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ABSTRACT

Wetlands are the link between land and water which provide imperative services to living forms. There are different kinds of wetlands around the world performing vivacious functions like water conservation, food supply, cultural value, biodiversity hotspots, pollution abatement etc. Nevertheless, increasing human population has lead to urbanization and land use changes resulting in climate change and pollution and ultimately in wetland destruction. Henceforth, conservation of wetlands is significant; for that at the international level Ramsar convention was steered and selected most important wetlands in the world which are under destruction. India has 26 Ramsar sites. Particulars regarding different kinds of wetlands, its significance, conservation and major wetlands in India are reviewed in this paper.

Key words: Conservation, Ramsar, Wetlands management.

Wetlands, also designated as living waters, the most productive ecosystems on the earth (Ghermandi *et al*., 2008), provide many vital amenities to manhood (ten Brink *et al*., 2012). Wetlands can be defined as the 'lands transitional between terrestrial and aquatic ecosystems, where the water table is usually at or near the surface or the land is covered by shallow water (Mitch and Gooselink, 1986) or can be defined as the areas of marsh, fen or peatland, 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 (Ramsar Secretariat, 2013).

A wetland and wet land is different. All wetlands are wet lands (*i.e*. land which is wet). But not all wet lands result in a wetland. A wetland is found where the land is wet enough (*i.e*., saturated or flooded) for long enough to be unfavourable to most plants but are favourable to plants adapted to anaerobic soil conditions. As soil becomes gradually wet, the water starts to, fill the space among the soil particles. The soil is said to be saturated, when all the spaces are filled with water. In areas which are not wetlands, water drains away rapidly and the soil does not remain saturated. Nevertheless, in wetlands the water persists or drains away very slowly and the soil remains saturated or flooded for long periods.

Globally, the areal extent of wetland ecosystems come to 570 million hectares (Ramsar Secretariat, 2013) with an estimated economic value of about US$ 15 trillion a year (MEA, 2005). The study of wetlands has recently been termed Paludology (Husain and Bhatnagar, 2013).

TYPES /CLASSIFICATION OF WETLANDS

Wetlands can be classified based on many criterias. Encyclopaedic Directory of Environment (1988) classified wetlands broadly into two: Inland wetlands and coastal wetlands.

Inland Wetlands: Classified in to inland natural and inland man-made wetlands.

Inland natural wetlands

Lakes: Larger bodies of standing water occupying distinct basins (Reid *et al.*, 1976).

Ox-bow lakes/ Cut off meanders: A meandering stream may erode the outside shores of its broad bends, and in time the loops may become cut-off, leaving basins. The resulting shallow crescent-shaped lakes are called oxbow lakes (Reid *et al.*, 1976).

High altitude lakes: These lakes occur in the Himalayan region. Landscapes around high lakes are characterized by hilly topography.

Riverine wetlands: Along the major rivers, especially in plains water accumulates leading to formation of swamps and marshes.

Marshes are frequently or continually inundated wetland characterized by emergent herbaceous vegetation adapted to saturated soil conditions and swamps are 'wetland dominated by trees or shrubs'.

Waterlogged areas: An area in which water stands near, at, or above the land surface, so that the roots of all plants except hydrophytes are drowned and the plants die (Margarate *et al*., 1974).

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River/stream: Rivers are linear water features of the landscape. Many stretches of the rivers in Indo-Gangetic Plains and Peninsular India are declared important National and International wetlands.

Inland man-made wetlands

Tanks / Ponds: Artificial pond, pool or lake formed by building a mud wall across the valley of a small stream to retain the monsoon (Margarate *et al.*, 1974).

Waterlogged: Man-made activities like canals cause waterlogging in adjacent areas due to seepage especially when canals are unlined.

Paddy fields can be depicted as'agronomically managed temporary wetland ecosystems'. These are actually man made wetlands developed by modifying naturally existing waterlogged wetland areas. In addition to ensured food security, other benefits of paddy fields include- flood control, water conservation and aquifer recharge.

Salt pans: Inland salt pans in India occur in Rajasthan (Sambhar lake). These are shallow rectangular man-made depressions in which saline water is accumulated for drying in the sun for making salt.

Reservoirs: A pond or lake built for the storage of water, usually by the construction of a dam across a river (Margarate *et al*., 1974).

Coastal wetlands: Classified in to coastal natural and coastal man-made wetlands.

Coastal natural wetlands

Lagoons: Coastal bodies of water, partly separated from the sea by barrier beaches or bass of marine origin.

Creek: These creeks develop as do rivers "with minor irregularities sooner or later causing the water to be deflected into definite channels" (Mitsch and Gosselink, 1986).

Sand beach: Beach is an unvegetated part of the shoreline formed of loose material, usually sand that extends from the upper berm (A ridge or ridges on the backshore of the beach, formed by the deposit of material by wave action, that marks the upper limit of ordinary high tides and wave wash to low water mark)(Clark,1977).

Mudflats: Most unvegetated areas that are alternately exposed and inundated by the falling and rising of the tide. (Clark, 1977).

Salt marsh: Natural or semi-natural halophytic grassland and dwarf brushwood on the alluvial sediments bordering saline water bodies whose water level fluctuates either tidally or non- tidally (Mitsch and Gosselink, 1986).

Mangroves: The mangrove swamp is an association of halophytic trees, shrubs, and other plants growing in brackish to saline tidal waters of tropical and sub-tropical coastlines (Mitsch and Gosselink, 1986). There are more than 18 million ha of mangroves populating in 112 countries and territories in the tropical and subtropical region (Tomlinson, 1986). Mangroves of South and Southeast Asia form the world's most extensive and diverse mangrove systems covering 41.4 per cent of global mangroves (Singh *et al*., 2012).

Mangrove forests provide food and shelter for diverse groups of fish and shellfish. By reducing the height and energy of wind and swell waves passing through them, mangroves perform as a cordon against destructive force of nature like tsunami and coastal erosion and reduces their ability to erode sediments and to cause damage to structures such as dikes and sea walls. During rising tides, as the sea comes in, waves enter the mangrove forests. They lose energy as they pass through the scrambled above-ground roots and branches and their height is rapidly diminished, by between 13 and 66 per cent over 100 m of mangroves. Mangroves also reduce winds across the surface of the water and this prevents the propagation or re-formation of waves. Mangrove swamps are also the natural sewage treatment plants (Mohandas *et al*., 2014).

Coral reefs: Consolidated living colonies of microscopic organisms found in warm tropical waters.

Coastal man-made wetlands

Salt pans: An undrained usually small and shallow rectangular, man-made depression or hollow in which saline water accumulates and evaporates leaving a salt deposit (Margarate *et al*., 1974).

Aquaculture ponds: Aquaculture is defined as " breeding and rearing of fresh-water or marine fish in captivity, fish farming or ranching". The water bodies used for the above are called aquaculture ponds. (Encyclopaedic Directory of Environment, 1988).

SIGNIFICANCE OF WETLANDS

Wetlands are the basis of all living forms in biosphere. Wetlands are considered to have unique ecological features which provide numerous products and services to humanity (Prasad *et al*., 2002). The value of ecosystem services of wetland is \$14,785 ha^{-1} $year^{-1}$ whereas that of tropical forest is equivalent to \$2007 ha^{-1} $year^{-1}$(Costanza *et al.*, 1997). The important functions are listed below with brief descriptions followed.

Flood control: Wetlands play a major role in flood control by decreasing the impacts of flooding by absorbing water and reducing the speed at which flood water flows. They trap suspended solids and nutrient load during periods of flooding. Hence, watercourses flowing into rivers through wetlands will transport only fewer suspended solids and nutrients to the rivers than if they flow directly into the rivers and due to this, wetlands are considered to be a natural capital substitute for conventional flood control investments such as dykes, dams, and embankments (Boyd and Banzhaf, 2007).

Water conservation: With the help of vegetation, wetlands literally act as sponges, preventing the evaporation of water, particularly during periods of intense summer (Husain and Bhatnagar, 2013). They store and conserve precious water-by infiltration, percolation and seepage. One hectare wetland stores 100 m^3 water (1,00,000 litres) in one cm depth. Henceforth, wetlands serve as natural water conservation tools.

Improving water quality: Wetland plants in the water take-up nutrients. Wetlands remove pollutants such as phosphorus, heavy metals and toxins which are trapped in the sediments of the wetlands. In addition, nitrogen and heavy metals are unified into peat during its formation. Hence, wetlands are often described as "kidneys of the landscape" (Mitsch and Gosselink 1986).

Food supply: Wetlands play a major role in the food web and act as the source of food for almost all the living organisms. Rice crop is the major contribution of wetlands. Rice fields can be depicted as 'agronomically managed temporary wetland ecosystems'. Rice is the staple diet of nearly 3 billion people - half the world's population. Forty two percent (59 million ha) of rice area in developing countries is rainfed wetland paddy, producing 24 per cent of total rice output of these countries (FAO, 2000).

Cultural value: Throughout history humans have gathered around wetlands, which has played an important part in human development and are of significant religious, historical or archaeological value to many cultures around the world.

Human communities in India are closely associated with wetlands as showed by the Indus Valley Civilization, which flourished along the banks of river Indus. The water bodies and their resources have been an integral part of the social and cultural ethos of human societies.

Materials and medicines: Wetlands yield fuelwood for cooking, fibres for textiles and paper making, thatch for roofing and timber for building. Medicines are extracted from their bark, leaves, and fruits, and they also provide tannins and dyes, used widely in the treatment of leather.

Recreation: Wetlands everywhere provide important leisure facilities - canoeing and fishing, shell collection and bird watching, swimming and snorkeling, hunting and sailing. "Island of Crows" in Sasthamkotta lake (Kerala) has been listed in National Geographic's 'Around the World in 24 Hours', a photographic tour of travel-worthy spots across the world.

Vital habitat: In supporting high numbers of endemic species**,** individual wetlands are extremely important. Since wetlands are the source of vivid fish species, they provide a nursery habitat for many commercially important fish species that are harvested outside the wetland.

Biodiversity hotspots: Wetlands are important in supporting species diversity compared to any other natural habitat. Some vertebrates and invertebrates depend on wetlands for their entire life cycle while others only associate with these areas during particular stages of their life.

In India, lakes, rivers and other freshwater bodies support a large diversity of biota representing almost all taxonomic groups. The total numbers of aquatic plant species exceed 1200 and they provide a valuable source of food, especially for waterfowl (Prasad *et al*., 2002). The freshwater ecosystems of Western Ghats, a biogeographic region in southern India which runs along the west coast covering a total area of 136,800 km^2, alone has about 290 species of fish; 77 species of Mollusc; 171 species of Odonates;608 species of aquatic plants; and 137 species of amphibians. Out of these, almost 53 per cent of freshwater fish, 36 per cent of freshwater Mollusc, and 24 per cent of aquatic plants species are endemic to this region (Molur *et al*., 2011).

Refuge for migratory birds: Winter across the northern hemisphere triggers the most extraordinary mass movement of any living creature on Earth - the annual migration of countless birds over huge distances. The world's wetlands provide food and shelter for the birds, offer a welcome pitspot, before the birds continue on to their final destination. In many such wetland areas of India, like Bharatpur wild life sanctuary in Rajasthan, and little Rann of Kutch and coastal areas of Saurashtra in Gujarat, many migratory species of birds from western and European countries come during winter. According to estimates, the approximate number of species of migratory birds recorded from India is between 1200 and 1300, which is about 24 per cent of India's total bird species (Agarwal, 2011).

Carbon sequestration: Swamps, mangroves, peat lands and marshes play an important role in carbon cycle. Though wetlands contribute about 40 per cent of the global methane (CH_4) emissions, they have the highest carbon (C) density among terrestrial ecosystems and relatively greater capacities to sequester additional carbon dioxide (CO_2). Wetland sediments are the long-term stores of carbon and short-term stores are in wetland existing biomass (plants, animals, bacteria and fungi) and dissolved components in the surface and groundwater (Wylynko, 1999). Wetlands sequester C through high rates of organic matter inputs and reduced rates of decompositions (Pant *et al*., 2003). Wetland soils may contain as much as 200 times more C than its vegetation. However, drainage of large areas of wetlands and their subsequent cultivation at many places had made them a net source of CO_2. Restoration of wetlands can reverse them to a sink of atmospheric CO_2 (Lal, 2008). As per the estimations, carbon sequestration potential of restored wetlands (over 50 year period) comes to about 0.4 tonnes C ha^{-1} $year^{-1}$ (IPCC, 2000). In India, coastal wetlands are playing a major role in carbon sequestration.

Pollution abatement: Wetlands have been suggested as a low-cost measure to reduce point and non-point pollution

from an economic perspective (Bystrom *et al.*, 2000). Wetlands act as a sink for contaminants in many agricultural and urban landscapes. Natural wetlands reduce the nutrient load of through-flowing water by removing nitrate and phosphorus from surface and subsurface run off (Verhoeven *et al.*, 2006). Maximum potential rate of nitrogen and phosphorus removal by wetlands in the temperate regions ranges from 1000 to 3000 kg N ha^{-1} $year^{-1}$ and from 60 to100 kg P ha^{-1} $year^{-1}$ (Groffman and Crawford, 2003).

GROWING THREATS TO WETLAND ECOSYSTEM

Worldwide, the main causes of wetland loss have been: urbanization; land use changes; drainage to agricultural use; infrastructure development; pollution from industrial effluent and agricultural runoff; climate change and variability.

Urbanization and land use changes: Between 1951 and 2011, total population in India increased from 0.4 billion to 1.2 billion with an average decadal growth rate of around 22 per cent. During the 90 year period from 1901 to 1991, the number of urban centers doubled while urban population has increased eight fold (Bassi and Kumar,2012). This magnitude of growth exerted tremendous pressure on wetlands and flood plain areas for meeting water and food demand of growing population. Between 1950–1951 and 2008–2009, total cultivated land in India increased from about 129 to 156 m ha. Also, area under non-agricultural uses (commercial or residential use) increased from 9 to 26 m ha (Data Source: Indiastat).

Urbanization exerts significant influence on the structure and function of wetlands, mainly through modifying the hydrological and sedimentation regimes, and the dynamics of nutrients and chemical pollutants. Further, lack of concrete conservation plans, poor management of water bodies, rapid increase in localized demands for water and rising pollution are pushing these precious eco-balancers to extermination (Indian National Trust for Art and Cultural Heritage, 1998).

Agricultural, municipal and industrial pollution: Agricultural runoff of pesticides and fertilizers and industrial and municipal wastewater discharges lead to widespread eutrophication, which roots to heavy degradation of water in most Asian rivers, lakes and streams (Liu and Diamond, 2005). As a result of intensification of agricultural activities over the past four decades, fertilizer consumption in India has increased from about 2.8 million tonnes in 1973–1974 to 28.3 million tonnes in 2010–2011 (Data Source: Indiastat). As per estimates, 10–15 per cent of the nutrients added to the soils through fertilizers eventually find their way to the surface water system (Indian Institute of Technology, 2011).

Eutrophication can detrimentally affect or eliminate fish population (Verhoeven *et al.*, 2006) and can also result in loss of many of the cultural services provided by lakes. Along with runoff from agricultural fields, untreated wastewater also contributes significantly to pollution of water bodies.

Climate change: High altitude wetlands and coastal wetlands (including mangroves and coral reefs) are some of the most sensitive classes affected by climate change (Patel *et al.*, 2009). In case of the coastal wetlands such as Indian part of Sundarbans mangrove, rising sea surface temperature and sea level rise due to thermal expansion, could affect the fish distribution and lead to the destruction of significant portion of mangrove ecosystem. Further destruction of the Sundarbans mangroves would diminish their critical role as natural buffers against tropical cyclones resulting in loss of lives and livelihoods (Centre for Science and Environment, 2012; UNESCO, 2007).

Climate change induced rising temperature and declining rainfall pattern presents a potential danger to the already disappearing lakes in the Gangetic plains (Sinha, 2011). Decreased precipitation will worsen problems associated with already growing demands for water and hence alter the freshwater inflows to wetland ecosystems (Erwin, 2009), whereas, rise in temperature can aggravate the problem of eutrophication, leading to algal blooms, fish kills, and dead zones in the surface water (Gopal *et al.*, 2010).

CONSEQUENCES OF WETLAND DESTRUCTION

Wetland loss has been associated with the direct loss of species diversity due to destruction and lowered recruitment of infringing vegetation communities and displacement of fauna. The loss of wetlands may end with a loss of flora and fauna, which not only support human interests, but also contribute to the health of other ecosystems, such as streams and rivers (Mitsch and Gosselink, 2000). Eg: Thousands of Titicaca water frog (*Telmatobius coleus*), one of the largest aquatic frogs in the world found dead in South America due to human sewage and heavy metal pollution in Titicaca lake (BBC News, 2016). Increased flooding events, decline in water quality and reduced food security are other related consequences of wetland destruction.

WETLAND CONSERVATION

Even though wetlands are considered to be a vital part of hydrological cycle, support large biological diversity and provide a wide array of ecosystem goods and services (Wetlands Rules, 2010), management of wetlands has received inadequate attention. As a result, many of the wetlands in urban and rural areas are subjected to anthropogenic pressures, including land use changes in the catchment; pollution from industry and households; encroachments; tourism; and over exploitation of their natural resources. 64 per cent of the world's wetlands have disappeared in the last century. Henceforth conservation of wetlands is necessary. In view of conserving wetlands many initiatives were developed at national and international level. Ramsar convention is the most important and successful one on this basis.

Ramsar convention: International treaty for "the conservation and sustainable use of wetlands". It is also known as the Convention on Wetlands. It is named after the city of Ramsar in Iran where the Convention was signed on 2nd of February, 1971. Hence, the 2nd of February each year is celebrated as World Wetlands Day. At the center of the Ramsar philosophy is the "wise use" of wetlands. Wise use means maintenance of ecological character within the context of sustainable development. Ramsar is the only global environmental treaty dealing with a particular ecosystem, *i.e.*, wetlands.

Number of parties to the convention (COP) is 169. Conference of the Parties (COP) is the Convention's governing body consisting of all governments that have ratified the treaty. Every three years, representatives of the Contracting Parties meet as the Conference of the Contracting Parties (COP). The most recent COP, *i.e.*, COP12 was held in Punta del Este, Uruguay in 2015. COP13 will take place in Dubai, United Arab Emirates, in 2018. The List of Wetlands of International Importance included 2,231 Ramsar Sites in March 2016. The country with the highest number of Sites is the United Kingdom with 170. The country with the greatest area of listed wetlands is Bolivia.

Criteria for Identification of Wetlands under Ramsar Convention:

- If it contains a representative, rare, or unique example of a natural or near-natural wetland type.
- If it supports vulnerable, endangered, or critically endangered species; or threatened ecological communities.
- If it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
- If it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
- If it regularly supports 20,000 or more water birds.
- If it regularly supports 1 per cent of the individuals in a population of one species or subspecies of water birds.
- If it supports a significant proportion of indigenous fish subspecies
- If it is an important source of food for fishes, spawning ground, nursery and/or migration path.
- If it is an important source of food and water resource, increased possibilities for recreation and eco-tourism, etc.

Overall, 1052 sites in Europe;289 sites in Asia; 359 sites in Africa; 175 sites in South America; 211 sites in North America; and 79 sites in Oceania region have been identified as Ramsar sites or wetlands of International importance (Ramsar Secretariat, 2013).

WETLAND SCENARIO IN INDIA

In India, with its varying topography and climatic regimes, supports diverse and unique wetland habitats (Prasad *et al.*, 2002). As per the Ramsar Convention definition most of the natural water bodies (such as rivers, lakes, coastal lagoons, mangroves, peat land, coral reefs) and man-made wetlands (such as ponds, farm ponds, irrigated fields, sacred groves, salt pans, reservoirs, gravel pits, sewage farms and canals) in India constitute the wetland ecosystem. Only 26 of these numerous wetlands have been designated as Ramsar Sites (Ramsar Secretariat, 2013) (Table 1).

Table 1: Ramsar sites in India.

Name of Wetland	State
Ashtamudi wetland	Kerala
Bhitarkanika Mangroves	Orissa
Bhoj Wetland	Madhya Pradesh
Chandertal Wetland	Himachal Pradesh
Chilika Lake	Orissa
Deepor Beel	Assam
East Culcutta Wetlands	West Bengal
Harike Lake	Punjab
Hokera Wetland	Jammu & Kashmir
Kanji	Punjab
Keoladeo National Park	Rajasthan
Kolleru Lake	Andhra Pradesh
Loktak Lake	Manipur
Nalsarovar Bird Sanctury	Gujrath
Point CalimereWildlife and Bird Sanctury	Tamilnadu
Pong Dam Lake	Himachal Pradesh
Renuka Wetland	Himachal Pradesh
Ropar	Punjab
Rudrasagar lake	Tripura
Sambhar Lake	Rajasthan
Sasthamkotta Lake	Kerala
Surinsar-Mansar Lakes	Jammu & Kashmir
Tsomoriri	Jammu &Kashmir
Upper ganga River (Brighat to Narora Stretch)	Uttar Pradesh
Vemband-Kole Wetland	Kerala
Wular Lake	Jammu & Kashmir

(SAC, 2013)

India has about 757 thousand wetlands with a total wetland area of 58.2 m ha. Out of this, area, inland wetlands accounts for 69 per cent, coastal wetlands 27 per cent, and other wetlands (smaller than 2.25 ha) 4 per cent (SAC, 2011). In terms of the proportion of the geographical area, Gujarat has the highest proportion (17.5 per cent) and Mizoram has the lowest proportion (0.66 per cent) of the area under wetlands. Among Union Territories in India, Lakshadweep has the highest proportion (around 96 per cent) and Chandigarh has the least proportion (3 per cent) of geographical area under wetlands.

Chilika lagoon: Located in Orissa with 1165 km^2 area. Chilika Lake is a brackish water lagoon at the mouth of the Daya River. It is spread over the Puri, Khurda and Ganjam districts of Odisha state on the east coast of India. It is the largest coastal lagoon in India and the second largest lagoon in the world. The lagoon hosts over 160 species of birds in

the peak migratory season. Birds from as far as the Caspian Sea, Lake Baikal, Aral Sea and other remote parts of Russia, Kirghiz steppes of Mongolia, Central and southeast Asia, Ladakh and Himalayas come here. In 1981, Chilika Lake was designated the first Indian wetland of international importance under the Ramsar Convention. Various birds include white bellied sea eagles, greylag geese, purple moorhen, jacana, flamingos, egrets, gray and purple herons, Indian roller, storks, white ibis, spoonbills, brahminy ducks, shovellers, pintails, and more. Nalbana Island is the core area of the Ramsar designated wetlands of Chilika Lake. Nalbana was notified in 1987 and declared a bird sanctuary in 1973 under the Wildlife Protection Act. The Irrawaddy dolphin (*Orcaella brevirostris*) is the flagship species of Chilika lake. Chilika is home to the only known population of Irrawaddy dolphins in India which is classified as critically endangered (Report on Visit to Chilika Lake, 2008).

Keoladeo National Park: Located in Rajasthan having an area of 28.73km^2. This is a complex of ten artificial, seasonal lagoons, varying in size, situated in a densely-populated region. It is constituted of an exclusive assortment of habitats including wetlands, woodlands, scrub forests, grasslands that supports a remarkable diversity of both plant and animal species. Keoladeo National Park's flora consists of 375 species of angiosperms of which 90 species are wetland species. The fauna includes more than 350 species of birds, 27 species of mammals, 13 species of reptiles, 7 amphibians and 43 fishes. Macro invertebrates too abound in the park. The park is both a Ramsar Site as well as a World Heritage site (UNESCO-IUCN Report, 2003).

Loktak Lake: The largest wetland of north-eastern region of India located in Manipur, also called the only Floating lake in the world due to the floating *phumdis* (heterogeneous mass of vegetation, soil, and organic matters at various stages of decomposition) on it. Its catchment area is 980 km^2 out of which 430 km^2 is under paddy cultivation, 150 km^2 under habitation and 400 km^2 under forest cover. Highly endangered species, locally called Sangai are managed by local people sustainably to maintain the rich biodiversity. The denudation of lake catchments due to jhum farming, deforestation and increasing demands of fodder, fuel and other forest products contributed to enhanced siltation and reduction of its water holding capacity. (http://www.rainwaterharvesting.org/loktak_lake/loktak_lake.html)

Vembanad-Kole wetland: The Vembanad-Kole wetland is a large complex aquatic ecosystem covering 2.5 per cent of the geographical area of Kerala State. Declared as Ramsar site on 19th August 2002. The largest brackish (Area: 23540 ha), humid tropical lagoon type wetland ecosystem on the southwest coast of India, fed by 10 rivers and typical of large estuarine system on the western coast, renowned for its clams and supporting the third largest waterfowl population in India during the winter months. Flood protection for thickly populated coastal areas of the districts of Kerala is considered major benefit of this wetland (Planning Commission Report, 2008).

Mangroves and paddylands: Mangroves occupy an estimated 0.45 million hectares. About 80 per cent of the mangroves were distributed in the Sunderbans of West Bengal and Andaman and Nicobar Islands. India with a long coastline of about 7516.6 km, including the island territories, has a mangrove cover of about 6,749 km , the fourth largest mangrove area in the world (Singh *et al.*, 2012). In India, the states like West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Andaman and Nicobar Islands, Kerala, Goa, Maharashtra, and Gujarat occupy vast area of Mangroves. The area under mangroves in Gujarat is the second largest along the Indian coast, after Sunderbans. Gujarat has about 23 per cent of India's estimated mangrove cover of 4.88 lakh ha. Mangroves in India account for about 3 per cent of the global mangroves and 8 per cent of Asian mangroves (FAO, 2007; SFR, 2009).

The Mangroves had been degraded due to construction of a number of barrages for irrigation purposes, clear felling and lack of fresh water supply, lack of tidal flushing of the degraded areas, release of pollutants from various domestic and industrial sources, changes in water quality, illegal sand mining etc. Hence there is an urgent need to protect the remaining mangrove areas and a massive afforestation campaign is to be initiated with the full hearted support of the local governess (Mohandas *et al.*, 2014). Kallen Pokkudan, also known as Kandal Pokkudan, was an Indian environmental activist and writer from Kerala, known for the protection and proliferation of the mangrove forests in Kerala.

Wetlands occupy 18.4 per cent of the country's geographic area (excluding rivers) of which 70 per cent (40.69 m ha) is under paddy cultivation (MoEF, GoI, 2010). But the area under paddy cultivation is being reduced year by year.

MANAGEMENT STRATEGIES OF WETLANDS IN INDIA

The primary responsibility for the management of these ecologically sensitive ecosystems is in the hands of the Ministry of Environment and Forests (MoEF), Government of India. As a signatory to Ramsar Convention on Wetlands and recognizing the importance of protecting such water bodies, the Government of India identified two sites, *i.e.*,Chilika lake (Orissa) and Keoladeo National Park (Rajasthan), as Ramsar Wetlands of International Importance in 1981 (MoEF, 2012). In Chilika, Irrawady dolphins and Barakudia limbless stink are the two species categorized as critically endangered. Many migratory bird species depends on the Bharatpur bird sanctuary which is now known as Keoladeo National Park. In 1985–1986, National Wetland

Conservation Programme (NWCP) was launched in close collaboration with concerned State Governments. NWCP was implemented till the year 2012-13. To have better synergy and to avoid overlap, the NWCP has been merged in February, 2013 with another scheme called National Lake Conservation Plan (NLCP) into a new integrated scheme of 'National Plan for Conservation of Aquatic Eco-systems' (NPCA) for holistic conservation of lakes and wetlands (ENVIS Centre on NGO and Parliament, 2015). Several measures were taken to arrest further degradation and shrinkage of the identified water bodies due to encroachment, siltation, weed infestation, catchment erosion, agricultural run-off carrying pesticides and fertilizers, and wastewater discharge. So far, the number of designated Ramsar Sites is 26 (Ramsar Convention on Wetlands, 2012), number of wetlands covered by the NWCP is 115 (MoEF, 2012).

CONCLUSION

Wetlands known as "the kidneys of the landscape," (due to its role in hydrological and chemical cycles) and as "biological supermarkets" (due to its role in extensive food webs and rich biodiversity they support) (Barbier *et al*., 1997), regulate ecological processes that contribute to a healthy environment. Wise use of wetlands is necessary for their conservation in order to maintain ecological balance and to ensure food security.

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