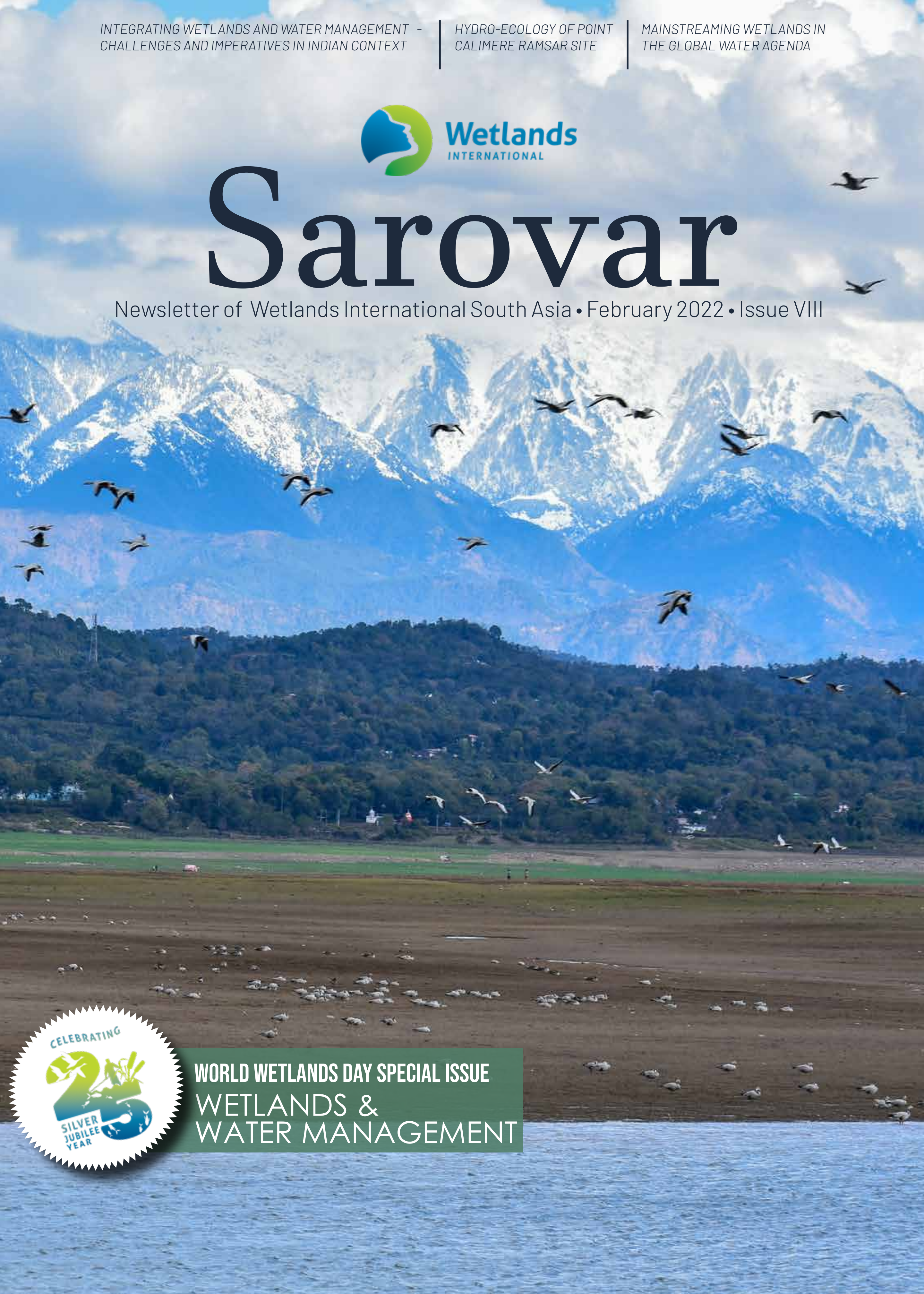
INTEGRATING WETLANDS AND WATER MANAGEMENT - CHALLENGES AND IMPERATIVES IN INDIAN CONTEXT | HYDRO-ECOLOGY OF POINT CALIMERE RAMSAR SITE | MAINSTREAMING WETLANDS IN THE GLOBAL WATER AGENDA

Wetlands INTERNATIONAL

# Sarovar

Newsletter of Wetlands International South Asia • February 2022 • Issue VIII



CELEBRATING 25 SILVER JUBILEE YEAR

**WORLD WETLANDS DAY SPECIAL ISSUE**

## WETLANDS & WATER MANAGEMENT

# Wetlands International South Asia

SAROVAR - Newsletter of Wetlands International South Asia
February 2022 • Issue VIII • World Wetlands Day Speacial Issue - Wetlands and Water Management

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## ABOUT US

Wetlands International South Asia is a nongovernment organisation working for sustaining and restoring wetlands, their resources and biodiversity in the South Asia region. Its office in New Delhi (India) was established in 1996 as a part of the Wetlands International network. Wetlands International is a global, independent, non-profit organisation dedicated to conservation and restoration of wetlands, and presently works in over 100 countries through a network of 20 regional and national offices and expert networks with Global Office in The Netherlands. Wetlands International is also one of the five International Organisation Partners of the Ramsar Convention.

In 2005, Wetlands International South Asia was registered under the Societies Registration Act of Government of India (retaining remit of South Asia region). Wetlands International South Asia works for wetland conservation in ways which relate to the nature of wetlands as ecosystems, and the wider biophysical and social contexts in which they are placed and function. The organisation endeavours to use a mix of approaches including technical knowledge, policy dialogue and field demonstrations for addressing various issues related to wetland management.

# *Message From The President*

In our unbridled pursuit of development in various sectors for human welfare we have hitherto ignored the environmental factor. The results are now staring at us as in this process many subtle ecosystems have become a casualty and one of those ecosystems are wetlands. It is ironic that we have sought to exploit the riches of these ecosystems, unconscious of their fragility.

Water is the key to sustainable development but water supplies are dependent on the protection and sustainable use of ecosystems that naturally capture, filter, store and release water such as wetlands. In this context, It gives me great pleasure to present the eighth volume of our newsletter ' Sarovar', published on World Wetlands Day which is on the theme 'Wetlands and Water Management'.

Wetlands have a significant role in ensuring water and climate security of India, as 40% of the life forms we know live and breed in wetlands. These ecosystems support human well being in providing fresh water, regulating water availability and thus buffering floods and draughts, recharging ground water, providing food in the form of rice, fish and range of plants and being an avenue of culture and recreation. Wetlands soak harmful greenhouse gases and thus help in climate change mitigation. Instead of all these values wetlands are being lost at a rapid pace. Attempts to address regional variability in water has resulted in some of the worlds densest irrigation infrastructures in the region drastically altering wetlands land scape interactions wherein lopsided development has adversely impacted the inherent buffering capacity of these ecosystems. Most of the devastating water related disasters in South Asia region have their genesis in mismanaged wetlands.

With broadening of the water resources thinking from runoff to precipitation-based management incorporating land use, the role of ecosystems such as wetlands in building water system resilience becomes highly significant in Indian context. Forging 'natural infrastructure' of wetlands with the conventional 'physical infrastructure' of water resources can bring multiple advantages to the water sector, and provide the required flexibility to address climate change induced uncertainties and risks.

Conserving wetlands requires affirmative actions from the entire society. A beginning can be made by raising universal awareness of the vital contributions wetlands make to biodiversity, climate mitigation and adaptation, freshwater availability, world economies — and thereby, to our prosperity, well-being and existence.

We are celebrating our silver jubilee this year. Wetlands International South Asia began its operations in South Asia, through its New Delhi office, in 1996, as a part of Wetlands International network. As a significant milestone for the organisation, and the intention to reach out to a wider network of community of practitioners, researchers, policy makers and those interested to join hands towards the cause of wetlands conservation, we have organised several competitions such as online amateur photography, essay writing, slogan writing and poster competition. A core focus of these activities is on children and youth, whose stewardship can halt and reverse the decline and degradation of wetlands ecosystems. Besides these competitions, a series of webinars, with noted wetlands practitioners, researchers and policy-makers on different science, policy and practice dimensions of wetlands conservation in South Asia are also being organised.

I am sure you will like this volume on Wetlands and Water Management. I look forward to your constructive comments to make our newsletter more useful and user friendly. I will also request you to contribute your expert articles on different wetland themes so that such good practices are available to all for guidance. You can also lend hand to our mission and vision by joining our membership.

***Dr Sidharth Kaul***
***President***
***New Delhi, January 2022***

# From The Director's Desk

Wetlands International South Asia has since its inception championed integration of wetlands in water resources planning, decision-making and investments, as it is the physical templates set by water regimes, sediments and nutrients that these ecosystems evolve and function. Treating water as a commodity and resource delivered through physical infrastructure as dams, pumps and pipes for various human usages obfuscates the fact that water is a component of healthy, functional ecosystems such as wetlands. In our work, we have found that in most cases, the lack of consideration of wetlands in water management is largely an issue of communication and capacities. Seldom do wetlands managers articulate the water needs of wetlands to water managers, in terms understood by the latter, and ways wetlands can help meet water resources management objectives.

The most significant body of work on wetlands and water is available within the Ramsar Convention. A number of resolutions have been adopted by Contracting Parties which have been summarized in four handbooks. A common element in all these guidelines is recognition of two important facts: a) water resources management is dependent to a large degree on the hydrological functions of wetlands; and b) wetland ecosystems need a certain amount of water allocated for maintenance of ecological character, in order to maintain these hydrological functions. Yet application of these guidelines on ground has been a challenge for various reasons, key being availability of simple and robust methods and tools to describe hydrological regimes of wetlands, particularly their variability, and an understanding of the consequences of modification of these regimes on wetlands, their benefits and values.

Integration of wetlands in water management cannot be treated as an additive process wherein the policies and programmes of wetlands and water sector are simply joined together, but require a more sophisticated and nuanced, collaborative and beyond sectoral disciplinary approaches. The issue at hand is not just about connecting two different policy areas at a single hydrological (catchment) or administrative (district) scale. Given the pervasive uncertainty (such as the manifestation of climate change on wetlands functioning as well as on extreme hydrological events, such as floods and droughts) and contested knowledge claims (such as increased need for hydrological regulation is required to address variability), the difficulty of joined-up management of wetlands and water cannot be overcome by policy and programme actors acting in isolation. The role of collaborative governance solutions is crucial for addressing challenges associated with building coherent conceptual and methodological narratives (such as wetlands degradation not just seen as tantamount to loss of critical ecosystem services, but reduced landscape resiliency to increasing water risks), and developing approaches for joint working that have potential to transform, rather than simply reaffirm segmented ways of research on natural systems and landscapes.

We hope that the articles in this issue shed light on these perspectives.

***Dr Ritesh Kumar***
***Director***

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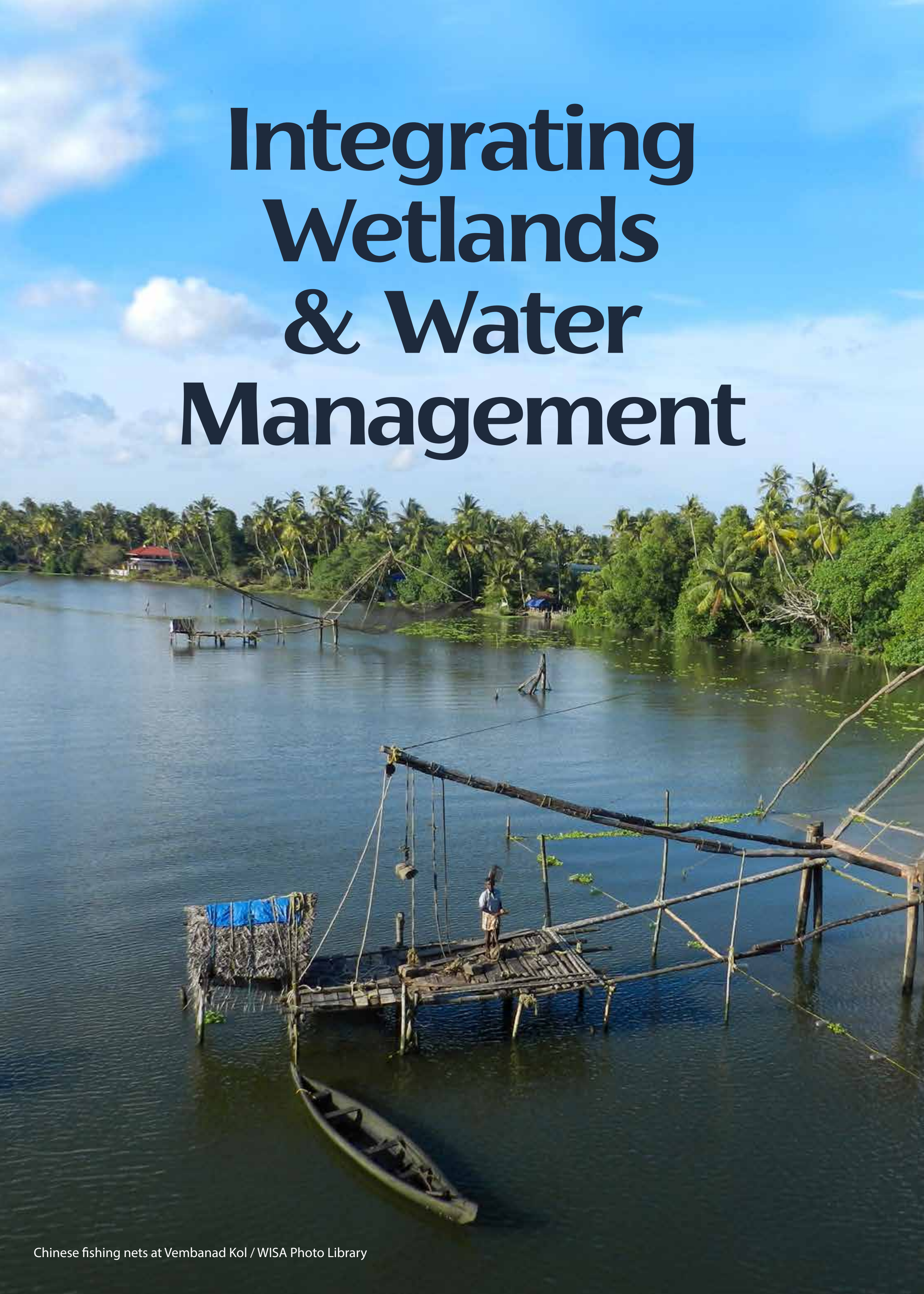
# Integrating Wetlands & Water Management



Chinese fishing nets at Vembanad Kol / WISA Photo Library

# Challenges and Imperatives in Indian Context

***Dr. Ritesh Kumar***
*Director, Wetlands International South Asia*
*&*
***Dr. Sidharth Kaul***
*President, Wetlands International South Asia*

In this article, the authors propose forging 'natural infrastructure' of wetlands within water sector planning and decision-making to provide the managers required flexibility to address the complex water challenges faced by India.

## WETLANDS DEGRADATION AND LOSS - A WATER SECURITY CHALLENGE

India faces complex water challenges – water demand outstrips supply in several basins, rampant aquifer depletion prevails, economic development driven by urbanization and industrialization is altering water use and efficiency by several proportions while creating water quality issues, and water conflicts have become more endemic. Future climate change projections for the country indicate increasing variability of precipitation, runoff and extreme events, and several other changes further exacerbating water risks.

With deepening water security challenges, the Government of India, of late, has rightly accorded high priority to water in its development agenda, and has taken strategic steps such as consolidation of institutional landscape for water by creating Jal Shakti Mantralaya in 2019 and adopting a mission of 'water for all'. Wetlands provide vital water-related ecosystem services at different scales (for example clean water provision, wastewater treatment, groundwater replenishment) and thereby offer significant opportunities to address water management objectives with sustainable, and in several instances, cost-effective solutions.

Wetlands are diverse, ranging from open-water dominated systems (such as lakes, ponds or tanks) wherein evapotranspiration is not constrained by water availability, to those wherein water is at or frequently below the surface (such as swamps and marshes), and evapotranspiration regulated by plant physiology. The Ramsar Convention (a multilateral environmental agreement on wetlands ratified by 172 countries, including India which ratified the Convention in 1982) uses a broad definition of wetlands 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*'. This broad-ranging definition thus covers a large category of inland aquatic ecosystems (such as ponds, lakes, marshes, swamps and peatlands); coastal and nearshore marine ecosystems (such as coral reefs, mangroves, seagrass beds and estuaries) and human-made wetlands (such as rice–paddies, fish-ponds, and water storage areas as tanks, reservoirs, and dams). As per the National Wetlands Atlas published by Space Application Center in 2011, India has 15.26 million ha under wetlands, accounting for nearly 4.6 % of her geographical area.

The high altitude wetlands of Himalayas serve as headwaters of the ten largest rivers of Asia, the basins of which support nearly one-fifth of the global population. For several cities, wetlands were the primary source of water, and continue to be so, as reflected in the moniker 'city of lakes' given to Bangalore, Udaipur, Bhopal and many others. For some, this water store can be highly significant, such as the water storage in Yamuna floodplains has been estimated to be equivalent to three-fourths of Delhi's water supply. Wetlands have traditionally been the backbone of agriculture practised in the Ganga-Brahmaputra floodplains. The waste treatment capability of wetlands has been effectively used by the City of Kolkata which depends upon the East Kolkata Wetlands to treat nearly 65% of its wastewater, saving nearly Rs. 4,600 million annually in terms of avoided treatment cost . Wetlands act as major flood defence systems for cities such as Srinagar (Jammu and Kashmir) and Guwahati (Assam). In the hard rock Deccan Plains and arid regions of the country, there has been an age-old tradition of constructing tanks to store rainwater for use in irrigation and domestic water supply. The value of coastal wetlands as a buffer against tropical storms has been brought out by several researchers. Wetlands are also intricately interwoven with the rich cultural and religious tapestry of the country, and several wetlands considered sacred .

India's total annual utilizable water resources have been assessed to be 1,123 km$^3$ of which 39% is accounted for by groundwater. The surface storage capacity of inland wetlands (projected from the wetland extent data from National Wetlands Atlas, and assuming an average depth of 1 m) comes roughly to 60 km$^3$. The contribution of inland wetlands to groundwater recharge estimated by Wetlands International South Asia using National Wetlands Atlas data and recharge factors of Central Ground Water Board, comes to 51 km$^3$, of which 21 km$^3$ is from natural inland wetlands. While the contribution of wetlands to the available water resources may appear small (in the want of a more systematic assessment), their value lies in their availability as a diffuse resource in virtually all landscapes. Unlike large water storage structures, these systems do not require massive investments into infrastructure for accessing and distributing water, rather can be accessed with very nominal technology. The ability to support diverse life forms while also playing a crucial role in food and climate security makes them an incredible water resource.

TREATING WATER AS A COMMODITY AND RESOURCE DELIVERED THROUGH PHYSICAL INFRASTRUCTURE AS DAMS, PUMPS AND PIPES FOR VARIOUS HUMAN USAGES (DOMESTIC, INDUSTRIAL OR AGRICULTURAL) OBFUSCATES THE FACT THAT WATER IS A COMPONENT OF HEALTHY, FUNCTIONAL ECOSYSTEMS SUCH AS WETLANDS.

Notwithstanding the high value of ecosystem services that wetlands provide to society, these ecosystems continue to be degraded, polluted, encroached upon and converted for alternate uses. A wetland area trend index constructed by Wetlands International South Asia for Indian wetlands based on 237 published data points for 1980 – 2014 indicates an average decline in natural wetlands area by 41% and a near commensurate increase in area under human-made wetlands by 44%. Such trends are worrying because natural wetlands are difficult to restore and their functions cannot be totally replaced by human-made wetlands.

Degradation and loss of natural wetlands enhances the vulnerability of landscapes. A positive relationship between an increase in the built-up area, increasing runoff, loss of wetlands and enhanced flood vulnerability has been observed for several cities, such as Mumbai, Bangalore, and Chennai. Extensive urbanization of floodplains and conversion of wetlands were identified as critical anthropogenic drivers of extensive damage due to 2014 extreme flooding in Kashmir. With the capacity of treating sewage limited to only 31% of total generation, pollution of wetlands is rampant. Wetlands are also degraded due to fragmentation of hydrological regimes, excessive siltation, encroachment, invasive species, unregulated tourism, and overharvesting of wetland resources, although the intensity of drivers of change varies in different biogeographic zones.

Wetlands evolve and function within physical templates set by water regimes and sediments. Treating water as a commodity and resource delivered through physical infrastructure as dams, pumps and pipes for various human usages (domestic, industrial or agricultural) obfuscates the fact that water is a component of healthy, functional ecosystems such as wetlands. Several water resources development projects have thereby lead to degradation of wetlands by altering flow patterns, reducing water availability and deteriorating water quality, ultimately rendering the entire water management unsustainable.

## WATER RESOURCES DEVELOPMENT TRAJECTORIES AND CONSEQUENCES FOR WETLANDS

The centrality of water resources development in shaping up of Indian State is well-recognized. Wetlands were accorded special status (referred as 'anupa', or incomparable lands) in religious texts, many wetlands species such as fish and lotus were considered sacred, and these ecosystems formed an essential source of water for domestic use and irrigation. The agrarian society was mostly dependent on surface water storages within natural as well as human made wetlands, and gravity flow irrigation to water crops. In the alluvial plains of the north, monsoon floodwaters were diverted and managed to enable riverine agriculture. The Deccan Plateau of peninsular India, which did not have an abundance of perennial rivers had a long tradition of constructing tanks to conserve rainwater. The cascading tank systems of Southern India were developed as multi-functional systems providing seasonal water storage, along with being centres of settlements and as providing social and cultural identity to the communities.

The supply side hydrology which characterised water sector for a large part of the 19th and 20th century has tended to overlook the role of wetlands, and at several instances, in an attempt to 'develop' these ecosystems on the lines of other water resources projects, created several adverse ecological and socioeconomic consequences. Colonial water technologies such as wiers, dams and barrages, were directed at providing perennial irrigation for settled agriculture, which was needed to address the food and development needs of a burgeoning population, but gradually led to reduced relevance of traditional water systems. The water technologies were also directed at draining and reclaiming marshes and swamps for more productive and revenue-generating usages such as agriculture. Attempts to tame floods through embankments scarred the alluvial floodplains and the deltas, which when done counter to natural fluvial regimes, prevented the spread of fertile sediments into the floodplains and ultimately led to extended periods of waterlogging and converting landscapes from being flood-dependant to flood vulnerable.

Post-independence, taming rivers and floods formed the cornerstone of water resources development. Colonial technologies were perpetuated in the forms of dams and embankments. Large scale water resources development projects backed by powerful state hydraulic bureaucracies stood robustly behind the construction of what the first Indian Prime Minister referred to as 'temples of modern India'. Increased control over water resources entrenched the prominence of human-made wetlands, the reservoirs and barrages. In contrast, the natural wetlands were seen as unproductive wastelands, and their reclamation incentivized by state-funded programmes, such as drainage programmes, especially in response to the great famines that the country faced in the fifties. Several states established drainage divisions specialised at draining wetlands.

The approach of 'developing' water resources were also applied to several wetlands. In the northeastern state of Manipur, the solution to devastating floods of 1966, and the region's deprivation of power was seen in the form of regulating the Loktak, the largest floodplain wetland of the state and converting it into a reservoir. The Ithai Barrage was constructed at the outflow to prevent depletion of water level in dry winters, and then divert water from the wetland to produce 105 MW of hydropower through the Ithai Multipurpose Project of the National Hydroelectric Power Corporation. The vision to green the deserts of Rajasthan by diverting waters from River Sutlej and Beas through Indira Gandhi Canal was realized by constructing a diversion barrage at Harike over a large riverine marsh. The Quilon Water Supply Scheme involved embanking the Sasthamcotta, a freshwater

Urbanization at the backdrop of East Kolkata Wetlands / WISA Photo Library

Haiderpur wetland at the Madhya Ganga Barrage / WISA Photo Library

wetland linked with Kallada River, to supply water to Kollam City, an important centre of spices trade in Kerala. The planners of Kolkata City saw the vast saline marshes on the eastern margins of the City as a safe place to discharge city's sewage, and in the process laid the basis of world's most extensive sewage fed fishery system. The famed backwaters of Kerala, the Vembanad was split by Thaneermukkom, a barrier to retain freshwater and enable its availability to Kuttanad, the rice bowl of Kerala. Kuttanad itself emerged out of polderization of floodplains.

The impact of water resources development projects, coupled with linked developmental changes in the catchments have been highly adverse. Harike has emerged as a large silt trap, and coupled with continued discharge of pollutants from upstream townships brought into Harike by Rivers Sutlej and Beas, has been perennially infested with water hyacinth. Regulation of water for hydropower in Loktak has converted a naturally pulsating wetland into a reservoir, causing loss of migratory fisheries and severe degradation of the habitat of globally endangered deer species, *Rucervus eldii* which inhabits the wetland. In Vembanad, the changes in hydrological regimes have led to a loss of migratory fish species, concentration of pollutants and reduced flood buffering capacity of the estuary. As water abstraction has exceeded the availability in Sasthamcotta, the wetland has faced bouts of prolonged drying.

In the last six decades, India has become the largest groundwater user in the world, accounting for nearly 65% of the country's gross irrigated area, abstracted collectively from ~30 million wells, bore wells and tubewells. The current situation of groundwater is alarming, with falling water levels and reduced well yields in several parts of the country, mobilization of heavy metals from deep aquifers, inequity of endowments, and an invidious nexus of mutual dependence between water, food, energy . The creation of a 'water-scavenging' irrigation economy has also meant reduced relevance of gravity flow irrigation from surface storages such as wetlands. For groundwater-dependent wetlands such as those prevalent in Northern India, lowered water levels and fragmentation of river connectivity led to shrinkage in natural inundation regimes. The declining significance of tanks meant they were allowed to decay, silted and at many instances constructed upon.

Water resources development efforts have singularly focused on freshwater, and thereby water and sediment regime needs of coastal ecosystems have been comprehensively compromised. In several mangrove areas, reduction in freshwater inflow has been identified as a significant causative factor for an increase in salinity resulting in reduced habitats of salinity sensitive species and dominance of high salt-tolerant ones. Estuaries such as Ashtamudi (Kerala) are gradually progressing towards hypersaline conditions, with reduced productivity and a high degree of transformation in species assemblages. Shrinkage of deltas due to sediment deprivation has been observed as a significant challenge in almost all parts of the globe, such trends having been noted in the deltas of Ganga, Mahanadi, Godavari and Krishna. The resulting shoreline erosion is one of the factors inducing investment into concrete shoreline protection measures, which have their adverse impacts on the coastal environment.

There has been a renewed interest in revitalizing tank systems to support local water security. In June 2005, a pilot scheme for the restoration of water bodies was initiated by the Ministry of Water Resources, which has since been upscaled into a full-fledged scheme by the title '*Repair, Renovation and Restoration (RRR) of Water Bodies*' since the twelfth national plan period to create 2.1 million ha irrigation potential. As per data retrieved on RRR dashboard at the time of writing this piece, the programme had covered nearly 2,300 waterbodies in 12 states restoring 1.09 $km^3$ water storage capacity at a total cost of Rs 19.6 billion. A mid-term analysis of Mission Kakatiya, a programme of Government of Telangana to restore over 40,000 derelict tanks in the states, has indicated a positive impact on water availability, groundwater recharge and farm economics, and also recognized as good practice by India's national policy think-tank – the NITI Aayog. Similar programmes have also been launched in several Indian states.

## INCLUSION OF WATER MANAGEMENT DIMENSIONS IN WETLANDS MANAGEMENT

Efforts for wetlands conservation emerged globally over concern for the declining population of waterbirds in Europe and North America. Designating wetlands of high ornithological values as protected areas under colonial laws, and post-independence, under Indian Wildlife Protection Act, 1972 was the primary approach for, as can be discerned from the closure of Vedanthangal, Keoladeo, Khijadia and Ranganathittu as bird sanctuaries or wilderness areas.

India's ratification of Ramsar Convention in 1982 and creation of the Ministry of Environment and Forest in 1985 (from a federal Department of Environment in 1980) provided the necessary backdrop for the establishment of a national programme on wetlands, which was launched in 1986 for assisting state governments for implementing management plans for prioritized wetlands. Subsequently, programmes for urban wetlands and mangroves and coral reefs were carved out from the national programme to focus on the issues of urban pollution, and increasing vulnerability of coastal wetlands. The national wetlands programme is currently known as the National Programme for Conservation of Aquatic Ecosystems (NPCA) and has subsumed the programme on urban wetlands. As of December 2021, over 250 wetlands have been covered under these national programmes, majority being protected areas, designated for biodiversity values, primarily waterbirds.

> THERE HAS BEEN A RENEWED INTEREST IN REVITALIZING TANK SYSTEMS TO SUPPORT LOCAL WATER SECURITY.

Towards the nineties, as the MoEFCC's National Wetlands Programme started gaining strength and increased emphasis was placed on integrated management plans taking into account their catchments, water-balance studies began to be taken up. This was also the period when the impact of water resources development projects and land use changes on wetlands started garnering the attention of researchers. In Keoladeo National Park, one of the prime waterbird habitats in eastern Rajasthan, construction of Panchana Dam over Gambhir River upstream of the park, increasing demand of water for irrigation in the upstream reaches and increasing variability of rainfall exposed the wetland to risks of prolonged drying and depleting waterbird population leading to an intense water conflict between allocation for wetland versus irrigation. In Loktak, construction of Ithai Barrage was identified as a causative factor for wetland degradation, particularly habitat of globally endangered ungulate species, *Rucervus eldii*. In Chilika, changing hydrology due to reduced connection with the Bay of Bengal was pitted as a significant causative factor for the decline in fisheries, and progression of the estuary towards a freshwater dominated state. Impact of freshwater flow reduction on mangrove species diversity in Sunderbans, West Bengal and Pichavaram, Tamil Nadu were also brought to fore. Elsewhere the impacts of the transformation of wetlands by altering natural hydrological regimes were highlighted, for example in Kolleru (Andhra Pradesh) wherein the natural flood buffering function was lost to aquaculture. During the late nineties, projects on Chilika, Bhoj and several other urban wetlands were framed on Integrated Lake Basin Management Framework, which was also adopted as an implementation framework for restoration of urban lakes.

Despite the emerging evidence base on the adverse impacts of hydrological transformation on wetlands, integration of wetlands into water resources planning and decision making has hit several roadblocks. The assessment of environmental flows for Chilika stands out possibly as the only positive example, wherein operational rules of Naraj Barrage at the head of Chilika catchment were formulated considering freshwater needs of the lagoon, and a river basin level monitoring of hydrological regimes has formed a part of wetland management strategies since year 2000. In the case of Loktak, despite over a decade of assessments and identification of a framework for revising operations of Ithai Barrage to secure Loktak ecosystem, implementation is yet to take place. For Vembanad, many assessments have indicated options for revision of Thaneermukkom to benefit the wetland environment, as well as address needs of farmers and fishers, actual change of barrage operation is yet to take place

The network of wetlands prioritized by states for conservation have often included hydraulic structures, as over time their biodiversity values were recognized beyond their role as a water resource. For example, the waterbird diversity and numbers in Hirakud Reservoir at present are next only to Chilika. Bird surveys in Pong Reservoir indicated that species diversity had considerably increased after the construction of the reservoir. The list of 37 wetlands designated by India as Wetlands of International Importance includes 17 reservoir and barrages. The management arrangements of such hydraulic structures have had to make necessarily incorporation of ecosystem requirements (such as water needs for maintaining waterbird habitats), which is an indication that cooperation between the two sectors is indeed possible.

## POLICY AND PROGRAMMING SYNERGIES AND BOTTLENECKS

Despite water and wetlands sector having adopted different development trajectories, there also exist several policy and programming complementarities. The National Environment Policy of 2006 makes explicit recognition of wetlands as 'freshwater resources', and emphasizes integration of conservation and wise use of wetlands into river basin management involving all relevant stakeholders. India's National Wildlife Action Plan (2017-2031) identifies conservation of inland aquatic ecosystems as one of the 17 priority areas, and envisages development of a national wetlands mission and a national wetlands biodiversity register. Mainstreaming the full range of wetlands ecosystem services into developmental planning is listed as the objective of the national wetlands programme.

Likewise, integration of wetlands in river basin management has been identified as a strategy for the management of river systems. The National Water Policy (2012) recommends adoption of a basin approach for water resources management and identifies conservation of river corridors, water bodies and associated ecosystems as an essential action area. The guidelines on Integrated Water Resources Management issued in 2016 by the Central Water Commission recommends using water balance as a basis for planning at basin level, and ensuring that upstream and downstream impacts are taken into account. The National Action Plan for Climate Change includes wetland conservation and sustainable management in the National Water Mission and the Green India Mission. The National Disaster Management Plan takes into account several non-structural measures for flood and cyclone risk reduction measures and makes direct reference to wetlands.

> THERE IS A MULTIPLICITY OF DEFINITION AND INTERPRETATION OF WETLANDS USED BY DIFFERENT MINISTRIES OF THE GOVERNMENT OF INDIA

At the same time, there are several science, policy and practice bottlenecks that hinder adoption of integration of wetlands in water management.

Firstly, there is a multiplicity of definition and interpretation of wetlands used by different Ministries of the Government of India. The MoEFCC subscribes to the wider definition of wetlands as agreed to in the text of Ramsar Convention – yet operates multiple schemes to fund conservation of different wetland types (such as urban lakes, mangroves and coral reefs). The Ministry of Jal Shakti on the other hand distinguishes between wetlands and water bodies. The National Water Policy of 2012 mentions wetlands only once, together with water bodies, with restoration efforts recommended to be directed to the latter. The Water Resources Information System of the MoWR includes information on water bodies and does not use the term wetlands at all. The Department of Land Resources of the Ministry of Rural Development in their inventory of wastelands include several wetland categories (such as waterlogged and marshy land, land affected by salinity, sands coastal and snow glacier dominated areas), but excludes waterbodies.

Secondly, limited efforts have been made to translate information on wetland structure to hydrological functions. For wetlands to be considered within water resources planning and decision-making, an inventory which renders an understanding of how wetlands function and deliver their hydrological may be more relevant, using approaches, such as hydro-geomorphic classification of wetlands.

Thirdly, the hydrological functions of wetlands are often communicated in generic terms based on simplistic extrapolation of site and wetlands specific evidence into more generalized statements which give an impression that all wetlands perform similar hydrological functions in all landscape settings. The ability of wetlands to moderate flow regimes is closely linked with soil condition, in particular, the extent of saturation and relative location within a landscape. Knowledge of how wetlands function within a landscape and deliver their hydrological buffering services is crucial for managers and policy planners to pursue integrated approaches.

Fourthly, wetlands are treated as 'water users' within water resources planning. Evapotranspiration usually forms a significant component of water budget of wetlands, and from the water resource perspective, it is often considered as a 'water loss'. The sub-committee on surface water management in its report for formulation of National Water Mission under the National places water use in wetlands to be amongst the highest amongst all options, compared with irrigated agriculture. Such a fragmented view of water, misses the point that water flowing through wetlands provides the wide ranging ecosystem services, such as food production and climate regulation, and thereby the disjunct between runoff and evapotranspiration is actually about the role of water in meeting human needs through built infrastructure and natural infrastructure.

Fifthly, cooperation between water and wetland management sectors is often limited due to inability to describe, quantify and communicate interests, objectives and operational requirements. Wetland managers need a sufficient understanding of the technical and operational aspects of water resources management to understand the methods of articulating and quantifying the requirements of wetland ecosystems in metrics and parameters used by water managers. Similarly, water managers require a quantitative understanding of the hydrological services of wetlands, and the water regime required to maintain these services. The training systems and institutions for water and wetlands hardly overlap, and thereby siloed thinking on water and ecosystems prevail and are frequently contested upon in policy and programming decisions.

## WAY AHEAD

India's quest for sustainable development is closely hinged on achieving water system resilience. The current paradigms of managing water from where it is sourced (surface water or groundwater), where it is used (agriculture, water supply, hydropower and others), technology (dams, reservoirs, canals and tanks) and social equity (the share of accessible water to a particular societal group and geography), precludes a unified vision of water. Given the coupling between land use and water use decisions, the need to widen the scope of integrated water resources management to include land management aspects is pertinent. With wholesale reforms as required to realize integrated water resources management being a difficult terrain, the beginning can be made by thinking on specific issues and challenges, such as managing floods and droughts, or improving water use efficiency in food production.

Integration of wetlands in water management in not about pitting grey and green infrastructure, but achieving complementarities and synergies. While making water infrastructure decisions, a beginning can be made by examining whether green infrastructure solutions such as wetlands can deliver the desired water resource outcome, and then filling the gap that may still exist by a grey-green combination. A harmonized understanding of wetlands and their hydrological functions in a landscape is the foundation step. To enable this, the science-base on wetlands will need to graduate from being dominated by describing ecosystem structures and processes to providing quantitative assessments of hydrological functions, in usable forms and terms suited to water sector policy-makers. Wetlands managers will also need to have the capacity to describe water regime requirements of wetlands to perform these functions, also acknowledging that climate change may render historical regime information insufficient to inform the future course of actions. For water managers, the role of wetlands will need to be evolve beyond just an allocation decision, to understanding water as it moves in a landscape, and the role wetlands play in influencing this movement. A natural convergence point is to plan at a catchment scale, wherein the landscape and water interactions can be assessed and planned for meaningfully.

Phumdis are a series of floating islands, exclusive to the Loktak Wetland in Manipur state / WISA Photo Library

# Unsustainable Water Management in India

Inflowing streams to Chilika are heavily polluted with nutrients from the catchment runoff / WISA Photo Library

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## INTRODUCTION

India's water management has been on an unsustainable path for centuries. Its record on wetlands management has been even worse.

In the 16th century, the celebrated Mughal Emperor, Akbar, decided to build a new capital in the dry northern plains which was named Fatehpur Sikri (City of Victory). India's best architects and artisans were brought to build this new capital. When the capital was constructed and Akbar moved into it, it had become a remarkable city. In 1589, Robert Fitch, one of the earliest English travellers to India, wrote that Agra and Fatehpur Sikri "*were two great cities, either of them much greater than London and more populous*." The fact that within a very few years of the city's establishment it had overtaken an old established city like London, speaks volumes of the quality of the Indian architects and artisans some 450 years ago.

However, the history of the new capital was not so auspicious. Akbar used it only for 13 years. He then abandoned it ignominiously and returned to Delhi, never to return to Fatehpur Sikri again.

The primary reason for Akbar's humiliating retreat was that during these 13 years, the new capital used up all its readily available water sources. It was constructed southeast of an artificial lake. When this artificial lake dried up, along with the groundwater that was sustaining it, the city simply could not survive without reliable sources of water supply which was not available.

In retrospect, Fatehpur Sikri is a magnificent monument to India's poor water planning. This water-scarce abandoned city is now considered to be a World Heritage Site of UNESCO.

Over the past 500 years, India's water management practices have improved slowly and at best incrementally, even though its water demands have grown exponentially. Not surprisingly, India's water situation has deteriorated steadily with time. It is now precarious.

India is now facing a water crisis that no earlier generation ever had to face in its entire history.

## WETLANDS

Oxford Dictionary defines wetlands as "*lands consisting of marshes or swamps; saturated land*." The Ramsar Convention on wetlands, which is an intergovernmental treaty that provides a framework for the conservation and wise use of wetlands and their resources, considers wetlands to include all lakes, rivers, aquifers, swamps, marshes, wet grasslands, peatlands, oases, estuaries, deltas, tidal flats, mangroves and human-made sites like fish ponds, rice paddles, reservoirs, artificial lakes and salt pans.

Thus, if one considers Ramsar Convention on wetlands and their management, it would encompass a very significant part of water management practices and processes as generally considered at present. Thus, water and wetlands management are closely interlinked.

Like water management, good management of wetlands can bring enormous benefits to any society. Wetlands are amongst the most productive ecosystems of the world. They provide numerous services to the people and the environment. They are an integral component of the ecology of all watersheds. The combination of shallow levels of water, high levels of many nutrients, good biodiversity and high primary productivity, mean that properly managed wetlands benefit all societies where they are located, on a long-term sustainable basis.

Among the numerous benefits of wetlands, the following are noteworthy.

- Wetlands are an excellent mechanism through which groundwater can be recharged. Currently, when groundwater levels in nearly all urban and agricultural areas of India are declining precipitously, wetlands can recharge depleting aquifers effectively. The Indo-Gangetic aquifer, one of the world's most important, is now the second most depleted aquifer anywhere in the globe. There is no sign the overall situation is getting better. On the contrary, the overall situation of this massive groundwater system continues to deteriorate.

- Wetlands act as a natural sponge and thus trap and store floodwater. They reduce flood intensities by storing and absorbing floodwaters and also by sharply reducing velocity of water flows. For example, China has promoted growth of sponge cities which is not only contributing to significant groundwater recharge but also in reducing flood damages. There is no similar effort in India.
- Wetlands are also an effective and low-cost measure to reduce both point and nonpoint sources of pollution. Consider the Delhi Jal Board. At present, it discharges nearly all its untreated wastewater to the Yamuna River. Wastewater is an important source of water and energy. Wastewater can be properly treated and can be used as an important source of potable water. Take the city of Windhoek, capital of Namibia. This very arid African city that has significantly less economic, technical and human resources has been treating its wastewater properly and then adding it directly to its potable water supply systems for nearly forty years. During this time, Windhoek has not had even one health-related problem due to the use of treated wastewater as a source of drinking water. If Windhoek can successfully do it for forty years, why cannot Delhi or Chennai follow Windhoek's footsteps?

At the very least Delhi Jal Board can use wastewater treated to primary and secondary levels, and then use this treated wastewater to create artificial wetlands or rejuvenate existing ones. Such a practice will not only contribute to significant groundwater recharge but also nature will purify the wastewater further to almost tertiary levels. This would contribute to improve Delhi's water security, further improve the quality of water and also enhance the ecological benefits of creating or strengthening wetlands. This type of policy action is very seldom seen in Indian megacities.

In addition, plants of wetlands would take out heavy metals that may be present in wastewater through bioaccumulation.

- Wetlands, like coral reefs, are highly biodiverse. They provide excellent conditions for immense varieties of species of microbes, insects, amphibians, reptiles, plants, birds, fish and mammals to survive and thrive. Primary productivities of wetlands are exceedingly high.
- Wetlands play important roles in global water, carbon, nitrogen and phosphorous cycles. They are very effective in terms of nutrient recycling.
- Wetlands provide ideal conditions for breeding of wildlife. They provide a refuge for migratory birds. For example, Bharatpur Bird Sanctuary in Rajasthan, Little Rann of Kutch and coastal areas of Saurashtra, Gujarat, are sanctuaries for migratory birds from Europe every winter.
- Wetlands are important sources of food and building materials for the local people. Wetland agriculture and aquaculture production are often the main sources of food and livelihood for the people around them.
- Wetlands often have high tourism and recreational potential, including birdwatching. As India's middle-class population has increased substantially, more and more people are visiting wetlands for historic, cultural, scientific and recreational values.

## WETLANDS UNDER DURESS

There is no question India's wetlands are now under serious duress. Sadly, not only in India but also in many other countries of the world, stakeholders have often considered wetlands as "wastelands" in the past and some even do it at present. There are many reasons for this anomaly, including apathy of central and state policymakers who still do not appreciate the benefits of wetlands to the overall society. Before 2000, policy support and resources provided to manage and conserve wetlands properly left much to be desired. Even now, while appreciation of the benefits is more than what was during the pre-2000 era, wetlands are still a stepchild of most Indian state governments in terms of attention they receive from policymakers, general public and the media.

There are many reasons for the decline of wetlands not only in India but also in most countries of the world. According to a study by Wetlands International South Asia, India has lost nearly one-third of its wetlands, between 1970 and 2014. The losses are primarily due to steady population increases, unplanned and rapid urbanisation, uncontrolled pollution from domestic, industrial and agricultural sources and absence of any form of land use planning. Mumbai lost maximum wetlands during this period (71.7%), followed by Ahmedabad (57%), Bengaluru (56%), Hyderabad (55%), Delhi and National Capital Region (38%) and Pune (37%).

Wetlands now cover around 4.6% of the geographical area of India. Around half of India's largest wetlands are under threat due to increasing encroachment, concretisation of surrounding areas due to continuing urbanisation and population increase, poor land-use practices, uncontrolled fertiliser runoffs and discharges of domestic and industrial wastes, increasing water utilisation and poor water management which have meant sources of surface water and groundwater to maintain and

Keoladeo National Park, Bharatpur, a paradise of nearly 350 species of birds in the winter season / Harsh Ganapath

conserve the wetlands have steadily declined. Other factors are also making the situation progressively worse.

## FUTURE OF WETLANDS IN INDIA

Based on current trends, most regrettably, the future of wetlands in India and their conservation for future generations are not bright. This is because there are no visible signs that the future of wetlands in India would improve during the next one or two decades. The future of water management in India is already dire because of centuries of poor water management practices and processes. For wetlands management, the situation is even worse! Wetlands need be considered as an integral component of water and land use management and overall development planning. Instead, it is considered in isolation by a few non-powerful central and state institutions.

Wetlands' conservation has never been high up in India's political agenda during the past 500 years. Even water is not high up in the national or state political agendas on a sustainable basis. Water gets high up in the political agenda only when there is a serious flood or a prolonged drought. The day the floods subside or rainfalls alleviate droughts, the politicians' interest in water simply evaporates. However, water at least gets in the political agendas of states every few years during extreme hydrological conditions. India's water problems can never be solved unless there is a sustainable interest of policymakers for a decade or two.

Wetlands, unfortunately, do not even enter the political agenda in any state, even for a few weeks every 5-6 years, as water does. Under these conditions, it is very difficult to see how India's wetlands management can be a priority national or state issue during the next one or two decades. This is sad prognosis for the Indian people and its environment.

# Mainstreaming Wetlands in the Global Water Agenda

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## INTRODUCTION

The International Lake Environment Committee (ILEC), headquartered on the shore of Lake Biwa, Japan, has been working closely with the UN Environment Program (UNEP) on the subject of mainstreaming lakes in the global water agenda, particularly since the 17th World Lake Conference held in 2017 at Lake Kasumigaura, Japan, resulting in a draft document entitled "*The Need to Mainstream Lakes and Other Lentic Waters within the Global Water Agenda*" (ILEC, 2019). The motivation for this mainstreaming initiative is to promote joint and concerted actions for reducing the rapid rate of decline in the state of lakes and wetlands, natural or man-made being naturalized, that exist widely across the continents. The subject of the need for mainstreaming was to be discussed at the 18th world Lake Conference to be held in November 2021 in Guanajuato City, Mexico. UNEP and ILEC are also currently preparing to facilitate deliberation by concerned governments on this subject at the upcoming UN Environment Assembly to be held in February 2022 in Nairobi, Kenya. This article reports on the background behind this mainstreaming agenda topic

## LAKES AND WETLANDS AROUND THE GLOBE

Of all the freshwater on the Earth's surface, only about one percent is in liquid form, with more than 90% of this volume being in natural lakes and wetlands (marshes, flood plains, bogs, fens, mires, collectively; Shiklomanov and Rodda, 2003). The remaining fraction exists primarily as flowing rivers and streams. Natural lakes and wetlands (as well as man-made ones that have become 'naturalized' over time or naturalizing intentionally) collectively provide a wide range of life-supporting ecosystems services, including human drinking and irrigation water, being a major source of animal protein (i.e., inland fisheries), and supporting recreational and tourism activities (e.g., sports fishing, swimming, skiing). They also are essential habitats for a wide variety of flora and fauna. Many lakes and wetlands also exhibit intrinsic values such as cultural heritages, being historic monuments, religious sites and facilities such as temples and shrines, as well as the source of folk tales and legends with associated artifacts about their mythical origin and existence. Some high-altitude lakes also serve for hydropower generation. Lakes and wetlands also play a mitigating buffer role for addressing the hydrologic uncertainties associated with predicted changes in precipitation patterns attributable to global climate change. The carbon sequestration capacity of large lakes and large clusters of wetlands is also considered very significant.

At the same time, however, lakes and wetlands receive stresses from many directions transcending their entire basin system and from virtually all sectors of the basin society. The type and magnitude of the threats facing them are many, complex and interacting, while our policies to protect them for their sustainable use are inadequate at virtually all governmental and societal levels. Thus, they remain exceptionally vulnerable to the impacts of human activities, exhibiting continuing degradation and misuse. Unfortunately, except for some prominent lakes drawing global attention, most lakes and wetlands have been left out of the national and international policy agenda, resulting in the creation of a significant missing gap in global water discussions and agreements. Unless they are properly protected, conserved and managed with great care, national and transboundary

Lakes in Tampara's catchment are critical sources of freshwater in the landscape / Dhruv Verma

lakes and wetlands may not be able to continue serving as, or to be able to serve anew in the future as, immediately available and usable freshwater resources for maintaining human health and well-being and for fueling socio-economic development, particularly for those facing increasing populations and transitional economic developmental needs in the coming decades.

## LAKES AND WETLANDS IN REGARD TO THE SDGS

The "Global Agenda" or the "Global Policy Agenda" represents possible policy options for addressing the global challenges faced; in this case, about managing lakes, wetlands and their basins for sustainable use of their resources globally. The UN Sustainable Development Goals (SDGs) adopted in September 2015 consist of 17 Goals and 169 Targets (United Nations, 2021), serving as the apex platform of the Global Policy Agenda. But how are lakes and wetlands treated in the SDG programs? There are two approaches to best evaluate this question. The first is to be rather stringent and seek to find direct references to the terms "lakes" and "wetlands" in the SDGs. The second is to be rather broad-minded and find indirect and implicit references to the opportunities offered to "lakes" and "wetlands" in relation to the other SDG targets.

As for the first approach, both terms "lakes" and "wetlands" appear in SDG Target 6.6 (i.e., "*By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes*"), which is included under Goal-6 (i.e., "Ensure availability and sustainable management of water and sanitation for all"). The term "wetlands" appears also in Target 15.1 (i.e., "B*y 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements"*). The terms "lakes" or "wetlands" do not appear explicitly in the remaining Targets under Goal-6, including Target 6.1 on safe and affordable drinking water; 6.2 on adequate and equitable sanitation and hygiene; 6.3 on water quality improvement; 6.4 on water-use efficiency; and 6.5 on integrated water resources management, although these targets implicitly relate to the role lakes and wetlands may play as sources of water supply.

The second and more broad-minded approach is to consider how "lakes" and "wetlands" are implied in the SDG goals and targets. This approach takes the view that implicit reference to lakes and wetlands in the broad range of 17 SGD Goals and their Targets is sufficiently encouraging in the pursuit of the sustainability of their ecosystem services. One literature specifically focusing on wetlands states, "*Thus,* *SDGs represent an opportunity for collaboration and synergies across conventions. In turn, wetlands protection, wise use and restoration provide governments with a path to reconciling numerous commitments under the environmental agreements….*" (Ramsar Convention, 2018). Another literature focusing on "lakes and reservoirs" refers to the possibility of using multiple indicators for evaluating their sustainability with respect to the SDGs by recognizing the synergy and potential conflicts facing them. It refers to nine of the 17 Goals, for example, exhibiting direct and indirect interlinkages to "lakes" and reservoirs. It also has identified positive links with the Goals characterized by the environmental dimensions (Goals 6, 13, 14 and 15), noting that they would be "*mutually reinforcing with each other*." It further goes on to state that "…..*policymakers are able to keep track of the development of lakes and reservoirs and, hence, decide on holistic and multidimensional management and policies for the sustainable future of lakes and reservoirs* (Ho and Goethals, 2019)." Unfortunately, however, neither approach adequately addresses the importance of mainstreaming lakes and wetlands more prominently in the Global Water Agenda.

## GLOBAL WATER AGENDA AND INTEGRATED WATER RESOURCES MANAGEMENT (IWRM)

### WATER SECURITY IN THE GLOBAL WATER AGENDA

Definition of the 'Global Water Agenda' is closely linked to Goal-6 of the SDGs, therefore being highly focused on water security as defined by the UN Taskforce on Water Security (United Nations, 2013) wherein water security is defined as "*The capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.*" Phrases such as "adequate water" and "preserving ecosystems" may be taken as indirect reference to such water sources as "lakes" and "wetlands." At the same time, the document also refers to a list of ten key issues critical for establishing good water governance, which includes; a) establishing the river basin and/or the aquifer system, as appropriate, as the basic bio-geographic unit for water management, requiring coordination and cooperation between political units across national and international borders; b) pursuing efficiency gains and providing for dispute resolution mechanisms, in order to offer equity and flexibility in the allocation of water rights among competing uses; c) prioritizing the environment and vital human rights in water allocation policies, laws and decision-making processes, including requirements to assess and manage environmental flows; and d) accounting for customary water allocation systems, rights and practices at the local level, where these exist; are particularly relevant to lakes and wetlands.

### INTEGRATED WATER RESOURCES MANAGEMENT (IWRM)

As noted before, Target 6.5 under SDG Goal 6 calls for implementation by 2030 at all levels of what is called "*integrated water resources management*," IWRM in short, a concept that has evolved since the late-1970s. It was defined later as "*a process which promotes coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of ecosystems*" (Global Water Partnership, 2000). According to one literature source (Smith and Clausen, 2017), although having been considered by most in the global water sector as an excellent concept, it also has received its share of criticism, including such views as being too over-reliant on top-down reforms, excessively technocratic and too heavily focused on an idealized, normative IWRM. At the time of the inauguration of the SDGs, however, UN-Water concluded that IWRM provided a framework for addressing the synergies and potential conflicts related to water among competing targets "*by balancing the demands from various sectors [and stakeholders] on water resources, as well as the potential impacts of different targets on each other, to form a coordinated planning and management framework*." With adoption of the SDGs and recognition of the potential for IWRM to mobilize synergies among goals and to manage trade-offs in targets, the demands on IWRM are now much larger than in the past. IWRM today is guided by six practical elements, including 1) a strong enabling environment, policies, laws and plans; 2) a clear, robust and comprehensive institutional framework; 3) effective use of available management and technical instruments, etc.; 4) sound investments in water infrastructure with adequate financing; 5) strategies for catalyzing and managing change at all levels; and 6) development of collaboration platforms.

### PROGRESS IN GLOBAL WATER AGENDA

The overall progress in achievement of the SDG Targets under its 17 Goals is reported on the SDG Tracker website entitled "*Measuring progress towards the Sustainable Development Goals*" (SDG Tracker, 2021). The qualitative goals and target statements are translated to quantitative expressions of a surrogate nature in this devised tracking system. However, many of the Targets illustrated qualitatively are difficult to express in quantitative terms. Even if there are quantities associated with the Targets, there will still be ambiguities associated with the interpretation of such figures supposedly representing the degree of their achievement. Further, the intricately interlinked nature of the Goals and Targets makes their overall assessment even more challenging. Nonetheless, the regularly updated analysis results of the degree of achievements are provided in the above reporting system. As an example, Target 6.5, which states that "*By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate*," was reported as being 54% achieved in 2020, compared to 49% in 2017 as the degree of integrated water resources management (IWRM) implementation. This degree of implementation of IWRM is determined by assessing the four key dimensions of IWRM; namely, enabling environment, institutions and participation, management instruments and financing (UN-Water, 2021). The report states, "*When it comes to IWRM, the current rate of progress needs to double to meet the global targets, ......*" Further, for Target 6.6 ("*By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.*"), which has already turned out to be less than convincing, the tracker number reported for 6.6.1 ( "*Proportion of river basins showing high surface water extent*") changed from 12% in 2015 to 21% in 2020, with supplementary information stating that "*High increases and/or declines in surface water area are most notable in Eastern Asia and Southeastern Asia, Central Asia and Southern Asia, Latin America and the Caribbean and Sub-Saharan Africa.*" The report also states, "*Of the 2,300 large lakes assessed nearly a quarter of them recorded high to extreme turbidity readings in 2019.*"

As expected, the overall SDG progress, including Goal 6, is lagging behind in that, "....*Many objectives set out in the SDGs are not well defined and are just aspirational. Some see the goals as contradictory - making good noises in the environmental and societal dimensions, but without really tackling the root causes in our economic systems that have created problems in the other two dimensions.*" (Vairavamoorthy, 2019). The author further states, "*In its latest progress report, the UN describes the situation as far as climate and biodiversity are concerned as 'alarming'. So, there is action, but clearly not enough of it*," and concludes "*The world is falling short on progress towards the SDGs.*" He further goes on to say, "*However, that means there remains an opportunity to influence the agenda, especially in terms of implementation at the national level. It also means there is a desperate need for references and benchmarks that provide tangible options on how to progress.*" This last statement is encouraging for those wishing to have lakes and wetlands more explicitly referred to in the next round of enrichment of the Global Water Agenda.

> ...DELIBERATIONS OF INTERNATIONAL BODIES SPECIALIZING IN MANAGEMENT OF WATER IN RELATION TO THE GLOBAL WATER AGENDA HAVE GENERALLY BEEN TOO FOCUSED ON DEALING WITH "HUMAN WATER SECURITY".

## IMPLICATIONS OF THE SDG PROGRESS FOR GLOBAL LAKES AND WETLANDS

Despite the fact that natural lakes and wetlands occupy more than 90% of all the liquid freshwater on the Earth's surface, provide a wide range of life-supporting ecosystems services, serve as essential habitats for a wide variety of flora and fauna, and collectively play a very important role in reducing human water security threats as well as biodiversity security threats, they have not been adequately paid attention to in the Global Policy Agenda of the SDGs, and specifically in the Global Water Agenda based on Goal 6 of the SDGs. While acknowledging some optimism that the goals and the targets set out in SDGs comprehensively encompass the human water security threat and biodiversity security threat issues, the situation analysis provided by the global assessments of the state of lakes and wetlands to date does not give a bright picture, despite the fact that the overall scientific knowledge, and the management experiences and lessons learned about individual lakes and wetlands, continues to increase.

Of particular concern to many individuals and organizations undertaking activities to help change the situation and challenges facing global lakes and wetlands is that the deliberations of international bodies specializing in management of water in relation to the Global Water Agenda have generally been too focused on dealing with "human water security". This implies either that "biodiversity security" and other matters of concern for lakes and wetlands are already being implicitly considered, or that the many challenges facing lakes and wetlands may be meaningfully attended only if the "human water security" goal is duly achieved. This may be so, but there are two important considerations that argue against either of them. The first is that, in terms of the behavioral feature of water with implications in management, there are "lentic" water systems, and their basins interlinked with inflowing and outflowing "lotic" systems, meaning that the water that lakes and wetlands represent is not just any water source, but rather that they are difficult water systems to deal with in terms of sustainable use, management, protection and conservation. The second is that, because of their lentic features, their management approach has also to be specially tailored to respond to such features, particularly for avoiding the unintended but irreversible trend of decline in the global biodiversity security while intending to pursue the human water security as envisioned in the Global Water Agenda Such an approach has to take into account that the process has to be fostered gradually, incrementally and over a time duration far beyond the time horizon set forth by such targets as SDGs. The next chapter provides some general illustrations of the above two considerations.

## LENTIC WATERS AND INTEGRATED LAKE BASIN MANAGEMENT (ILBM)

Lakes and wetlands are broadly considered as "standing" or "static" water systems, or using an ecology term, they are designated as "lentic" systems. Similarly, rivers are considered as "dynamic" or "moving" water systems, or in ecological terms, they are "lotic" systems. The term "lentic - lotic" expresses the ecological and anthropogenic state of water with evolutional and historic memories of human-nature interactions, as contrasted to the term "hydrostatic – hydrodynamic." The management approach toward natural lakes and wetlands, and their basins consisting of the "lentic – lotic" water systems, needs to be different from, and often more sophisticated than, the management approach taken toward what may be considered "hydrostatic-hydrodynamic systems" that do not reflect their ecological and anthropogenic implications. More specifically, the natural water systems particular to lakes and wetlands possess three distinguishing characteristics of lentic water systems, including (1) an integrating nature, meaning external matters and the forces inflicted upon them get mixed in and perpetuated from all directions, with the resulting problems being inseparably interlinked; (2) a long water residence time, meaning such problems can remain long, and resolving them to improve the situation also can take an extraordinarily long time in many cases; and (3) complex response dynamics, meaning everything within a lake affects everything else within the waterbody, with the associated in-lake phenomena often being quite unpredictable and uncontrollable.

Taking the above defining characteristics into account, a conceptual framework called Integrated Lake Basin Management (ILBM) was developed over the past decades. ILBM is an approach for achieving sustainable management of lakes and wetlands through gradual, incremental and continuous and holistic improvement of basin governance, including sustained efforts for integration of institutional responsibilities, policy directions, stakeholder participation, scientific and traditional knowledge, technological possibilities, and funding prospects and constraints, resorting to the accumulated global knowledge and experience in managing water systems highly dictated by the three features of lentic waters and their basins. ILBM is also fundamentally a highly bottom-up approach, wherein the integration of governance elements is based on "integration by necessity and as possible," based on the interactions among stakeholders, and properly facilitated by experts and government authorities as deemed appropriate. The ILBM process is also designed for lake basin stakeholders to collectively fill the gaps between what has already been achieved, and what remains to be achieved in the continuing governance improvement cycles over a long period of time - as long as possible and being deemed useful. It also takes the position that the problems facing individual lakes cannot be properly addressed unless the fundamental issue of sustainable resource development, use and conservation facing lakes is addressed globally, and with strong, long-term political commitment. In fact, a reality is that a great many lakes and wetlands must depend on this highly informal and bottom-up management approach, without the availability of necessary resources to deal with the kinds of water security threats described under Goal 6 of SDG. For numerous lakes and wetlands, both small and large, the sustainable livelihood aspect of their life may actually be more dependent on "biodiversity security" forming the basis of "water security." The "wise use principle" of the Ramsar Convention; namely, "*the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development*" (Ramsar Convention, 2021) attests to such situations.

While few people would dispute the importance of IWRM in water management efforts, the reality is that 'operationalization' of the IWRM principles has not proven to be easy, particularly for those having to deal with on-the-ground basin management challenges facing lakes and other lentic water bodies. One of the overriding reasons for the difficulty is that most, if not all, lake basin management stakeholders are not in a position to play a significant role in influencing

> ...PROMOTING ILBM BROADLY AND UBIQUITOUSLY, EVEN IN THE ABSENCE OF IWRM, MAY REALISTICALLY LEAD TO NEW POSSIBILITIES OF ACCELERATING THE KIND OF OBJECTIVES SET FORTH IN THE GLOBAL WATER AGENDA....

IWRM integration needs, focusing instead on on-the-ground governance improvements, rather than on governance improvements at a higher level of policy making at the national government water sector level, and their counterparts in the international water sector community. Therefore, infusion of the ILBM concept within the IWRM approach is not only useful, but also necessary in many such cases. Further, promoting ILBM broadly and ubiquitously, even in the absence of IWRM, may realistically lead to new possibilities of accelerating the kind of objectives set forth in the Global Water Agenda, as well as in the entire Global Policy Agenda of SDGs, therefore facilitating new possibilities for its infusion within the IWRM approach currently facing serious uphill battles in meaningful adoption by governments.

## CONCLUSION

What could be the major reasons that little attention has been paid thus far to the need for mainstreaming lakes and wetlands in the Global Water Agenda? It may be that a relatively small portion of our global population depends on lakes and wetlands as direct sources for their water supplies, therefore not warranting the mainstreaming attention. Or it may be that the number of lakes and wetlands serving as sources of water supply is too numerous and/or that they are individually too small, therefore not worthy of other than rudimentary attention. The reality, however, is that lakes and wetlands collectively constitute the very precious global lentic water systems serving not only to address human water security, but also in a subtle balance with biodiversity security. In fact, they play an enormously important role as the primary global-scale integrator and assimilator of the impacts of human activities in their basins. The enormity of this role of lakes and wetlands is easy to take for granted, unfortunately being similar to the situation regarding global warming whereby the early warning signs of its impacts were overlooked, leading to a later and more complicated response at greatly expanded costs in lamentation. Further, it is unrealistic to consider that the pursuits on multiple fronts of the SDG Goals and Targets will eventually lead to realization of the sustainability of lakes and wetlands without also attending to the issue of the 'missing link' exemplified by the absence of lakes and wetlands in the Global Water Agenda. Fortunately, the notion of lentic-lotic waters, in contrast to hydrostatic-hydrodynamic waters, is gradually becoming better understood and appreciated in efforts to manage them and their basins within the context of ILBM, with the key governance issues to be attended gradually and incrementally for a much longer timeframe than that required for individual project interventions typically characterizing projects pursued under the goals of the current IWRM framework. Worthy of serious consideration, therefore, is the transfusion of the ILBM approach into the overarching IWRM framework, and vice versa, at the local, national, regional and global scales.

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Based on the consultancy work carried out for
GIZ – Gesellschaft für Internationale Zusammenarbeit India

# Hydro-ecology of Point Calimere Ramsar Site


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Karunya Wetland Team
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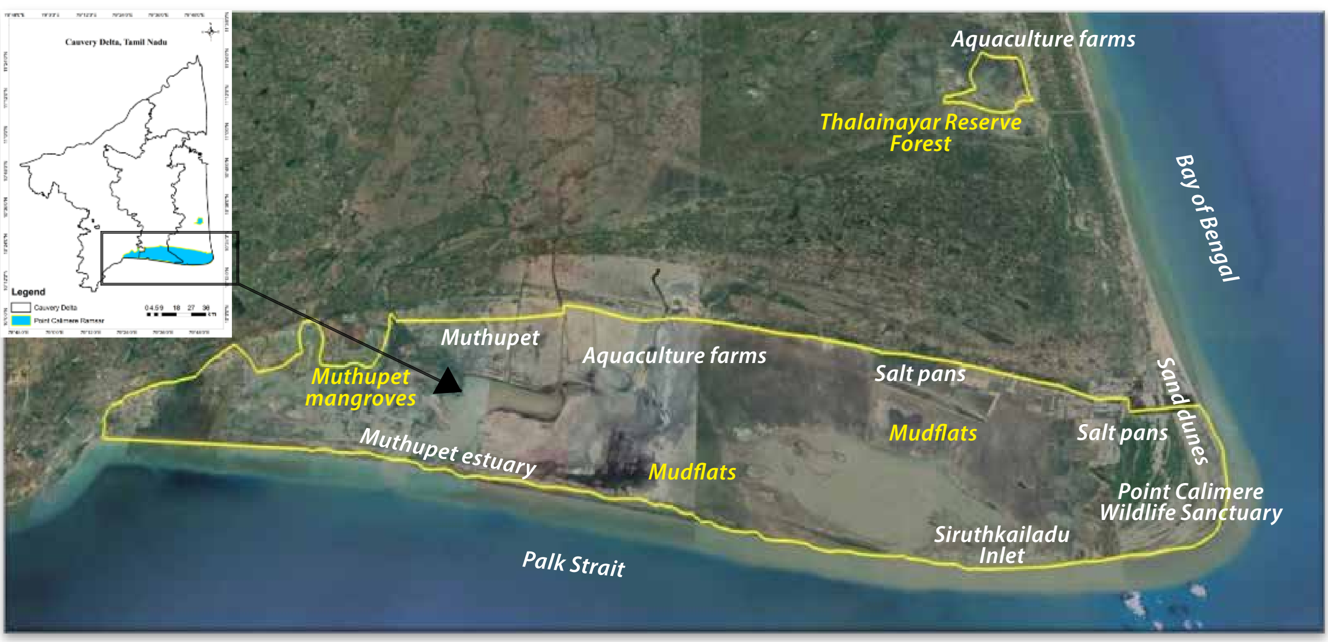
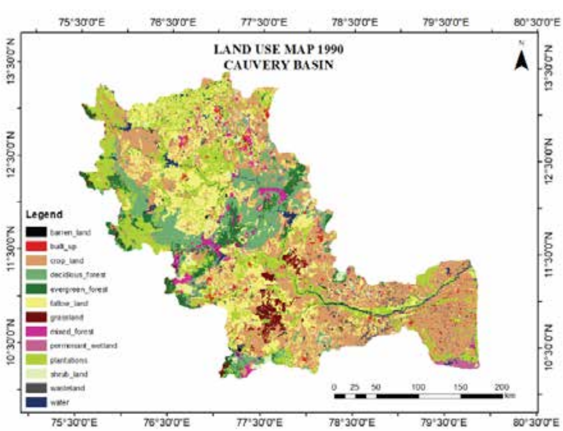



FIGURE 1. Map of Point Calimere

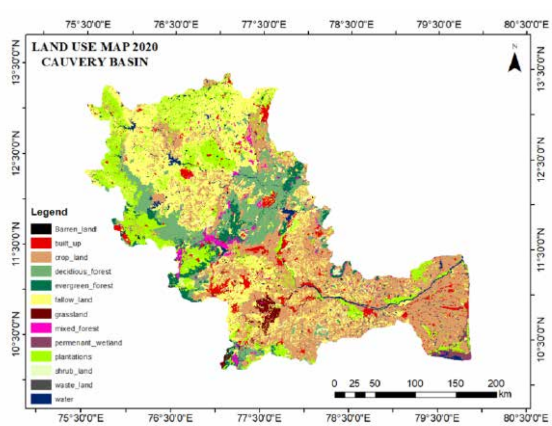
The Point Calimere, the only Ramsar site in Tamil Nadu, is a unique wetland complex at the tail-end of Cauvery Delta with diverse ecosystems like estuaries, coastal inlets, mudflats, mangroves, wildlife and bird sanctuary as well as sand dunes and man-made salt pans and aquaculture farms (Figure 1). The delta in which these wetlands are located is the rice-bowl of Tamil Nadu. The location of the ancient sea port of Kaveripattinam is still traceable, which port has been the hub of international trade and commerce, and from where Indian culture spread out to the entire Far East. Over a period of time, the interaction of this large river system and the sea, and the dynamics of water and sediments gave birth to several unique ecosystems in the downstream reaches. The hydrology and fluvial hydraulics have been influenced by the impounding and diversion structures upstream, mainly aiming at rice cultivation in the delta, and also the urbanization and industrial development in the upper reaches and also in the delta as such. One of the earliest diversion structures is attributed to Karikala of the ancient Chola Dynasty. The water from Cauvery River is shared by the states of Kerala, Karnataka and Tamil Nadu and the Union Territory of Puducherry. There were several claims by different riparian states of this river, and finally the water allocation has been decided by the Cauvery Water Disputes Tribunal (CWDT) and the Supreme Court. However, the award of the Tribunal mentions only about an arbitrary allocation of 10 TMC (thousand million cubic feet) of water for environment, which is to be shared by the states for other purposes during the deficit years. The Supreme Court directed that 4 TMC of water should be allowed to flow to the sea, without mentioning the requirements of the downstream wetlands.

## IMPACT OF LAND USE AND LAND COVER CHANGES

The land use and land cover changes in the entire Cauvery Basin is given in Figure 2. The increase in built-up area, and reduction in crop and forest land cause changes in the temporal availability of water. Since the flows are regulated upstream, the seasonal variations are not directly reflected in the downstream availability of water for rice cultivation. However, the SWAT model shows a phenomenal increase of 80% in sediment yield during the past one decade, which causes reduction in the capacity of reservoirs upstream and subsequently the availability of stored water to be released downstream during the summer months. The land use and land cover changes in the buffer zone of the wetland complex are given in Figure 3. The increase in the area under settlement, cultivated land and open scrub has their impact on the hydrologic regime. The aquaculture clusters and area under saltpans have increased considerably at the cost of mudflats and rice fields. The area of mangroves has increased significantly by 34 percent during the past three decades as a result of the joint efforts of stakeholders. The SWAT model shows that the soil erosion in different pockets

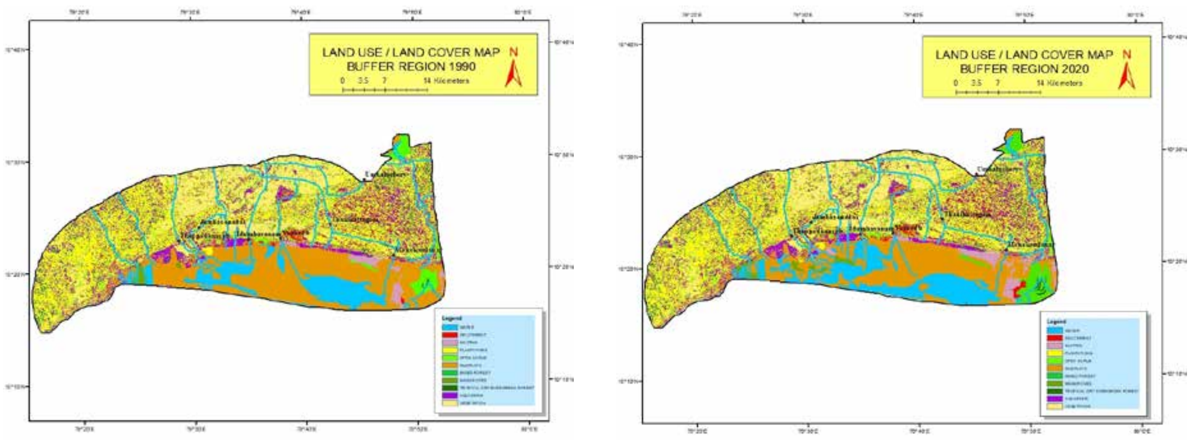



[A] 1990




[B] 2020

FIGURE 2. Land use map of Cauvery Basin




[A] 1990

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FIGURE 3. Land use map of the buffer zone of the wetland complex

of the direct catchment of Point Calimere Wetland Complex varies from 100 tonnes/ha/year to 1,496 tonnes/ha/year. Higher values of soil erosion are observed in the upstream of Muthupet estuary, Panchanadhikulam mudflats and Thalainayar Reserve Forest.

The average annual rainfall in the wetland complex is about 1,300 mm, received mainly during the northeast and the southwest monsoons, namely 70% and 18% respectively. Based on the trend analysis, a statistically significant increasing trend in rainfall is observed in both the monsoon seasons in the delta and the wetland complex. The extreme rainfall event indices, estimated based on IPCC norms, showed an increase in number of heavy precipitation days, which coincides with the regional trends (Figure 4). The precipitation concentration index values suggest strongly irregular rainfall in the wetland complex. The rainfall showed a positive correlation to global teleconnection indicators like El Nino southern oscillation. When the daily rainfall exceeds 150 mm, the mudflats are inundated to an

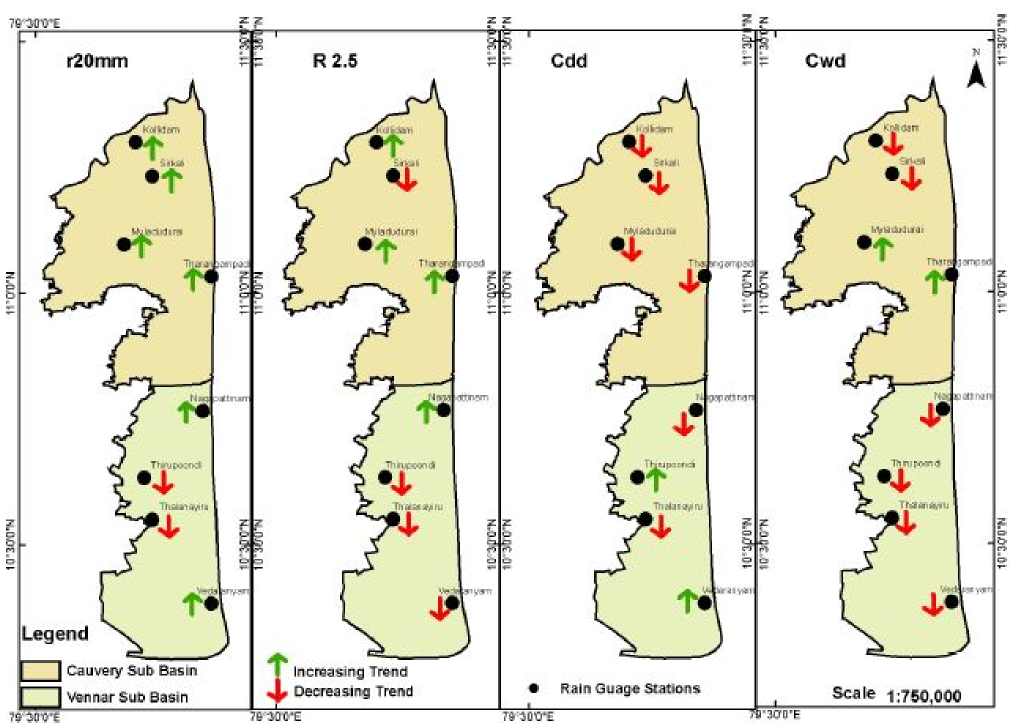



FIGURE 4. Trend of extreme rainfall event indices: r20mm, R25, Cdd and Cwd

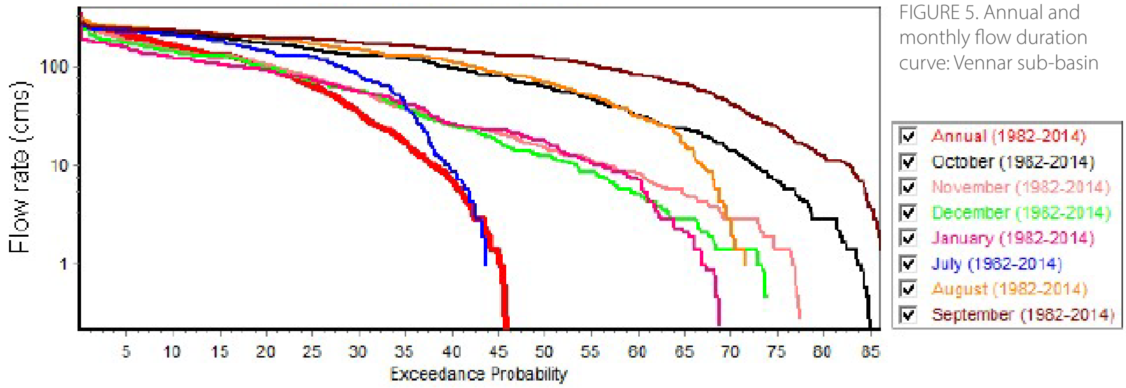



FIGURE 5. Annual and monthly flow duration curve: Vennar sub-basin

average depth of 40 cm and when the two-day rainfall exceeds 150 mm, the mudflats inundate to a depth of 30 cm. Cyclones generally bring more rainfall and inundate and connect up the entire delta.

The annual streamflow to the wetland is confined to only three months, October-December, constituting just 3.45 TMC. The application of Indicators of Hydrologic Alteration of the Nature Conservancy showed an increase in streamflow to the delta immediately after the Interim Award of CWDT in 1992, which has come down marginally over the last three decades (Figure 5). However, the temporal distribution of streamflows has slightly improved in the delta.

The wetland complex is located mainly in Thiruvarur, Nagapattinam and Thanjavur districts. In the three districts, there are 32 overexploited (> 100% exploitation), 8 critical (90-100% exploitation), 9 semi-critical (70-90% exploitation), 21 saline, and 15 safe (<70% utilization) Revenue Blocks, as per CGWB norms. The relationship among rainfall, streamflow and groundwater level in the delta is given in Figure 6.

## WATER QUALITY STATUS

Based on the spatio-temporal analysis of groundwater quality

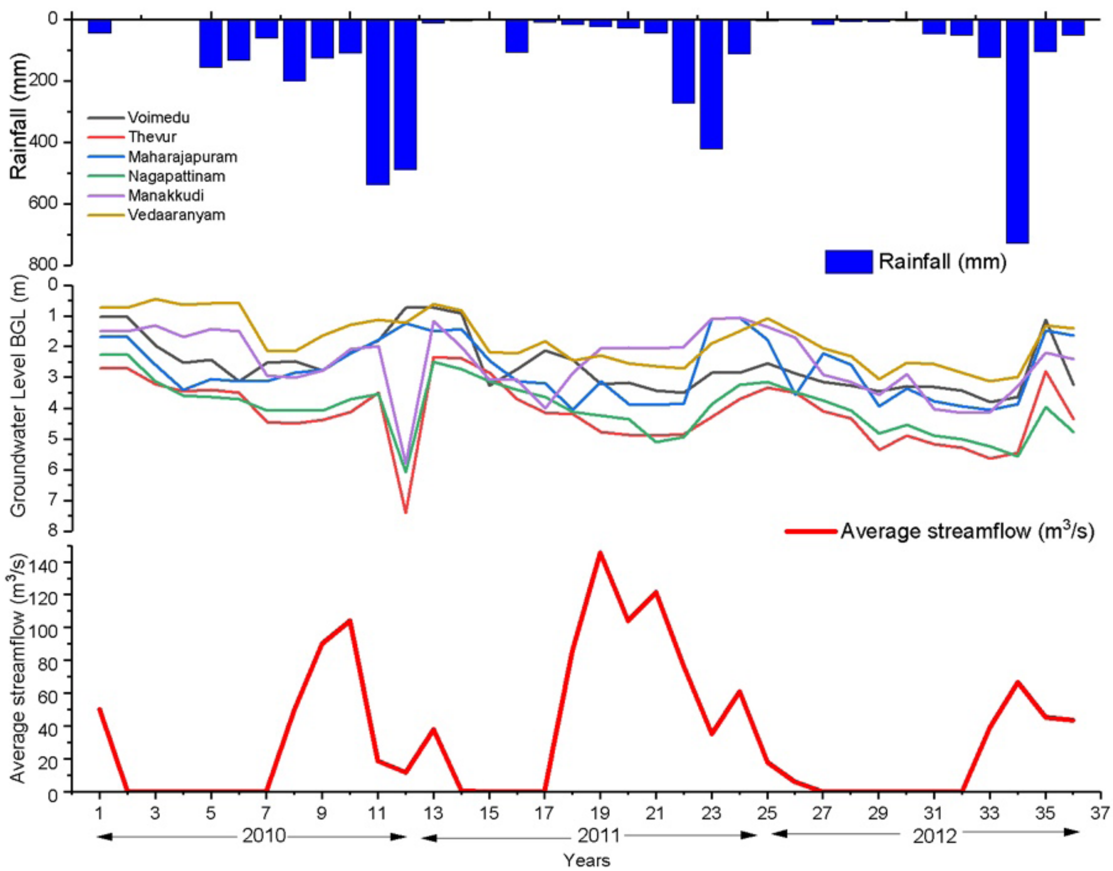



FIGURE 6. Relationship among rainfall, streamflow and groundwater level in Vennar sub-basin: 2010-12

TABLE 1. Groundwater quality for drinking purpose - northeast monsoon and post-monsoon seasons: comparison with WHO standards and BIS

| Parameters, mg/l | WHO (2011) | BIS (2012) | | Northeast monsoon season | | | Post-monsoon season | | |
|---|---|---|---|---|---|---|---|---|---|
| | Permissible limits | Most desirable limits | Maximum allowable limits | Min. | Max. | Mean | Min. | Max. | Mean |
| pH | 6.5-8.5 | 6.5 | 8.5 | 6.6 | 8.1 | 7.3 | 6.9 | 8.7 | 7.7 |
| EC ($\mu$S/cm) | 1500 | - | - | 372 | 10600 | 2208 | 299 | 6312 | 2160 |
| TDS | 500 | 500 | 2000 | 238 | 6784 | 1413 | 191 | 4039 | 1382 |
| Ca | 75 | 75 | 200 | 48 | 1096 | 237 | 16 | 800 | 193 |
| Mg | 50 | 30 | 100 | 19 | 350 | 96 | 24 | 561 | 114 |
| Na | 200 | - | - | 34 | 1415 | 242 | 10 | 865 | 248 |
| K | 12 | - | - | 12 | 347 | 61 | 2 | 257 | 57 |
| Cl | 250 | 250 | 1000 | 60 | 3453 | 481 | 50 | 1892 | 445 |
| $CO_3$ | - | - | - | 0 | 160 | 42 | 0 | 320 | 111 |
| $HCO_3$ | 500 | 200 | 600 | 220 | 1300 | 604 | 130 | 850 | 383 |
| $SO_4$ | 250 | 200 | 400 | 15 | 583 | 130 | 26 | 669 | 200 |
| T H | - | 200 | 600 | 280 | 3640 | 996 | 180 | 3080 | 935 |

parameters in the delta, it was observed that the water quality parameters like TDS, EC, chlorides, magnesium, potassium and hardness exceeded the permissible limits as per BIS (Table 1). The groundwater remains suitable for irrigation in the post-monsoon season in most parts of the buffer zone of the wetland due to the lithology and aquifer characteristics. However, the quality was very poor during the pre-monsoon due to over-exploitation, pumping or saltwater intrusion.

In the wetland complex, the major sources of water quality deterioration are salinity intrusion, rock-water interaction as well as agrochemicals and domestic sewage, the major causes identified being reverse ion exchange (Na gets exchanged with $Ca^{2+}$ and $Mg^{2+}$ in the soil matrix) and salinity intrusion. The industries in the buffer zone are given in Figure 7.

## ESTUARINE DYNAMICS

Freshwater flow is the major factor that arrests salinity intrusion, formation of salt plug, movement of estuarine turbidity maximum (ETM), transport of salt and suspended particulate matter (SPM) in the Muthupet Estuary (Figure 8). Higher the freshwater flow, more is the salinity gradient and less the settling velocity. A minimum combined flow of 10 $m^3$ /sec from Paminiyar

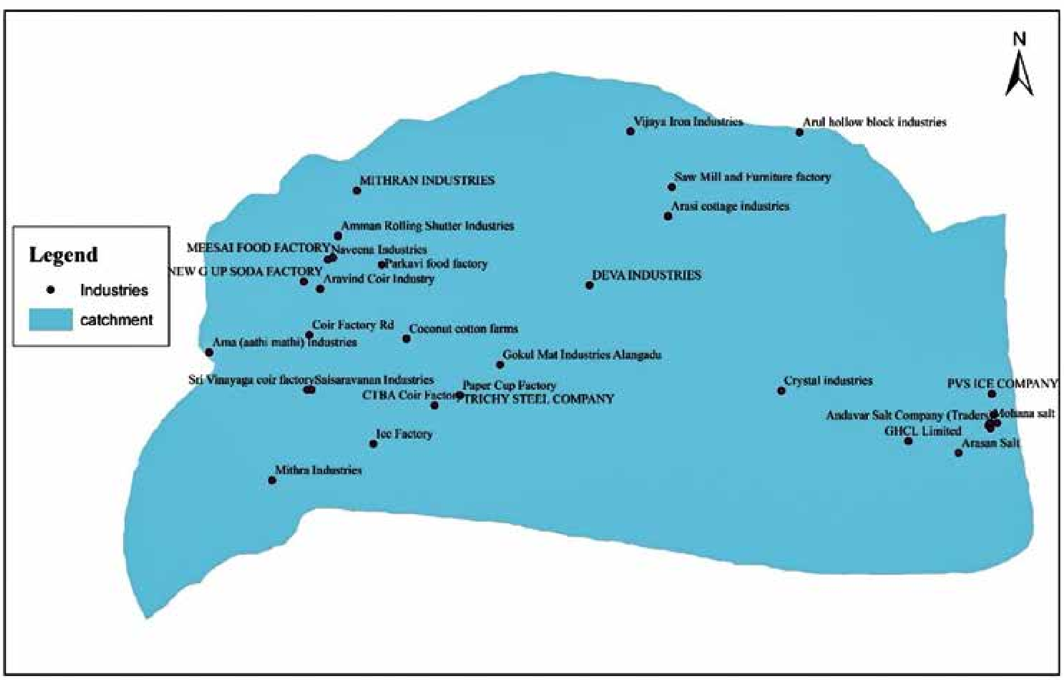


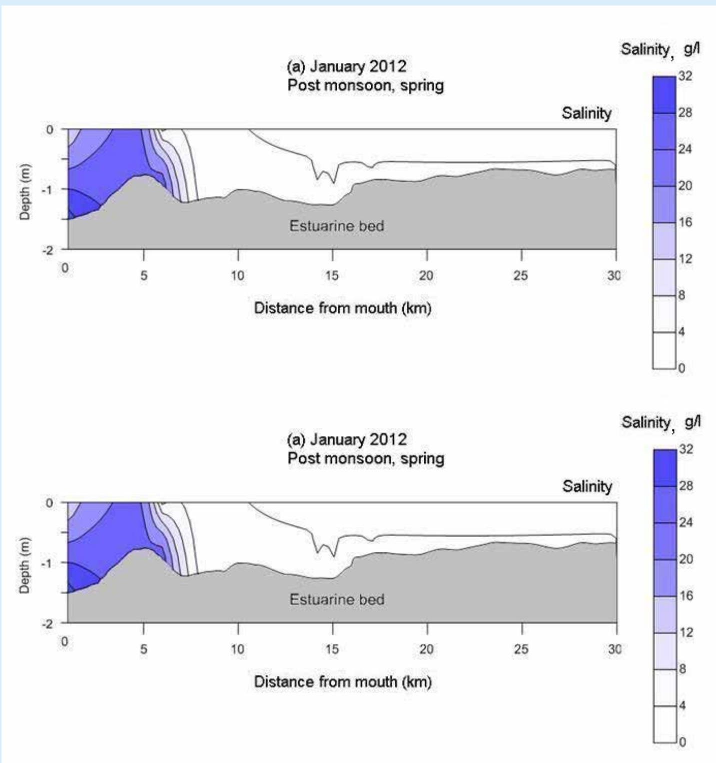

FIGURE 7. Industries: the major sources of pollution in the buffer zone

and Koraiyar all through the year is found to be ideal to maintain the salinity level just downstream of these streams (upto the confluence of the lagoon) at 17 ppt for the healthy growth of mangroves and for catering to the ecosystem services (Figure 9). Another combined flow of 10 m$^3$/sec is recommended in Mulliyar, Valavanar and Manakundan rivers to sustain the health of mudflats, mangroves and Siruthalaikadu Inlet.

## COASTAL GEOMORPHOLOGY

From studies on the geomorphology of 61.3 km stretch of coast adjacent to the wetland complex, it is found that 21.41 km show erosion tendencies. During the past five decades, the area subject to erosion has been 3.62 km; the erosion rate has been 2.805 m/year. The vulnerability index indicated 20.35 km length of coast adjacent to the wetland complex as highly vulnerable and 11.31 km as moderately vulnerable. The mouth of Muthupet Estuary comes under low vulnerability category and the mouth of Siruthalaikadu Inlet under moderate vulnerability. The sediment deposition from the Kodiakkarai and Vedaranyam areas causes accretion at the nose of Point Calimere. The mouth of Adappar and Harichandranathi rivers flowing through the wetlands are heavily silted up. The coastline along the Reserve Forest (RF) of Planjur, Thamarakottai, Maravakadu, Vadakkadu and Thalainayar are vulnerable to erosion. Artificial nourishment and vegetation measures are recommended for protecting the vulnerable stretches of the shoreline close to the wetland.

Contd. ▶

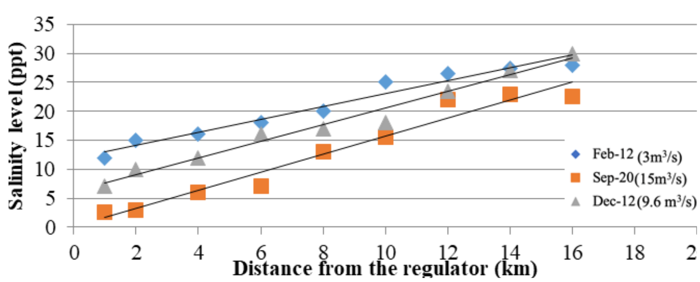



[A] Post-monsoon - spring tide (23 January 2012)

[B] Post-monsoon - neap tide (17 February 2012)

FIGURE 8. Longitudinal profile of salinity (g/l)

FIGURE 9. Salinity along the length of the estuary for different flow conditions ▶



## SCENARIO DUE TO SEA LEVEL RISE

The projected sea level rise of 0.5 metre is expected to submerge 2.18 km², 2.03 km², 2.67 km² and 12.37 km² of the estuary, mangroves, inlets and mudflats respectively. A sea level rise of 1 metre may submerge 6.13 km² of the estuary and inlet, 4.34 km² of mangroves and 16.87 km² of mudflats and swamp.

## HYDROLOGIC CONNECTIVITY

The major issues related to the hydrologic connectivity among the ecosystems of the wetland complex of Point Calimere and the related water quality problems are:

I. the five rivers draining into the Muthupet Estuary are subject to regulations upstream;

II. water from these rivers is subjected to pollution due to the application of agrochemicals in the rice fields and sewage from the thickly populated pockets;

III. a few aquaculture ponds on the sides of Muthupet Estuary discharge their waste water to the estuary;

IV. the micro-tidal and shallow Muthupet Estuary enters the Palk Strait through a very narrow mouth of 800 m;

V. saline water enters the mangroves on the fringes of the estuary through artificial fishbone canals;

VI. there is no connectivity between the Muthupet Estuary and the adjacent Siruthalaikadu Inlet and also there is practically no freshwater flow to the inlet from the upstream;

VII. mangroves on the fringes of Siruthalaikadu and in the Panchanadhikulam and Thondiakadu Mudflats are practically deprived of freshwater flows;

VIII. most of the saltpans are located in the mudflats and divide the mudflats into grids

IX. in some of the saltpans, salt water is pumped from deep borewells to produce edible salts;

X. several aquaculture farms are located in the mudflats;

XI. streams flowing to the Thalainayar RF are independent of those draining to the Muthupet Estuary and Siruthalaikadu Inlet;

XII. the Adappar and Handranadhi rivers are regulated, diverted and silted;

XIII. the branch of Valavanar flowing into the Siruthalaikadu Inlet has silted up and dried and both Mulliyar and Manakundan rivers flowing to the inlet are ephemeral and flow only for three months; and

XIV. the only freshwater stream flowing into the wildlife sanctuary has become

Flock of flamingos at the saline mudflats in Point Calimere / Dr. Ridling Margaret Waller

practically dry. Considering the fact that there is no water connectivity among the different wetlands during most part of the year, the drivers of change and management action plans are separately treated keeping in view the overall perspective.

## DRIVERS AND MANAGEMENT ACTION PLANS

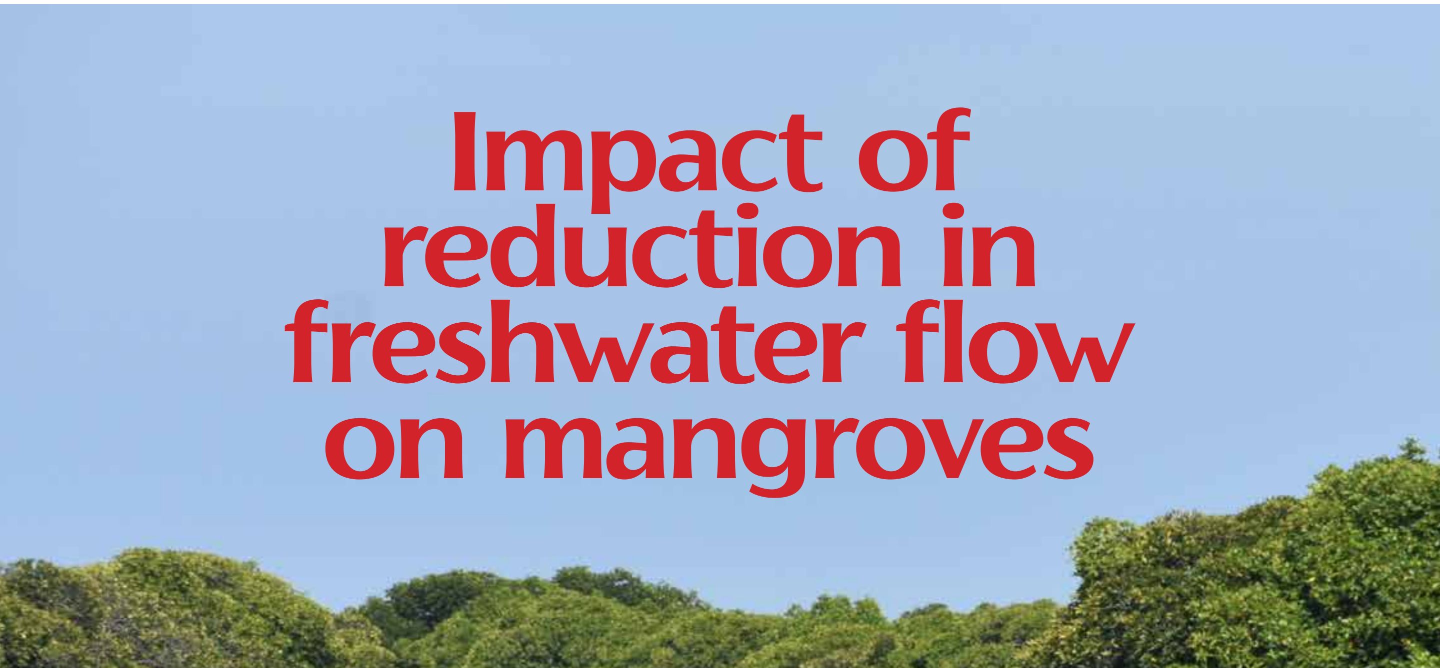
The major drivers for degradation of myriad wetland habitats in the Point Calimere Wetland Complex are sea water intrusion, drying up of rivers, conversion of mudflats into salt pans and aquaculture farms and effect of climate change. An integrated Management plan taking into account, the needs of the wetland habitat and wetland defendant people is being prepared under the GIZ project "Wetlands Management for Biodiversity and Climate Protection".

The plan also recognizes the fact that, sufficient data for detailed studies and operation of structures are not available. Therefore a network of hydrologic-ecological stations are proposed to monitor and act promptly . An institutional mechanism is also recommended, aiming at the wise use of this strategic wetland complex.

## ACKNOWLEDGEMENT

GIZ India is gratefully acknowledged for all support rendered for this study. The authors are grateful to Dr. Avantika Bhaskar of GIZ for scientific input, and Mr. K. Arivozhli and Mr. S. Kalanidhi of Forest Department, Tamil Nadu for logistical support.

Painted storks and Great egrets at Point Calimere Ramsar Site / Dr. Ridling Margaret Waller



# Impact of reduction in freshwater flow on mangroves

*Dr. V. Selvam*
Independent Researcher

Mangrove wetland is a dominant feature of the deltaic coastline of tropical and subtropical regions. The wealth (extent, diversity and biomass) and health of the mangrove wetlands (soil condition and hydrological process) are determined by i) wave energy along the coastline, ii) the topography of the coast, iii) tidal amplitude and iv) duration and quantity of freshwater flow. The settlement and rooting of seeds and propagules of mangrove plants and their growth are often physically hampered by the excessive energy transmitted by the long waves, a characteristic feature of the high wave energy coasts. Because of this reason, distribution of mangroves is mostly restricted to the part of a coastline, where the wave energy is low. On the other hand, flat topography and the gentle slope of the coast together with high tidal amplitude facilitate the establishment of mangroves in large areas. A coastal plain with a slope of 0.2 to 0.5% (very flat slope) is ideal for the development of mangroves of considerable size. If the tidal amplitude - the difference between high and low tide - in this type of flat coast is high, an enormous amount of seawater enters and create the required saline environment for vast extent mangroves to establish. For example, tidal amplitude in the Sundarbans mangroves is about 4.8 m, and the slope of the coast is also very flat. As a result, seawater reaches up to

90 km inland from the sea, resulting in the mangrove wetland of the Indian part of Sundarbans alone occupying an area of 4,26,000 ha (actual forest cover is about 2,112,00 ha).

On the other hand, the area of Pichavaram Mangroves in Tamil Nadu, where the tidal amplitude is around 0.65 m and the slope is high, is only 1,300 ha. Thus, wave energy decides the presence or absence of mangroves in a coastal stretch, whereas the slope of the coast and tidal amplitude determine the areal extent of mangroves. However, the diversity of mangrove plants and their community structure and biomass of mangrove vegetation are primarily decided by the duration and quantity of fresh water flowing into the mangrove wetlands.

## MANGROVE SPECIES

The flora of mangrove wetland is divided into a) true mangrove species and b) mangrove associate species. The true mangrove species, otherwise called exclusive mangroves, possess the following characters: i) occurring only in mangrove environment and not extending into terrestrial communities; ii) possess morphological specialization such as aerial roots, stilt roots, vivipary etc; iii) possess physiological mechanisms for salt exclusion and salt excretion; iv) taxonomically isolated from their terrestrial relatives. A total number of 70 species have so far been identified as true mangrove species. The Indian mangroves consist of 46 true mangrove species belonging to 14 families and 22 genera. All the true mangrove plants are facultative halophytes. It means these species are capable of growing in freshwater but also respond to an increase in salinity by increase in growth rate up to an optimum level, beyond which the growth rate of mangrove species declines. This optimum salinity level for many mangrove species ranges between 5 to 17 parts per thousand (means one litre of seawater contains 5 to 17 grams of salt). In this optimum saline condition, mangrove species diversity and productivity will be high, and the production of healthy propagules and seeds will be abundant.

## HYDROLOGY IN MANGROVES

Hydrology in the mangrove wetland is the master variable because it plays a critical role in creating optimum salinity. However, hydrology exerts its influence through a very complex process. Three interacting factors, namely, freshwater flow, seawater inundation and evapotranspiration, control the hydrology of the mangroves. The freshwater flow - both surface and groundwater flow - is further influenced by the rainfall and geology of the catchment area. Tidal amplitude in the nearshore environment plays a critical role in determining the quantity of seawater flow. In some cases, such as shallow mangrove water, salinity is also influenced by the rate of evapotranspiration. In a mangrove wetland, it has been observed that large quantities of freshwater flow for a longer period of time in a year with no restriction in tidal water ingress create the optimal saline condition for a large number of mangrove species to colonise, survive and flourish. For example, perennial rivers such as the Ganges and Brahmaputra that discharge large quantities of freshwater into Sundarbans mangroves for a period of not less than eight months create three different salinity zones, namely, oligohaline (low saline), mesohaline (moderate salinity zone) and polyhaline zone (highly variable salinity zone). Each of these zones acts as a habitat and supports a group of mangrove species. For example, freshwater loving and low saline tolerant mangrove species occupy the oligohaline zone, whereas mangrove species that can tolerate a wide range of salinity dominate the polyhaline site. Any changes in the flows, particularly reduction in the natural flow of freshwater, leads to drastic changes in the hydrological condition affecting species diversity, productivity and ecosystems services.

## PICHAVARAM MANGROVES: A CASE STUDY

Pichavaram Mangroves are located on the northernmost part of the Cauvery delta in Tamil Nadu. It is a small mangrove wetland (1,300 ha) with a vegetated area of about 770 ha. It was declared as a Reserve Forest in 1893. A recent survey indicates 12 species of true mangroves (*Acanthus ilicifolius*, *Aegiceras corniculatum*, *Avicennia marina*, *Avicennia officinalis*, *Bruguiera cylindrica*, *Ceriops decandra*, *Excoecaria agallocha*, *Lumnitzera racemosa*, *Rhizophora mucronata*, *Rhizophora apiculata and Rhizophora xannamalayana and Xylocarpus moluccensis*) are present in the Pichavaram Mangroves. However, surveys conducted in the past showed that many other true mangrove species were also present in the Pichavaram Mangroves, which have become locally extinct. These include *Bruguiera gymnorrhiza*, *Ceriops tagal*, *Kandelia candel*, *Sonneratia apetala and Xylocarpus granatum*. The specimens of these species were collected by the British foresters such as R. H. Beddome, H. L. Wooldridge, J. S. Gamble from 1880 to 1890, which are still preserved in the herbarium of the Botanical Survey of India, Coimbatore. As the surveys conducted by the French Institute, Pondicherry indicate that some of the species like *B. gymnorrhiza* and *S. apetala* were present till the late 1970s but now no individual of these species is present. One of the major factors responsible for the local extinction of these low saline tolerant species is the reduction in the duration and quantity of freshwater flow into the Pichavaram Mangroves.

The Pichavaram Mangroves is located in the tail-end region of a large drainage canal of the Cauvery riverine system called Kollidam (the Coleroon River). All the floodwaters of the Cauvery system diverted into this canal reached the Pichavaram Mangroves through a network of backwater canals. However, in 1902 a barrage (called Lower Anicut) was constructed by the British across the Coleroon about 70 km upstream of the Pichavaram Mangroves to diver the water for agricultural development. As a result, the amount of fresh water reaching the Pichavaram started to decline. As per the Public Works Department, discharge from the Lower Anicut had been reduced from 115 TMC (thousand million cubic feet) during 1949 - 63 to 60 TMC during 1964 - 83 and 51 TMC from 1984 - 98.

This systematic reduction in freshwater flow should have increased the salinity of the Pichavaram Mangroves causing severe physiological and reproductive stress to low saline tolerant species such as *X. grantum*, *K. candel*, *C. tagal* and *S. apetala* leading to the reduction and final disappearance of their population. It is well known that in higher salinity, rate of photosynthesis of true mangrove species reduces drastically and plant growth is stunted, leading to the overall reduction of biomass. In addition, high salinity promotes senescence and cause flower abortions, leading to a reduction in population.

Regarding the currently available 12 true mangrove species, *Avicennia marina*, a high saline tolerant species, constitutes 74% of the population, whereas, *Rhizophora mucronata* and *R. apiculata*, which tolerate a wide range of salinity, constitute 15%. The remaining nine species add up only 11% of the population. The distribution of these eight species is restricted to a narrow band along the border of tidal creeks and their physiognomy indicates that they are stunted in growth, flowering is poor, propagules are very weak and many of them show the sign of shoot dieback. All these indicate that these nine species are on the verge of local extinction.

The present case study shows that maintenance of the natural hydrological condition of a mangrove wetland is essential to sustain its biodiversity, biomass and ecosystem services. The situation of reduced freshwater flow is more or less similar to many other mangroves of India. Though in the present situation of food requirement, diversion of freshwater is inevitable, but in order to avoid further degradation of mangrove wetlands, the government should organize interdisciplinary studies to estimate the minimum environmental flow of water required to each major mangrove wetland and take steps to ensure the release of required quantity of water every year.

*Background Photo*
Pichavaram Mangroves, Cuddalore,
A very rare sight – Where mangrove forest trees are permanently rooted in a few feet of water / Harsh Ganapathi

# Integrated Water Storage in Landscapes

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Freshwater storage is a cornerstone of socio-economic development. Ancient civilizations developed in locations where it was possible to exploit natural water sources, including rivers, lakes and groundwater and were directly dependent on natural water stores. For example, in the Middle East, from about 1,000 BCE, the Persian civilization built qanats (i.e., gently sloping underground channels) to bring groundwater stored in aquifers to their fields. Some of these qanats are still in operation today. Other civilizations depended on very sophisticated water stores, including dams, cisterns, and reservoirs, as well as methods for harvesting rainwater, floodwater, groundwater, and natural springs. For example, the Angkhor Civilization (AD 800 to 1400) developed an extensive and complex water management system that made use of groundwater but also connected the natural lake of Tonle Sap in the Mekong River basin to large human-made reservoirs.

Today, all societies rely on water storage in one form or another. Since 1950, modern technologies have enabled the construction of more than 57,000 large dams (taller than 15 m) globally. The water stored is used for irrigation, hydropower, water supply, flood control, navigation and recreation. In addition, huge numbers of small reservoirs, ponds, cisterns, tanks and other micro-storage facilities have been constructed to store water, primarily for small-scale irrigation but also for livestock watering and domestic use. There are no global datasets quantifying the area or storage capacity of small reservoirs but on the basis of statistical distributions, it is estimated that, globally there are about 2.8 million reservoirs with surface area larger than 0.1 ha and 16.7 million small reservoirs with surface area greater than 0.01 ha. In total, human made reservoirs now cover approximately 0.26 million $km^2$ (i.e., 0.2% of the global land area) and store approximately 11,000 $km^3$ of freshwater.

The construction of dams has helped secure water supplies and fuel economic development.

THE TOTAL WATER STORED IN WETLANDS GLOBALLY IS APPROXIMATELY THE SAME AS THAT IN ALL HUMAN-MADE RESERVOIRS – 9,300 KM$^3$.

However, even with the sophisticated technology available today all societies remain dependent to a greater or lesser extent on natural stores of water. Natural lakes and other wetlands act as natural harvesters of water within landscapes and are important stores of water for domestic water supply and agriculture throughout the world, particularly in dryland areas. Water within wetlands is stored as standing water, within soils and within plants and shallow groundwater. Degradation of wetlands, through direct drainage, infilling or burning (e.g. peatlands), or through disruption of natural hydrological regimes (e.g. downstream of dams and irrigation systems), disrupts wetland storage and typically leads to a reduction in volumes of water stored.

The total water stored in wetlands globally is approximately the same as that in all human-made reservoirs - 9,300 km$^3$. However, storage of freshwater in natural lakes (182,900 km$^3$), groundwater (22,600,000 km$^3$) and as ice in mountain glaciers (158,000 km$^3$) hugely exceeds that in human-made reservoirs and remains vitally important for people, the environment and biodiversity.

Each form of water storage has its own niche in terms of technical feasibility, socioeconomic sustainability, impact on health and environment and institutional requirements. Each needs to be considered carefully within the context of its geographic, cultural and political location. With so much uncertainty in climate change scenarios, the best option is to focus on flexibility in storage systems

Dr. Matthew McCartney

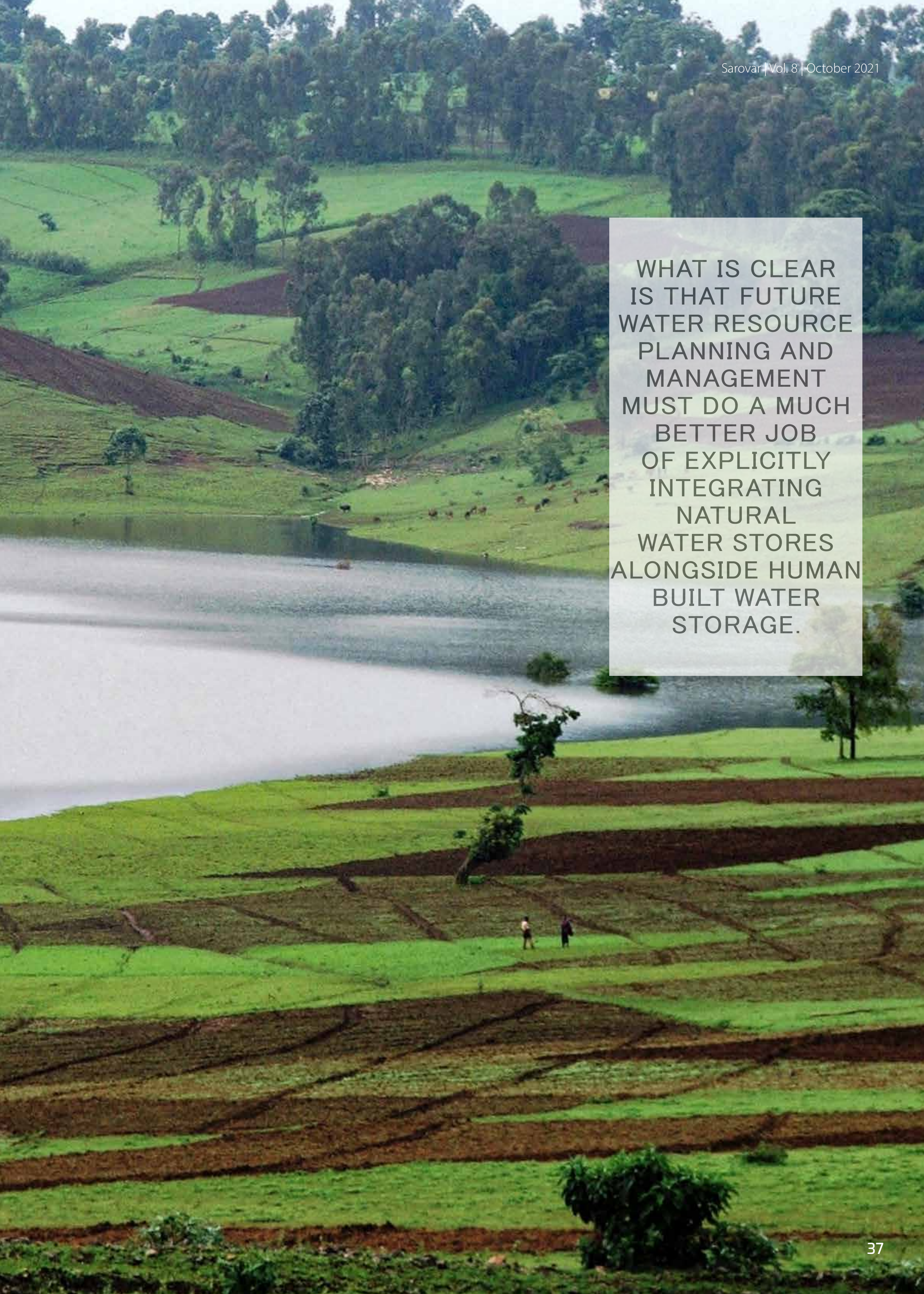
wherever possible, combining a variety of types to take advantage of their unique characteristics. System resilience is enhanced by utilizing a range of different water storage options (ground and surface water) in interconnected systems that only fail when concurrent shortfalls arise in more than one storage type.

Human societies have modified global water stores, directly and indirectly for thousands of years. Until recently, such changes were insignificant in comparison to changes arising as a consequence of natural climate variability. However, in the age of the Anthropocene, human induced changes in terrestrial water storage are growing and long-term cumulative losses from natural stores are no longer insignificant. Decades of degradation of lakes and wetlands, as well as depletion of groundwater and melting ice, as a consequence of climate change, are resulting in reduced freshwater storage.

Currently, changes are small relative to the total amounts of water stored and globally have been partly offset by the proliferation of large and small dams. However, reductions in water stored have occurred disproportionately in areas where human populations are greatest and water storage is most important for human well-being. Reduction in water storage complicates future water resource management, reduces adaptive capacity and ultimately undermines the resilience of rapidly growing societies that are increasingly under threat from climate change.

The contribution of both human-made and natural water stores to human well-being cannot be overstated. The demands of growing populations with rapidly changing consumption patterns for food and energy are exerting ever increasing pressure on water resources. Whatsmore, the future is likely to hold many surprises because of climate change, the legacy of past perturbations, and the wide range of other stressors. Under these circumstances, the need to develop more storage of all types (natural and built) – or at least manage current storage better – for resilient development is growing. The costs and benefits of different types of storage can be both large and uncertain, and storage development can be risky and controversial. With many competing demands for water and more variable supplies, well integrated storage systems (with a proper balance between natural and built approaches) will provide water managers with greater options, flexibility and adaptability. What is clear is that future water resource planning and management must do a much better job of explicitly integrating natural water stores alongside human built water storage.

Dr. Matthew McCartney ►

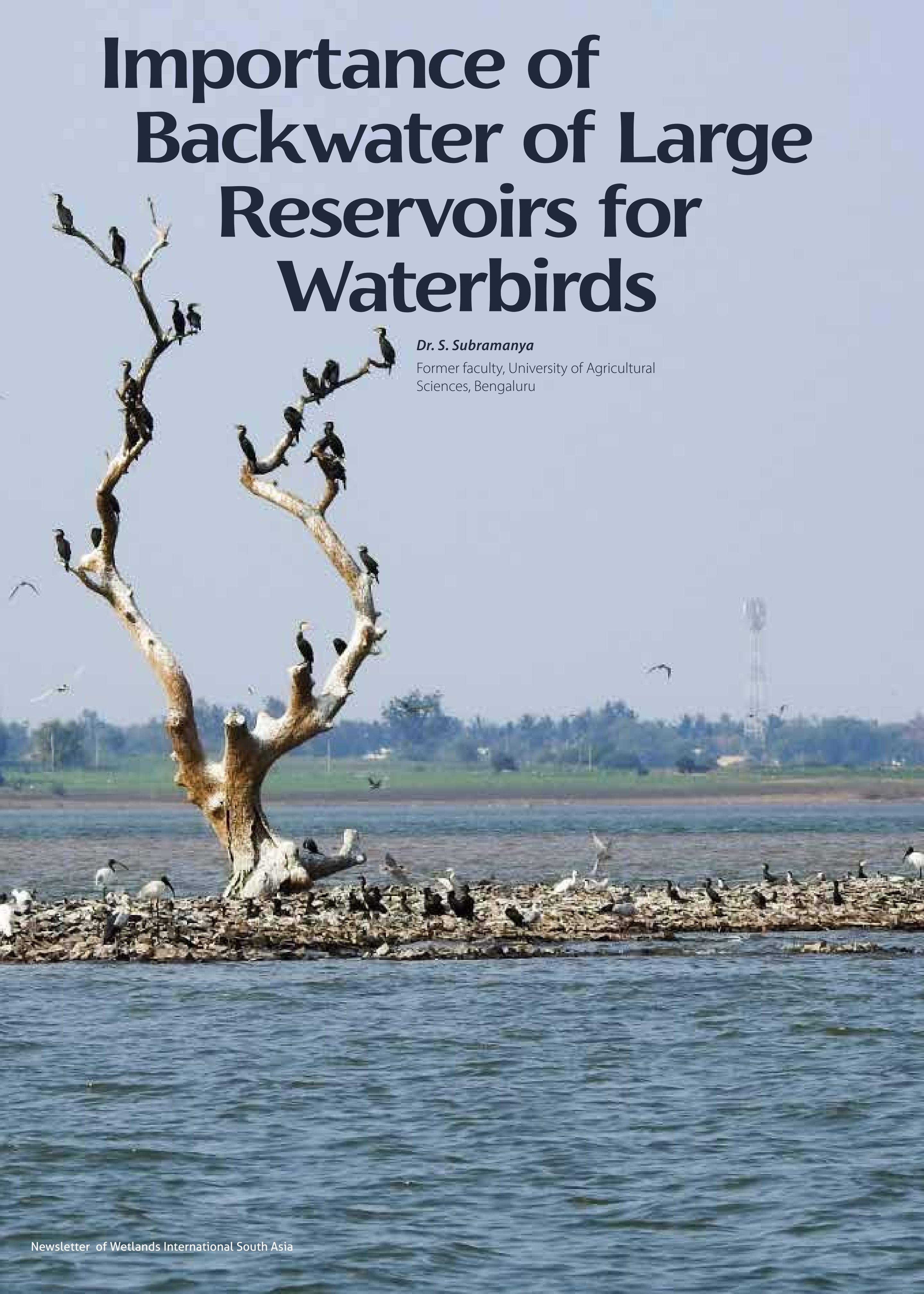


WHAT IS CLEAR IS THAT FUTURE WATER RESOURCE PLANNING AND MANAGEMENT MUST DO A MUCH BETTER JOB OF EXPLICITLY INTEGRATING NATURAL WATER STORES ALONGSIDE HUMAN BUILT WATER STORAGE.

# Importance of Backwater of Large Reservoirs for Waterbirds

***Dr. S. Subramanya***

Former faculty, University of Agricultural Sciences, Bengaluru



Backwaters of large reservoirs are one of the unique freshwater habitats whose meandering margins stretch well over a hundred kilometres, ending on either side of a barrage downstream. Fed by monsoon inflow, at full capacity, these stretches get submerged underwater by several meters. As the waters recede towards summer, these shallow margins expose vast foraging areas and attract large congregations of both resident and migratory waterbirds, whose numbers cannot be counted or estimated over short survey trips lasting over a few hours and over a few kilometres, but calls for a different survey methodology of taking a GPS traversed route along the backwaters from within the reservoir in a powered boat, and taking time segmented counts of birds found along the shallows. There is no doubt that such an exercise would work up species diversity and congregations that would easily satisfy Ramsar Criteria 5 and 6, needed to designate a Wetland of International importance.

One of the finest examples of such an extensive habitat has been the Backwaters of Almatti Reservoir, which has been built across River Krishna in Bagalkote in North Karnataka. Surveys in winter have logged waterbird numbers in excess of 50,000 birds. Visits at different times in winter have indicated the presence of large congregations of different species. For example, by the end of November and December, the numbers of Black-tailed Godwits (*Limosa limosa*) swell in excess of 30,000 birds and an equal number of mixed congregation of ducks can be seen by early January. Well over a dozen low-level islets that get exposed from January onwards, offering a welcome habitat for large congregation of nesting River Terns (*Sterna aurentia*), whose breeding population has been put by conservative estimates at 10,000 nests, making these backwaters to support, what is possibly the world's largest breeding population of the species, making around 20 percent of the global population of the species.

Backwaters of reservoirs in North Karnataka are home for

A small section of Black-tailed Godwit flock at Almatti Backwaters / Dr. S. Subramanya

◄ Backwaters of Almatti Reservoir in Bagalkot district of Karnataka, India / Dr. S. Subramanya thousands of Oriental Pratincoles, whose migratory habits have come to the fore only very recently. A satellite tracking study by the Australasian Wader Study Group discovered that, one of the five Oriental Pratincoles that were tagged with Satellite Transmitters turned out to be a champion, which travelled across the continents and flew across two different flyways.

SEP, a male Oriental Pratincole, left North-western Australia in early March 2019, flew over Java, Sumatra, South China Sea, touched Cambodia and Thailand, flew across the Bay of Bengal to land in Odisha, before making its way to the Central Island in Almatti Reservoir in Bagalkote in Karnataka by the end of April. When a search party sought it out and photographed it, SEP was busy breeding amidst thousands of its kind that were spread all along the vast backwaters of the reservoir. When SEP left its breeding ground in mid-July, it flew via Chennai, Sri Lanka, to reach Java and return to its former haunts by mid-December: a round trip distance of around 13,500 Km, making it a Champion summer breeding visitor to India.

◄ River Terns in Almatti Reservoir / Dr. S. Subramanya

One of the several River Tern nesting islands at Almatti Reservoir / Dr. S. Subramanya ▼

Realizing the importance of backwaters of large reservoirs the Karnataka State Forest Department has been a forerunner in proposing the 125 Km$^2$ of the backwaters of Almatti Reservoir to be declared as a Conservation Reserve. The extensive shallow water margins support anywhere between 50,000 - 10,000 resident and migratory waterbirds at different times during winter.

However, it is not known to what extent the backwaters of large reservoirs across India play an important role in supporting large congregations of resident and migratory waterbirds. Towards this, there is a need for a renewed focus on evaluating the importance of these backwaters during winters. Concerted efforts on a monthly basis through the migratory period (October – March), would reveal the population levels of different species supported by these extensive shallow-water margins of large reservoirs. Thus, it is high time that these extensive backwaters of reservoirs are recognised for their importance to waterbirds and efforts be invested in bringing as many of them as possible under protection as Conservation Reserves or wetlands of National and International Importance.

THE EXTENSIVE SHALLOW WATER MARGINS SUPPORT ANYWHERE BETWEEN 50,000 – 10,000 RESIDENT AND MIGRATORY WATERBIRDS AT DIFFERENT TIMES DURING WINTER.

SEP, the Champion Oriental Pratincole that travelled from NW Australia to Breed at Almatti Reservoir in Karnataka, India / Dr. S. Subramanya
▼

# NAJAFGARH JHEEL

## Reviving a Transboundary Wetland

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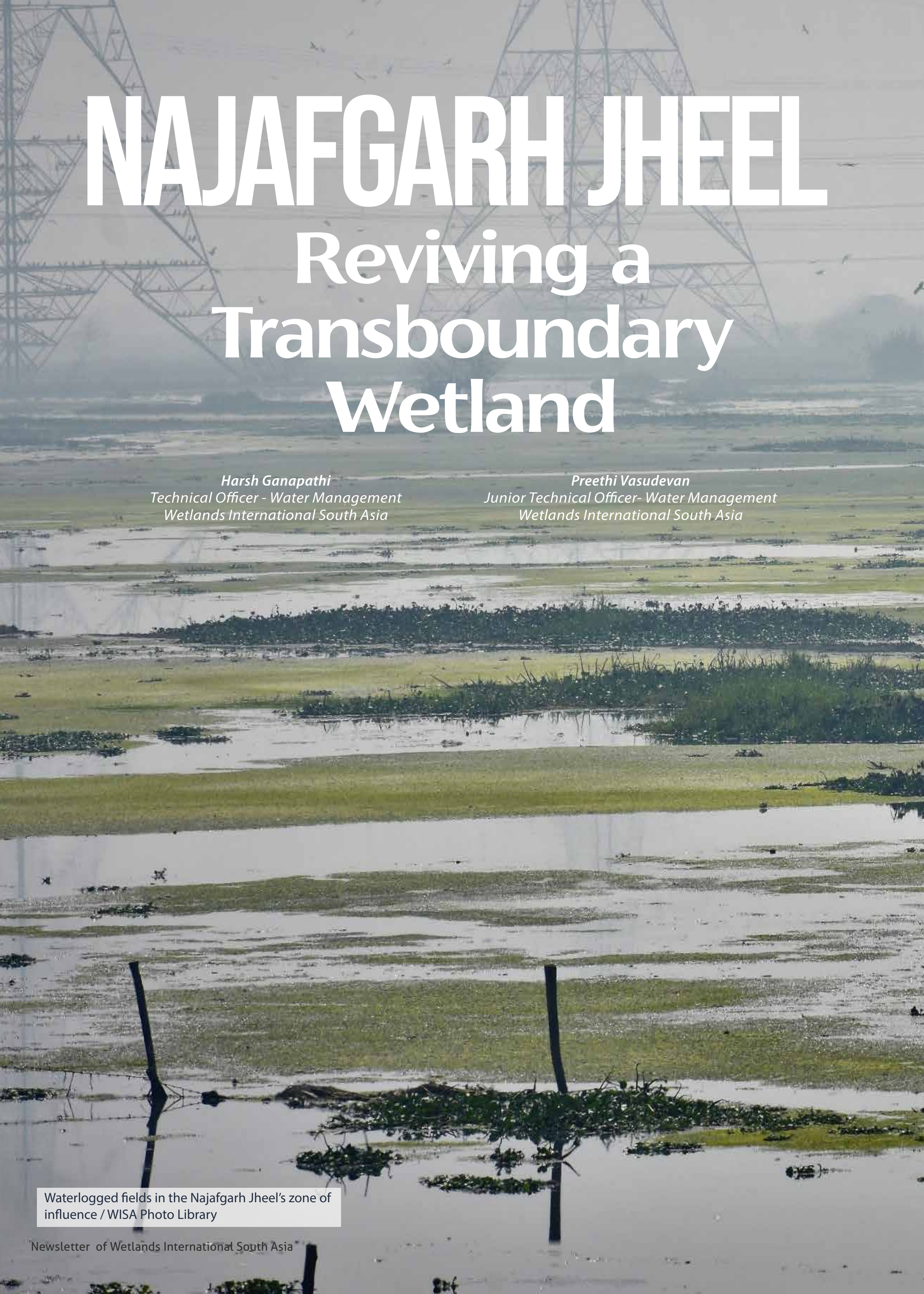


Waterlogged fields in the Najafgarh Jheel's zone of influence / WISA Photo Library

Najafgarh Jheel, a transboundary wetland spanning nearly over 2,500 ha shared between Haryana and the National Capital Territory of Delhi, is a critical natural infrastructure for the landscape. It provides a significant number of ecosystem services like buffering floods, treating waste water, recharging groundwater and providing habitat to numerous plant and animal species.

The high ornithological value of this wetland is indicated by the presence of 281 bird species, including several threatened ones (such as Egyptian vulture, Sarus Crane, Steppe Eagle, Greater Spotted Eagle, Imperial Eagle) and those migrating along the Central Asian Flyway. An estimate of 2,000 greater flamingos have been observed in Najafgarh during the winters of 2017.

The thick mud embankments along the Najafgarh Drain that was built to prevent floods are covered with trees and shrubs which serve as habitat for wildlife occurring in nearby and surrounding farms. These include common foxes, jackals, hares, wild cats, nilgai, porcupines and various reptiles and snakes including cobras. Many local birds and migratory birds roost and nest in these wooded strips. The wetland also supports heronries of Darters, Cormorants, Cattle Egrets and Ibises.

## TRANSFORMATION OF NAJAFGARH JHEEL DUE TO ANTHROPOGENIC PRESSURES

Until the 1860s, the wetland was relatively natural, with the surface inundation extending up to 22,600 ha. In 1865, the Sahibi river channel was excavated and extended from the eastern end of the wetland to the Yamuna River thereby forming the Najafgarh Nala. Extending the channel from Najafgarh Jheel to the Yamuna drained the Jheel and reduced its spatial spread. An embankment was constructed on the Delhi side of the wetland after the 1964 floods to alleviate any future flooding scenario. Once again when flooding occurred in 1977, the Najafgarh Nala was widened and expanded to provide relief. All these interventions heavily modified the hydrological regime of the wetland and the extent of surface inundation was curtailed to a lesser extent. Since the draining of the wetland in 1977, the surrounding lands have been converted to agriculture fields.

Since the 1990s, the increase in the extent of urbanization in both Delhi and Gurgaon has modified the land use surrounding the wetland extensively. The extent of surface inundation is majorly curtailed to the 210 m amsl, with the zone of influence extending up to 211 m amsl and the high flood level up to 212.5 m amsl. The rural settlements around the wetland are located right outside the boundary of the wetland at 210 m amsl and have naturally evolved around the usual inundation level. The region under the wetland boundary is largely agricultural fields. The built-up area fell entirely outside of the wetland boundary till 2010. From 2010 to 2020, Sector 108 of Gurgaon was developed inside the boundary of the wetland. The built-up area inside the 211 m amsl increased from 1.3% in 1991 to 10.4% in 2020.

The inundation level observed is maximum post-monsoon and near-minimum during the summer months. The inundation pattern is

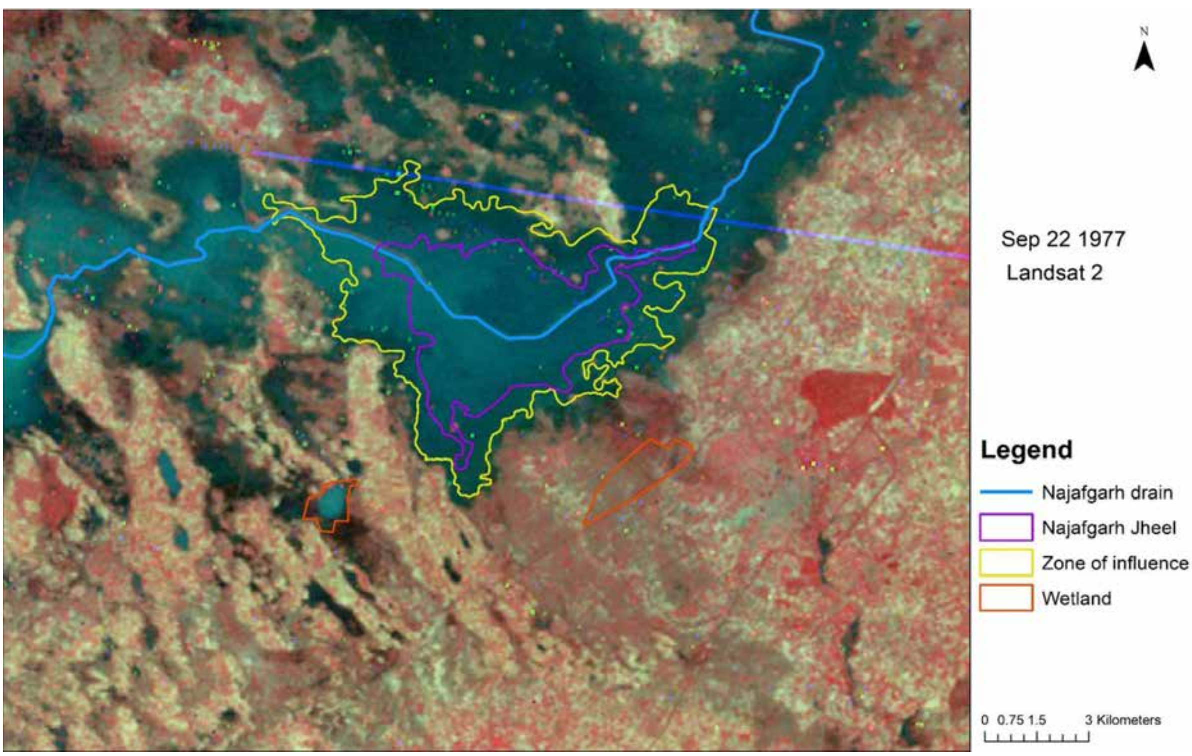



FIGURE 1. False Color Composition of Najafgarh Jheel's extent of inundation during 1977 (Source: Najafgarh Jheel - a framework EMP)

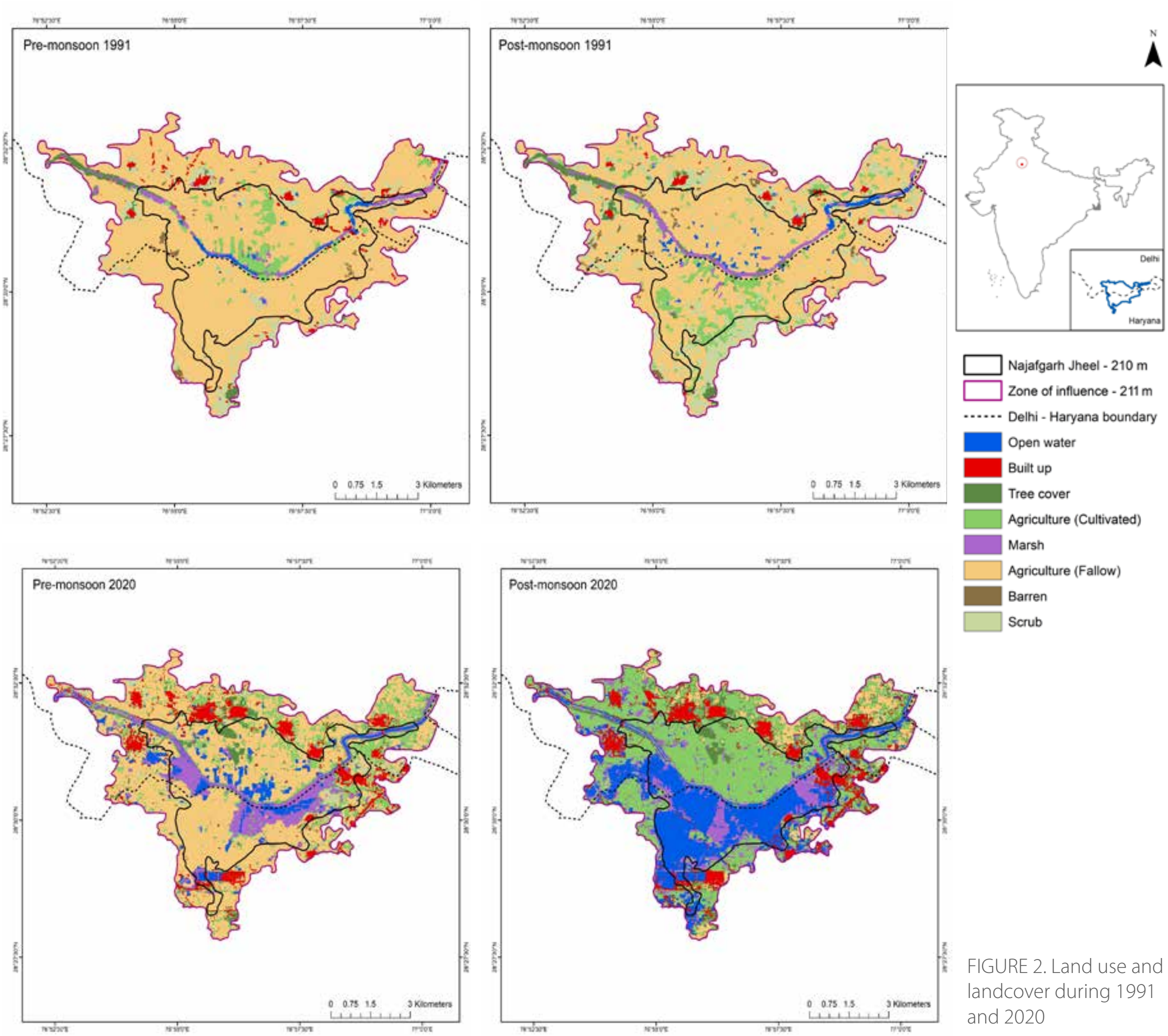



FIGURE 2. Land use and landcover during 1991 and 2020

not only governed by the rainfall pattern but also by the wastewater discharge from the Najafgarh Nala, Badshahpur drain and the multiple other waste water drains that empty into the wetland. This has also considerably reduced the quality of water.

## THE CONSEQUENCES OF WETLAND LOSS AND RISK OF HUMAN INDUCED CLIMATIC HAZARD

The embankment on the Delhi side prevents water spread towards Delhi except for high flood events, thereby furthering the extent of water spread on the Haryana side. The wetland provides flood relief for both southwest Delhi and Gurgaon as the natural drainage pattern in the region is towards the wetland. The increase in urbanization over the past three decades has increased the amount of surface runoff that reaches the wetland which adds to the floodwaters.

As a result of some of the villages and Sector 108 being in close proximity to or inside the wetland boundary, reports of buildings or agricultural fields being underwater for a large part of the year have become common occurrences. If Gurgaon expands further in the direction of the wetland, it is with certainty that it will face serious flooding. Though the wetland boundary sits at 210 m amsl, the influence of the wetland can extend up to 211 m amsl in very wet years. All of the rural villages and some part of urban built-up is located between this contour of 210 m amsl and 211 m amsl, meaning they are at an increased risk of flooding in case of an extreme rainfall event.

The area is naturally flat and low-lying with relatively high groundwater levels, and the wetland helps maintain these levels for the nearby regions of southwest Delhi and Gurgaon. The untreated or partially treated wastewater from the Najafgarh Nala or other wastewater drains makes the groundwater in the region very vulnerable to contamination. The wastewater in the long term can also potentially affect the agriculture and soil in the region.

With the increase in urbanization and development of Gurgaon, the areas constructed within the wetlands zone of influence will be at a high risk of flooding and seismic hazards like earthquake and land subsidence as the entire zone of influence falls under seismic zone IV. The vigorous shaking of the land evidenced during earthquakes, when coupled with the saturated, loose, or sandy soil prevalent to areas around the wetland, results in that ground turning into a slurry also known as liquification. If an unfortunate high magnitude earthquake events with a combination of event like flood come to pass, it may result in the tilting or total collapse of buildings in the area. This level of havoc on the buildings in the area will cause incalculable damage to life and property. Altering or modifying the hydrological extent of the wetland by construction of more embankments will further fragment the wetland and reduce the services it provides to the surrounding region along with complicating the whole integrity of the wetland.

## CONSERVATION AND RESTORATION PATHWAYS

To harness the complete potential of Najafgarh Jheel to deliver its ecosystem services, it needs to be restored to its former state. This can be done by declaring the area within contour 209.5-210m as permanent water spread or core zone and the area beyond up to contour 212.5 m amsl (100-year HFL) may be declared a buffer zone. As the entire buffer zone falls under hazard zone based on inundation levels, soil liquefaction profile and seismic zone IV and thus is a no building zone. The buffer zone may be notified as a wetland under Wetland Rules, 2017 and various regulations for the same may be announced. Further, the wetland area up to HFL (212.5 m amsl) may be declared a natural conservation zone (NCZ) as per the policy of NCR Regional Plan (2021)

The wetland can receive tertiary treated water from the drains and return to Yamuna through the Najafgarh Drain. The Delhi side embankment can be initially opened up as a culvert to enable the water spread to occupy its normal space in Delhi side depression and subsequently, the number of culverts can be increased to have the wetland's water holding capacity at its fullest state. This will also reduce the extreme floods that Gurgaon has been racked with every year. Farmers can be compensated for the loss of their land that is submerged and the compensation can be recovered by abstraction and supply of groundwater from the wetland periphery and ecotourism activities like boating and bird watching in the wetland area. A Najafgarh Jheel Conservation & Management Board can be formed involving representatives from various stakeholder departments for integrated management of the wetland.

With these aforementioned interventions, Najafgarh Jheel would be in a better state to absorb the excess water thus moderating the urban waterlogging. It would act like a vast carbon sink sequestering significant carbon from the atmosphere and provide a relief from impacts of climate change to surrounding areas by moderating the extreme summer temperatures and providing a pleasant local climate. Najafgarh Jheel would vastly improve the quality of urban life – visually, psychologically, functionally by providing a contrast to harsh urbanism through unity with nature.

Najafgarh Jheel as seen at Dhansa regulator / WISA Photo Library

# Wetlands Management in Bangladesh

***Imran Ahmed***
Conservator of Forests, Dhaka Social Forest Circle; and Director, Sheikh Kamal Wildlife Center, Gazipur; Bangladesh Forest Department

Ratargul Swamp Forest is a freshwater swamp forest located in Gowain River, Fatehpur Union, Gowainghat, Sylhet, Bangladesh. It is the only swamp forest located in Bangladesh and one of the few freshwater swamp forests in the world / Harsh Ganapathi

Bangladesh comprises most of the delta of two great rivers – the Ganges and Brahmaputra and several rivers and creeks traverse through the country. About 6-7% of Bangladesh is always under water. Wetlands in Bangladesh cover approximately 50% of the total land surface i.e about 7 - 8 million ha. They encompass a wide variety of ecosystems including natural lakes, freshwater marshes, oxbows, reservoirs, mangrove forests, permanent freshwater depression (*beels*), extensively inundated floodplains (*haors*), estuarine waters and man-made wetlands which includes ditches, fish ponds and tank. The areal extent of the wetlands is indicated on the right.

The institutional capacity developed in Bangladesh for the propagation of the spirit, education and expatriation for protecting, managing and utilizing wetlands is negligible. However, few government and non-government institutions are playing a considerable role in this concern. Despite the government institutions playing a vital role in the conservation of the wetlands, ironically no specific or integrated legislation for the management and monitoring of wetlands prevails in the country A few sectoral laws are indicated in next page.

National Water Resources Council (NWRC), the apex body to provide policy guidance for the implementation of water resources, National Water Policy, National Water Resource Plan and the Bangladesh Water Act. The committee comprises of 34 members (including 12 Ministers, 13 Secretaries among others) and is chaired by the Hon'ble Prime Minister. The Secretary, Ministry of Water Resources acts as the Member Secretary of the NWRC.

There have been numerous activities adopted under the wetlands conservation program and the funds allocated in this concern are also encouraging. The Wetlands Conservation Fund is an international policy and legal assistance adopted for nature conservation. Implementation of several projects have been sustained through these funds. The core objective of these projects was sustainable management of wetlands. Community based wetland management has been successful in some areas; Baikka Beel is a classic example. Since there are no strong long-term management commitments, the project implementation often is not very fruitful and many projects loose ground.

The Tanguar Haor in Bangladesh provides a striking example of how decades of poor ecological management and violation of people's rights can be turned around with dedicated collaboration of governments, NGOs and local people. But it also highlights the challenges. From the 1930s until 2000, the fisheries of Tanguar Haor were taken over by elites who over-exploited the fisheries resources preventing the local people from having access to the wetland or its resources. By 2001, the ecological state of the habitat degraded to the extent that the national government had to step in and halt the harmful leasing by elites. Subsequently, a 10-year community-based sustainable management project was initiated by the government in year 2006, promoting a people-centric model for wetlands sustainable management. This resulted in the livelihoods of many families improving, through fishing income and alternative income generating activities. Local biodiversity also improved through, for example, fishing regulations and restoration of swamp forests. Fishing regulations helped in improving local biodiversity and the livelihood of local communities through sustainable fishing activities and alternative sources of income generation.

Despite all the efforts, the challenges remained, particularly with respect to funding mechanism. The national government therefore invested its own funding for a 'bridging phase', with the aim of making the scheme sustainable in the long-term. Unfortunately, this too failed, although there was partial success with sustainable fish harvesting from November 2019 to March 2020. A common understanding has now developed between the local community leaders and the government to make changes in how the schemes are to be implemented in order to suit the local needs and enable communities and local NGOs to manage the wetland sustainably without depending on external funding.

Wetland area in Bangladesh

| WETLAND TYPE | AREA IN KM² |
|---|---|
| Rivers | 7,497 |
| Estuarine & Mangrove Swamps | 6,102 |
| Beels, Jheels & Haors | 1,142 |
| Inundable Floodplains | 54,866 |
| Kaptai Lake | 688 |
| Ponds & Tanks | 1,469 |
| Baors (Oxbow Lakes) | 55 50% |
| Brackish-water Farms | 1,080 |
| TOTAL | 72,899 |

In Bangladesh, Tanguar Haor was declared a Ramsar Site in 2000 due to its status as the home to rare and endangered swamp forests, hundreds of species of birds, fishes, amphibians, reptiles and mammals while sustaining the livelihoods of surrounding villages and contributing to national food security. IUCN Bangladesh worked on behalf of the Ministry of Environment, Forests and Climate Change and established a co-management model to converge and develop the natural resources of Tanguar Haor for the benefit of its dependents in association with local communities. In this regard, the Ministry in association with IUCN implemented the community based sustainable management

- The Forest Act, 1927 that prohibits hunting, shooting and fishing in the reserved forests.
- Wildlife (Conservation & Security) Act, 2012, that prohibits hunting, killing and capturing of animals prescribed for protection.
- East Bengal Protection and Conservation of Fish Act, 1950 (amended in 1982), that provides protection and conservation of fish in the inland waters of Bangladesh.
- The East Bengal State Acquisition and Tenancy Act, 1950, that transfers ownership of Jalmahals from the landlords to the Govt.
- The Haor Development Board Ordinance 1977, that prepares projects and schemes for the development of the haors and other similar low-laying and depressed areas.
- The Acquisition of Wasteland Act, 1950.
- The Culture Wasteland Ordinance, 1959.
- The Canal Act, 1927.
- The irrigation Act, 1864.
- The Environmental Pollution Control Ordinance, 1977.
- The Inland Shipping Ordinance, 1976.
- The Inland Water Transport Authority Ordinance, 1958.
- The Land Reform Board Act, 1989.
- The Agricultural Pest Ordinance, 1962.
- The Embankment and Drainage Act, 1952.
- The Penal Code, 1860.
- The Non-Agricultural Tenancy Act, 1947.
- Environmental Conservation Act, 1995
- Bangladesh Water Act, 2013 (BWA) is a framework Law to integrate and coordinate the water resources management in the country. The Water Act will establish a new, integrated approach to the protection, improvement and sustainable use of country's rivers, lakes, estuaries, coastal waters and groundwater

of Tanguar Haor (CBSMTH) project which has focused on access rights, local empowerment and capacity building to institutionalize and follow Ramsar's wise use principles in natural resource management.

Haors in the north-east of Bangladesh are situated in the transboundary Meghna Basin. They are considered as key sources of benefit-sharing between Bangladesh and India due to the ecosystem services these wetlands offer for both the countries. Considering that, IUCN's Building River Dialogue and Governance in the Ganges-Brahmaputra-Meghna (BRIDGE GBM) initiative has initiated research activities and a long-term dialogue to develop a benefit-sharing strategy for the Meghna Basin considering important services that our wetlands provide. The strategy will facilitate multi-level cooperation for the inclusive governance and ecologically sound management of the Meghna Basin including the wetlands through considering the challenges like climate change, wetlands degradation, biodiversity loss and poverty. To ensure the development of the strategy inclusively, IUCN is supporting the multi-disciplinary Meghna Advisory Group (MAG) with representatives from the government, civil societies and academia.

In 2020, IUCN launched the global standard on Nature-based Solutions (NbS) and has been promoting a global community of practice on NbS. Wetlands play a significant role in the practices of NbS as wetland ecosystems reduce the impact of storm surges, cyclones and tsunamis while providing a vital source of food and materials to resource-dependent communities. Well managed urban wetlands provide habitat for a range of species and limit flooding, improve water quality, and improve city-dwellers' health and well-being. Moreover, wetlands filter contaminated water and store large water supplies while offering nature-based solutions related to water. With a growing focus on NbS to address societal challenges, ensure human well-being and reap biodiversity benefits, wetlands ecosystems form one of the most important solutions in Bangladesh. Thus, to be able to promote wetlands as NbS it becomes imperative to strengthen the efforts to protect, sustainably manage, and restore wetland ecosystems of Bangladesh to a great deal in facing the multifaceted future challenges.

As wetlands are dynamic ecosystems and considered as natural connectors between upland and aquatic systems, movement of water and animals within and among wetlands are important to ensure wetland connectivity. Monitoring the movement and taking related actions help in sustaining the wetland biodiversity and thereby the benefits offered by the wetlands. Extensive migratory waterfowl population uses wetlands in Bangladesh as its habitat. Bangladesh is within the Central Asian Flyway (CAF) and East Asian Australasians Flyway of migratory birds which rest in the resourceful wetlands like Tanguar Haor, Hakaluki Haor, Nijhum Dwip and Baikka Beel along with many other wetlands. Since their presence indicates the health and richness of wetlands, IUCN Bangladesh, Prokiti O Jibon Foundation (POJ) and Bangladesh Bird Club (BBC) conducts waterbird census each year in Bangladesh. Research activities include satellite tagging of migratory waterfowl by the IUCN, POJ and Forest Department in a bid to understand their flight patterns and wetland connectivity. Subsequently, for better management of such key wetland habitats, a conservation action plan will be formulated by June 2022.

# NEWS

**'Wetlands Action for People & Nature' to be World Wetlands Day theme for 2022**

Ramsar

World Wetlands Day
2 February 2022
Wetlands Action for People and Nature

World Wetlands Day, celebrated every year on 2 February, marks the date of the adoption of the Convention on Wetlands on 2 February 1971, in the Iranian city of Ramsar on the shores of the Caspian Sea. Each year, the day is attached to a seminal theme to draw attention to pressing issues facing wetlands.

The 2022 World Wetlands Day theme is Wetlands Action for People & Nature. The theme seeks to highlight sustainable use of wetlands and encourage investments of time, heart and money towards their protection. The Standing Committee of the Convention on Wetlands has approved 'Wetland Restoration' and 'Wetlands and Human well-being' as the themes for World Wetlands Day 2023 and 2024 respectively.

**Four More Indian Sites Recognised as Wetlands of International Importance**

The Ministry of Environment, Forest and Climate Change designated four wetlands to the list of Ramsar sites in August 2021. The four new sites include Sultanpur National Park and Bhindawas Wildlife Sanctuary from Haryana and Wadhvana Wetland and Thol Lake Wildlife Sanctuary from Gujarat. Designating 46 wetlands spanning 1.08 million hectares, India has created the largest network of Ramsar Sites in South Asia. The network of Indian Ramsar Sites now covers over 8% of the known wetlands' extent of the country.

**Training on Eco-DRR/EbA for Ramsar Sites and Protected Areas**

An online training on Ecosystem-based Disaster Risk Reduction and Adaptation (Eco-DRR/EbA) for Ramsar Sites/protected areas was held from 3 - 7 May 2021. The five-day events included participants from Ramsar National Focal Points, Ramsar Site and wetland managers and stakeholders, and national DRR agency representatives from East, Southeast and South Asia. The training was organised by the Ramsar Regional Center – East Asia (RRC-EA), United Nations Environment Programme (UNEP), and Wetlands International South Asia to enable participants to understand the concepts of Nature-based Solutions (Eco-DRR/EbA), learn and exchange on Eco-DRR/EbA site management planning, and understand information/reporting requirements and how to support member states.

**South Asia Regional Training Workshop on Wetlands and Water**

A three-day online South Asian Regional Training Workshop on Wetlands and Water was co-hosted by Regional Ramsar Centre East Asia (RRC-EA) and Wetlands International South Asia from 9 - 11 November 2021. The training programme had representation from Bangladesh, Bhutan, India and Sri Lanka along with expert speakers from worldwide. The sessions included discussions on concepts and approaches to integrated wetlands and water management, tools and approaches, tools and approaches that emphasised the integration of catchment level planning with a focus on nature-based solutions and green engineering approaches and governance for wetlands and water management.

**Importance of Wetlands Emphasised During Climate talks at CoP26**

Recognising the role of wetlands in climate regulation, the COP 26 at Glasgow reinstated the need to restore carbon-saturated peatlands and coastal wetlands like mangroves and sea grasses along with forests. The Glasgow climate pact recognised "*the importance of protecting, conserving and restoring nature and ecosystems to achieve the Paris Agreement temperature goal, including through forests and other terrestrial and marine ecosystems acting as sinks and reservoirs of greenhouse gases and by protecting biodiversity, while ensuring social and environmental safeguards*".

# PUBLICATIONS

**HOME OF THE BLUE LILY – A Manual on Wetland Ecology**

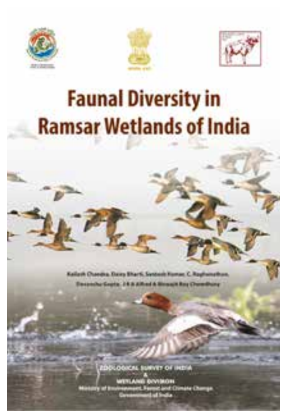
Home of the Blue Lily, a manual on wetland ecology published by CARE Earth, is aimed at drawing children's attention to ecosystems native to their region. With child friendly layout and illustrations, the manual delves on five themes: ecology and ecosystems; biodiversity; wetland ecology; culture and heritage; and, nature-based solutions. Picking examples from South India, the manual includes section-wise activities, introductory exercises, tasks that involve investigation and decision making to encourage inquiry-based learning.

Copies of the publication can be obtained by writing to: education@careearth.in


**Faunal Diversity in Ramsar Wetlands of India**

The book prepared by Zoological Survey of India and the Wetlands Division of the Ministry of Environment, Forest and Climate Change documents the comprehensive baseline data of the faunal diversity in 42 Ramsar sites across India. Altogether, 6,873 species of different faunal groups, belonging to 3,304 genera and 1.077 species families are reported.

The publication is available at: https://indianwetlands.in/wp-content/uploads/library/1635227120.pdf




**Building with Nature**

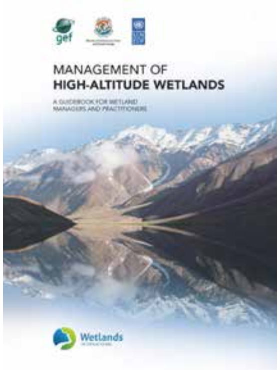
Building with Nature is an, innovative approach to realize water-related Nature-based Solutions for societal challenges. This approach utilizes the forces of nature and strengthens the opportunities for nature development, creating added value for the environment, economy and society. The book was developed by all partners of the EcoShape network, a unique collaboration of scientists, engineers, builders, designers, NGOs, and governments that in the last decade jointly designed, realized, monitored, and studied Building with Nature projects. These projects show that it is possible to implement Nature-based Solutions on a larger scale. In addition to sustainable and safe coastal defenses, these solutions also provide ecologically rich and resilient landscapes, making these highly suited for addressing climate change adaptation and mitigation.

The copies of this publication are available for purchase through this link: https://www.amazon.in/Building-Nature-Implementing-Upscaling-Nature-based/dp/946208582X/ref=sr_1_1?crid=2V3E2JPXLP4L4&keywords=Building+with+Nature%3A+Creating%2C+Implementing+and+Upscaling+Nature-Based+Solutions&qid=1646038135&sprefix=building+with+nature+creating%2C+implementing+and+upscaling+nature-based+solutions%2Caps%2C244&sr=8-1

**Management of High-Altitude Wetlands – A Guidebook for Wetland Managers and Practitioners**

High-altitude wetlands are critical for water and climate security. Under the aegis of the GEF – MoEF&CC – UNDP SECURE Himalaya project, Wetlands International South Asia has published a guidebook for management of these unique and fragile wetlands. The guidebook covers aspects of setting up a management planning process, developing an integrated management plan, implementing management, and review and adaptation. The document also contains guidance on designating these wetlands as Ramsar sites and notifying under the Wetlands (Conservation & Management) Rules, 2017.

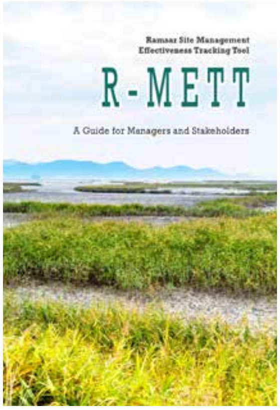
The publication is available at: https://indianwetlands.in/wp-content/uploads/library/1635227120.pdf




**Ramsar Site Management Effectiveness Tracking Tool (R-METT) - A Guide for Managers and StakeholdersIndia**

Ramsar COP12 Resolution XII.15 "Evaluation of the management and conservation effectiveness of Ramsar Sites" endorsed the Ramsar Site Management Effectiveness Tracking Tool (R-METT) published by Ramsar Regional Center - East Asia (RRCEA) is a voluntary self-assessment tool for evaluating the management effectiveness of Ramsar Sites and other wetlands. The R-METT is a modified version of the METT (Management Effectiveness Tracking Tool) which was developed in 2003 by the World Bank/WWF Alliance for Forest Conservation and Sustainable Use.

The publication is available at: http://rrcea.org/r-mett-guide/




## ACCESSING MORE OUTREACH MATERIALS

The Wetlands International South Asia website also provides access to blogs, case studies, videos and upcoming event announcements. Find these in the 'Resource' section: https://south-asia.wetlands.org/resources/

You can also write to us for queries by sending an email to wi.southasia@wi-sa.org

***STAY IN TOUCH***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