Economic and Ecological Services of Wetlands

***Dr.I.Sundar**

*Associate Professor of Economics, Directorate of Distance Education, Annamalai University, Annamalai Nagar – 608 002.

Abstract

'Wetland' is a generic term for water bodies of various types, and includes diverse hydrological entities, namely, lakes, marshes, swamps, estuaries, tidal flats, river flood plains, and mangroves. The finite natural resources of our planet are under tremendous stress due to demographic pressures and economic growth. This paper deals with wetlands in India and causes of wetland degradation. It outlines the benefits of wetland goods and services, wetland degradation, wetland restoration strategies and benefits of wetland restoration strategies. This paper concludes with some interesting findings along with appropriate policy measures.

Introduction

Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life. They occur where the water table is at or near the surface of the land, or where the land is covered by water. Once treated as transitional habitats or seral stages in succession from open water to land, the wetlands are now considered to be distinct ecosystems with specific ecological characteristics, functions and values. According to most widespread definition wetlands are defined as: "lands transitional between terrestrial and aquatic eco-systems where the water table is usually at or near the surface or the land is covered by shallow water". Ramsar Convention on Wetlands define 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". Wetlands, natural and manmade, freshwater or brackish, provide numerous ecological services. The density of birds, in particular, is an accurate indication of the ecological health of a particular wetland. However, unsustainable use of wetland without reckoning of their assimilative capacity constitutes major threat to the conservation and management of these vital biodiversity rich areas.

Wetlands India

Wetland helps in supporting directly and indirectly millions of people in India including supply of clean water and food, fibre and raw materials. There are 19 different types of wetlands in India. It includes mangroves, high-altitude lakes, marshes and ponds. It covers an estimated 3 percent of India's land area

Wetlands in India occupy 58.2 million ha, including areas under wet paddy cultivation. The majority of the inland wetlands are directly or indirectly dependent on the major rivers like Ganga, Bhramaputra, Narmada, Godavari, Krishna, Kaveri and Tapti. They occur in the hot arid regions of Gujarat and Rajasthan, the deltaic regions of the east and west coasts, highlands of central India, wet humid zones of south peninsular India and the Andaman and Nicobar and Lakshwadeep Islands.

The following wetlands is found in India Area under paddy cultivation 40.9 in million ha, area suitable for fish culture 3.6 in million ha, area under capture fisheries brackish and freshwater 2.9 in million ha, mangroves 0.4 in million ha, estuaries 3.9 in million ha, backwater 3.5 in million ha, man-made impoundments 3.0 in million ha, rivers, including main tributaries 28,000 km, canals and irrigation channels 113,000 km and total area of wetlands excluding rivers 58.2 in million ha.

Sustainable Wetland Products

Wetlands "produce" a number of valuable plants and animals, which can be harvested on a sustainable basis to provide an economic return. Such "products" include: trees for lumber, pulp, fencing and firewood, wild rice, cranberries and blueberries, fish and commercial baitfish, bullfrogs and snapping turtles, waterfowl, furbearers including beaver, muskrat and mink and natural medicines. These products can be harvested from wetlands in a sustainable, ecologically-conscious manner, avoiding degradation of the wetland. A few products from wetlands, such as peat, are not renewable and their large-scale removal can seriously degrade the wetland and negatively impact its dependant plants and wildlife.

Pure Water

Wetlands are commonly compared to kidneys because of their ability to purify water. Acting as natural filters, wetlands remove pollution in runoff that flows from our streets, parking lots, golf courses, lawns and agricultural lands. Wetland plants and microbes trap sediments, accumulate fertilizers, transform a variety of toxic substances such as pesticides and heavy metals, and can remove potentially dangerous microorganisms. While technological means to remove such pollutants from waters is highly expensive, healthy wetlands can provide this service for free. This wetland function is critical to maintaining clean and healthy waters that are drinkable, swimmable, and fishable for current and future generations in Wisconsin**.**

Drinking Water Quality

Wetlands improve water quality in nearby rivers and streams, and thus have considerable value as filters for future drinking water. When water enters a wetland, it slows down and moves around wetland plants. Much of the suspended sediment drops out and settles to the wetland floor. Plant roots and microorganisms on plant stems and in the soil absorb excess nutrients in the water from fertilizers, manure, leaking septic tanks and municipal sewage. While a certain level of nutrients is necessary in water ecosystems, excess nutrients can cause algae growth that's harmful to fish and other aquatic life.

Wetland Services

Surface water runoff from cities, towns, roads, agriculture, and mining and forestry operations may contain sediments, excess nutrients, viruses and pathogens and a variety of chemicals. If this runoff flows through a wetland, the wetland acts like a filter to remove sediments, absorb nutrients and biologically change many chemicals into less harmful forms. "Treatment wetlands" can be specifically designed and constructed to improve surface water quality, such as artificial wetlands to treat storm water runoff. Natural wetlands can perform the same functions but care is needed not to "overload" these systems. The capacity of wetlands to neutralize harmful substances is limited; too much runoff can degrade or destroy the wetland. For example, too many nutrients such as phosphorus entering a wetland can cause algal blooms eutrophication which reduces the oxygen content in the water, killing fish and other wildlife, and rendering recreation unpleasant or impossible.

Wetlands Reduce Flood Damage

Wetlands can reduce flooding by holding back peak water flows when water levels are high and, in some cases, storing water within the wetland. This results in more gradual discharges of water over a longer period of time, which can protect downstream property owners from flood damage.

Wetlands Reduce Erosion

Wetland vegetation along the shorelines of rivers, streams and lakes reduces erosion. Plants trap soils in their roots, helping to stabilize shorelines by dampening wave action and slowing water currents. When such vegetation is removed, efforts to control shoreline erosion are usually expensive, not always successful and can result in further degradation of fish and wildlife habitat.

Wetlands and Groundwater Recharge

Wetlands are essential components of the water cycle and many are a link between surface and groundwater. The level of groundwater in terms of the "water table" varies depending on the type of soil and bedrock, time of year and climate conditions. A wetland is a groundwater discharge area if water enters it by moving upwards from the soils beneath the wetland or from the upland areas surrounding it. These "discharge wetlands" are ecologically important because they help control erosion and maintain water quality. Conversely, some wetlands act as recharge areas, collecting surface water and allowing it to percolate down through the soil and rock to the groundwater. This water recharge helps to maintain water quality and groundwater supplies, especially during dry periods. This contributes to the water required for essential activities such as human consumption and agriculture. Some wetlands may be discharge areas in the spring, when the water table is high, and recharge areas in the summer, when the water table has dropped. They also contribute moisture to the atmosphere, influencing rainfall patterns. In the absence of wetlands, the summer months would be much drier.

Wetlands and Climate Change

Peat consists of partially-decomposed plants. Peatlands – wetlands that actively accumulate peat – act as long-term sinks for carbon dioxide in the atmosphere. Carbon dioxide is one of the "greenhouse" gases that contribute to global warming. Carbon is retained in peat lands instead of being released into the atmosphere as carbon dioxide.

Recreation and Tourism

Wetlands are popular places for non-consumptive recreation such as photography, bird watching, canoeing, hiking, snowshoeing, relaxation and spiritual or cultural experiences. Some wetlands have interpretive facilities, boardwalks and viewing towers where people can go to observe wildlife and learn about nature. Such facilities attract people to the wetland and provide an economic return to local communities and the tourism industry. Wetlands can also serve as "outdoor classrooms" and can be extremely valuable to scientific research studies. Wetlands are also valuable for more consumptive recreational uses, such as hunting, fishing and trapping. Such activities can also increase tourism and boost local economies.

Human Health and Sustainable Livelihoods

The ability of wetlands to filter and supply fresh water is perhaps the single most important service impacting the health of urban, rural and coastal communities around the world. In addition to supplies of fresh water, many communities are dependent in one way or another on the services provided by wetlands for their subsistence and economic livelihoods, further increasing the urgency and importance of restoring degraded wetlands.

Water, Food and Energy Security

Water, food and energy security in many countries are, in large part, dependent on wetland functioning and are necessary conditions for economic development and poverty alleviation. Wetland restoration is one tool to redress the over-

exploitation of groundwater and the draining or diversion of surface water, particularly in low-income countries with significant population pressures and susceptibility to desertification, land degradation, and drought. Food and energy security are also threatened by the same unsustainable uses and pressures that negatively impact the fisheries, agriculture, water supply and treatment, hydro-electric and transport sectors.

Resilience of Socio-Ecological Systems

Protecting and restoring wetlands should be a critical element in national and global strategies to mitigate and adapt to climate change. Restoring degraded wetlands increases the adaptive capacity of these ecosystems and their dependent communities to absorb and adjust to extreme events and other disturbances, such as floods, droughts, and sea level rise. Wetland restoration activities that enhance resilience are therefore critical to the health and sustainability of socio-ecological systems. However, we must understand the nature of climatic and ecological changes that are likely to occur regionally in order to properly design wetland management and restoration plans at the mega-watershed level (Erwin, 2009).

Flood Control

Wetlands can play a role in reducing the frequency and intensity of floods by acting as natural buffers, soaking up and storing a significant amount of floodwater. A wetland can typically store about three-acre feet of water, or one million gallons. An acre-foot is one acre of land, about three-quarters the size of a football field, covered one foot deep in water. Three acre-feet describes the same area of land covered by three feet of water. Coastal wetlands serve as storm surge protectors when hurricanes or tropical storms come ashore.

Wildlife Habitat

Diverse species of mammals, plants, insects, amphibians, reptiles, birds and fish rely on wetlands for food, habitat or shelter. Wetlands are some of the most biologically productive natural ecosystems in the world, comparable to tropical rain forests or coral reefs in the number and variety of species they support. Some species must have a wetland in order to reproduce. Migrating waterfowl rely on wetlands for resting, eating and breeding areas, leading to increased populations. As noted, the appeal of wetlands and the diversity of plant and animal life they attract contribute to or support many businesses.

Other Commercial Benefits

Many industries, in addition to the fishing industry, derive benefits or produce products dependent on wetlands. Part of this economic value lies in the variety of commercial products they provide, such as food and energy sources. Rice can be grown in a wetland during part of the year, and the same area can serve as a wildlife habitat for the rest of the year. Some wetland plant species, such as wild rice and various reeds can be harvested for or used to produce specialty foods, medicines, cosmetics and decorative items. In many coastal and river delta wetlands, haying of wetland vegetation is important to livestock producers.

In addition to the many ways wetlands provide economic benefits, they offer numerous less tangible benefits as well. These include providing aesthetic value to residential communities, reducing stream bank erosion and providing educational opportunities as an ideal “outdoor classroom.” By nearly any measure used, it pays to save wetlands.

Wetland Degradation

The world's wetlands continue to be lost and degraded at an alarming rate as a result of human activities. Consequently, the essential benefits provided by wetlands to people continue to be seriously eroded. These benefits, derived from wetland ecosystem services, are unique, varied and extend across many sectors, but their contribution and value is not always fully captured in wetland management decision-making. A better understanding of wetland benefits is required in order to make the case for halting further loss and degradation, and to support activities that assist in the recovery of their biodiversity and ecosystem functioning.

Wetland Loss and Degradation

When wetlands are degraded, the broad range of benefits they produce begins to deteriorate and eventually vanish. In some cases, degradation occurs because one particular benefit is valued above all others, such as water supply for irrigation in agricultural production systems. Wetland degradation is defined as the alteration of an existing or intact wetland resulting in a simplification or disruption in its structure, function and composition and, in turn, a loss of biodiversity and ecosystem services. This is most often caused by human activities or disturbances that are too frequent or severe to allow for natural recovery. Not only have population pressures and other human-induced stressors resulted in the degradation of wetlands across the globe, but the effects of climate change in terms of sea level rise, temperature increases, and changes in flood and drought patterns are also increasingly impacting the quality and flow of wetland services. The continued loss and degradation of wetlands will result in a further reduction in benefits and thus negatively impact human health and well-being into the future, particularly for the poor and disenfranchised who often depend disproportionately on these public goods and services. The wetland degradation takes place in India due to drainage development for agriculture, forestry and mosquito control particularly in estuaries, open coasts, flood plains, fresh water, peat lands, swamp forest and marshes. In India Dredging and stream channelization for and flood protection leads to wetland degradation in estuaries and fresh water. It could be noted that filling for solid waste disposal, roads results in wetland degradation in estuaries, open coasts, flood plains, fresh water, peat lands in India. The aquaculture and mariculture leads to wetland degradation in estuaries, open coasts, flood plains, fresh water and peat lands. The activities relating to construction of dykes, dams, and seawalls for flood control results in Indian wetland degradation in estuaries, open coasts, flood plains, and fresh water and peat lands. The discharge of pesticides, herbicides and nutrients from domestic sewage results in wetland degradation in estuaries, open coasts, flood plains, and fresh water and peat lands. The mining of wetland for peat coal, gravel, phosphate and other minerals results in wetland degradation in estuaries, open coasts, flood plains, fresh water peat lands and swamp forest. The ground water abstraction results in wetland degradation in flood plains and fresh water. The wetland degradation in terms of sediment diversion by dams, and deep channels results in degradation of estuaries, open coasts, flood plains and fresh water. The activities relating to hydrological alterations by canals, roads and other structures results in degradation of dykes, dams, and seawalls for flood control. The activities relating to subsidence due to extraction of ground water oil, gas and other minerals results in degradation of estuaries, open coasts, flood plains and fresh water. Further in India wetland degradation takes place due to natural causes relating to subsidence, sea level rise, drought, hurricane and other storms, erosions and biotic effects.

Restoration of Wetlands

Removing the stressors or pressures on the ecological character of wetlands is the best practice for preventing further loss and degradation; when this is not feasible,

however, or when degradation has already occurred, wetland restoration must be considered as a potential response option. The commitments and obligations under the Ramsar Convention clearly mandate wise use and the avoidance of wetland loss and degradation in the first instance. The Convention has also provided national governments and others with a framework on how to avoid, mitigate and compensate for wetland loss and degradation which includes opportunities for wetland restoration.

Wetland Restoration Action

Restoration is not a substitute for protecting and ensuring the wise use of wetlands, i.e., the potential to restore a wetland is not a justification or suitable trade-off for the continued degradation of wetlands. Furthermore, while restoration can play an important role in enhancing wetland benefits, experience shows that a "restored" wetland rarely provides the full range and

Wetland Restoration Objectives

In the past, some wetland restoration efforts have failed due to, among other things, narrow objectives which focus on one benefit or a partial suite of benefits. The inability to recognize or appreciate the potential for achieving multiple benefits across sectors has, in some cases, precluded cost-effective, participatory approaches to wetland restoration that may be more successful in recovering benefits and delivering more sustainable outcomes for people and the environment.

Wetland Restoration Strategies

Acreman et al. (2007) reported that wetland restoration is needed to counteract the loss and degradation of wetland ecosystems and their benefits in many countries. The catalysts for initiating wetland restoration activities are present at a number of levels, from obligations under international treaties to local opportunities and community-based initiatives. The essential element in prioritizing wetland restoration is to recognize the benefits it can deliver to people. However, the recognition that wetland restoration has relevance across multiple sectors is dependent on a broad understanding and awareness of these opportunities. The need for awareness extends both across and among government departments or socio-economic sectors and vertically within the same departments and sectors. Examples of policy sectors where wetland restoration can play a role include, among others, climate change, economic investment, development planning, housing, sanitation and water resources, food production, transport and education. Governments need to encourage dialogue and leadership across these sectors to ensure that social, economic and environmental benefits are delivered.

Many countries have national policies and laws which explicitly or implicitly call for wetland restoration. Some of these encourage a strategic approach to wetland restoration. Under the commitments of the Ramsar Convention, and manifest in National Wetland Policies, a strategic approach should consider prioritizing wetland restoration in order to avoid or mitigate impacts on designated Ramsar Sites or, if degraded, to reinstate their ecological character. Wetland restoration in this context should be carried out within the framework of the overall management of protected areas, the protected area network, and the surrounding land- or seascape.

Whilst precise information on the scale of global and national wetland loss is still limited, wetland inventories and an understanding of the degree of degradation and the level of importance in terms of benefits can be used to establish local or national priorities for restoration. Wetland restoration can deliver a range of benefits to social, economic and environmental sectors that extend beyond the conservation of protected or threatened species. Local or national policies which do not directly or explicitly address biodiversity conservation, such as water resource management or disaster reduction strategies, may assist in prioritizing or highlighting such wetland benefits. Prioritization

is only possible if the potential benefits of wetland restoration are first acknowledged by multiple sectors and subsequently integrated across disparate policy areas in order to identify win-win outcomes.

When both government and non-governmental organizations are considering the prioritization of wetland restoration activities they should consider not just single wetland sites, but multiple wetlands at a variety of scales within the land- or seascape. Any assessment should also consider the feasibility and ecological necessity of restoration activities and their long-term management and sustainability. Feasibility is often dictated by the availability of finite and limited resources. By addressing the priorities from multiple sectors it may be possible to pool limited resources in order to optimise the scope of wetland restoration and the range, quality and quantity of benefits delivered.

The Benefits of Restoring Degraded Wetlands

The Ramsar Convention defines restoration in its broadest sense, including activities that promote a return to previous conditions as well as those that improve the functioning of a wetland without necessarily seeking to return it to its pre-disturbance condition (Ramsar HB191). This notion of restoration proceeds from the widely-cited definition of ecological restoration as "the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed" (SER, 2004). The attributes of successful wetland restoration activities include: 1) the utilization of native wetland species in characteristic assemblages and functional groups, 2) self-sustaining and resilient wetland ecosystems integrated within the larger landscape, and 3) the reduction or elimination of the drivers of wetland degradation (SER, 2004). In 2002, the Ramsar Convention adopted principles and guidelines for wetland restoration to assist decision-makers and wetland managers (Ramsar HB19).

Restoring lost or degraded wetlands represents a valuable and cost-effective opportunity for society to recover and enhance benefits for human health and well-being, including reduced risk from storms and other extreme events, improved food and water security, and the capacity to mitigate and adapt to climate change. The restoration of mangroves and near-shore habitats, for example, provides food fish and invertebrates and other basic necessities, habitat for birds, reptiles and mammals, carbon sequestration, and climate protection, and it contributes to enhanced socio-economic resilience among coastal communities. The total value of benefits that flow from a restored wetland can often be several times higher than the cost of restoration when added to the value of the benefits lost due to degradation. As nature characteristically provides ecosystem services at a lower cost than human-made systems, wetland restoration can be a cost-effective, long-term strategy for achieving conservation and development objectives simultaneously.

According to Moreno-Mateos et al. (2012), restoration can clearly play an important role in enhancing existing and recovering lost benefits, experience shows that a "restored" wetland rarely provides the full range and magnitude of services delivered by a wetland that has not been degraded. Thus, the first priority should be to conserve and sustainably use wetlands rather than allow for their continued degradation. Regrettably, given the current state of loss and degradation, conservation alone is not sufficient to protect and enhance these wetland benefits. Restoration has now become a necessary wetland management tool in many countries to ensure a desirable and sustainable future.

Rey Benayas et al. (2009) indicate that restoration activities that enhance biodiversity are positively correlated with the increased provisioning of ecosystem services. Figure 1 reveals the causal relationship between different socio-economic sectors, wetland restoration activities, biodiversity and ecosystem functioning, and the

delivery of benefits. Because the objectives of restoration activities have become increasingly focused on ecosystem services (Bullock et al. 2011), it is important to account for the impacts of wetland use on biodiversity and ecosystem functioning. When the drivers of wetland degradation cannot be reduced or eliminated, restoration activities can still play a role in reducing negative impacts and enhancing benefits.

Wetland Restoration Benefits Multiple Sectors

Wetlands have the potential to provide long-term benefits to multiple sectors concurrently, such as agriculture, fisheries, water, forestry, health, energy, extractive industries, recreation, transport, education, development, and indigenous and local communities. The relative importance given to various wetland benefits derived from restoration activities will depend to some extent on the degree of information available to decision-makers and wetland managers. When considering wetland restoration opportunities, an adequate evidence base is needed to demonstrate and communicate the full suite of benefits and their relevance across sectors. Here sectors are defined as discrete subdivisions within a socio-economic system such as private landowners and corporations, local, regional or national authorities, and components of civil society, including NGOs and indigenous and local communities.

Community and grass-roots participation in wetland restoration activities often contribute to their long-term success by educating local communities and focusing attention on the causes of degradation, as well as by creating employment and a more equitable distribution of benefits. However, care must be taken to properly train community volunteers and provide appropriate guidance from experienced managers and restoration professionals. Similarly, the use of indigenous or traditional knowledge can contribute to the long-term success of restoration activities by providing critical insights into historical conditions that may improve the design and implementation of wetland restoration projects and programmes. Wetland restoration activities that optimize for a narrow range of ecosystem services and result in trade-offs in the delivery of competing services often preclude the provision of an equitable suite of benefits. For example, wetland restoration projects or programmes that exclusively target improvements in water quality and flow for the urban or agricultural sectors may neglect wildlife habitat, sedimentation, and nutrient cycling that support a wide variety of other services. In order to ensure greater equity and the long-term sustainability of wet land restoration outcomes, an Ecosystem Approach is often best suited to effectively manage the design and implementation of restoration activities as well as prioritize the inevitable trade-off in benefits.

It is evident from the work of Finlayson et al. (2011) the ecosystem approach is a strategy for the integrated management of land, water, and biological resources that promotes conservation and sustainable use in an equitable way. The Ramsar Convention's concept of wise use is perhaps the oldest example of the Ecosystem Approach among the intergovernmental processes concerned with the conservation and sustainable development of natural resources. In addition to understanding ecological processes within the context of the larger watershed or river basin, restoration projects and programmes must be designed and implemented with the aim of fostering multisectoral cooperation and stakeholder participation to allow for the pooling or leveraging of knowledge and resources, the resolution of long-term governance issues, and equitable socio-economic development. The CBD's Ecosystem Approach outlines twelve principles, two of which are particularly relevant to wetland restoration considerations (CBD, 2004). Principle 1 recognizes that sectors often have different economic, cultural and societal needs which determine the benefits they seek from wetland restoration activities. It therefore encourages communication and collaboration among different sectors in order to establish common ground, determine the types of

activities to be undertaken, and equitably manage the trade-offs between multiple benefits. Principle 3 encourages sectors and stakeholders to consider the impacts of wetland restoration activities on other ecosystems and in the context of the wider landscape.

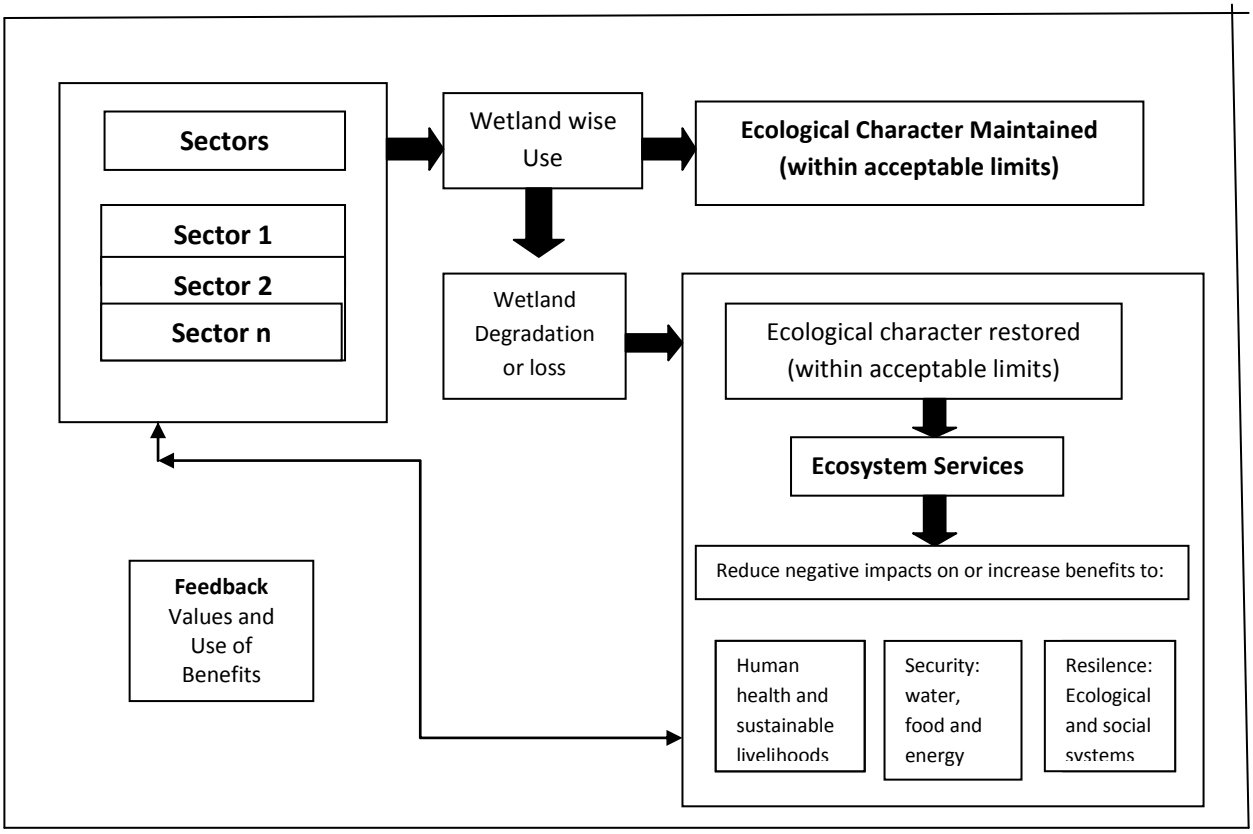

Figure 1: Relationship between sectoral use of wetlands and the delivery of benefits (modified from TEEB 2010)

Wetland functioning and benefits in the wider landscape

Whenever possible, wetland restoration planning and design should be conducted at the river basin, watershed or catchment level. A multi-scale approach, both spatial and temporal, to wetland restoration that fully accounts for connectivity within the larger landscape is best suited to enhance biodiversity and ecosystem functioning over the long term and deliver multiple benefits. Since wetlands connect terrestrial (upland), tidal and marine environments, these linkages must be strengthened so as to optimize wetland functioning while avoiding negative impacts on adjacent ecosystems, both aquatic and terrestrial.

Wetland restoration activities that focus on re-establishing a specific hydrologic regime must consider how this might alter the hydrology and functioning of adjacent ecosystems. Restoration outcomes or benefits may not always be favourable to or desired by the surrounding communities. Thus, the enhancement of benefits from wetland restoration must be considered at the landscape or regional scale. For example, diverting water from a river to restore a wetland might reduce the flow of freshwater to an estuary and affect salt-sensitive fish species which, in turn, could negatively impact the livelihoods of fisher folk. However, the lack of detailed scientific data at larger landscape scales should not deter the planning and implementation of smaller wetland restoration projects and programmes which still require appropriate site-specific information.

Restoration activities should also strive to maintain the diversity of wetland ecosystems within the landscape so as to protect overall species, habitat and functional diversity while recognizing that the benefits delivered by wetland restoration may accrue at some distance from site-specific activities, such as groundwater recharge or migratory bird habitat. Integrated river basin management (Ramsar HB9) and coastal zone management (Ramsar HB12) strategies recognize that wetland conditions are determined by landscape-scale ecological processes, such as water supply, sedimentation, and geo-morphology. These, in turn, are often influenced by socio-economic factors that tend to drive wetland loss and degradation, such as population growth, conversion of wetlands for agriculture, and the felling of forests in upland areas. In order for wetland restoration to be effective and realize multiple benefits, a shared vision and on-the-ground planning and coordination among the relevant public and private stakeholders is critical, and so is an understanding of the ecological history of the proposed restoration site. In doing so, the education, recreation and income-generating benefits of wetland restoration have the potential to reach a broad community of stakeholders.

Conclusion

It could be seen clearly from the above discussion that wetlands services are very essential to protect the environment and life support system. India being a mega-diversity country, so far managed to delineate a mere six sites till date. There is obviously much ground to be covered in our conservation efforts of wetlands. In addition, a paradigm shift in conservation ethic is also a strong need of the hour. This shift is necessary and perhaps mandatory due to the very nature of resource being conserved and 'protected'. Since wetlands are a common property resource, it is an uphill task to protect or conserve the ecosystems unless; the principal stakeholders are involved in the process. In order to make effective conservation of wetlands depends on the following suggestions. There is need to have a greater understanding and ability to predict with greater certainty the impacts of alternative management strategies for wetland ecosystems, The costs of implementing, monitoring and policing the alternative incentive policies are not well understood at present. There is a need to be able to assess the relative cost-effectiveness of these alternative policies in achieving wetland management goals. It should be noted in assessing alternative policies that there is very little compliance monitoring of existing water management options. Comparisons between options also need to consider what 'should' be being spent on compliance in existing arrangements. Markets may be able to integrate environmental and economic outcomes if appropriate mechanisms, market structures and institutions can be designed. There is a need to better understand how environmental considerations can be best integrated into market structures and how these can be incorporated into wetland policies in particular.

References

American Sportfishing Association. www.asafishing.org

"A New Framework for Planning the Future of Coastal Louisiana after the Hurricanes of 2005." Working Group for Post-Hurricane Planning for the Louisiana Coast. University of Maryland Center for Environmental Science www.umces.edu/la-restore

"Constructed Wetlands for Wastewater Treatment and Wildlife Habitat: 17 Case Studies." (EPA832-R-93-005) 1993. U.S. Environmental Protection Agency, Washington, DC www.epa.gov/owow/wetlands

Ducks unlimited www.ducks.org

"Economic Valuation of Environmental Benefits" www.nemw.org/ERconval.htm

"Economic Valuation of Wetlands: A Guide for Policy Makers and Planners" . www.ramsar.org

"Flood Damage Reduction in the Upper Mississippi River Basin – An Ecological Alternative." 2004. Donald L. Hey, et al. The Wetlands Initiative, Chicago, ILwww.wetlands-initiative.org

"National List of Plant Species that Occur in Wetlands: 1988 National Summary." Porter B. Reed for U.S. Fish and Wildlife Service in cooperation with the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Soil Conservation Service www.nwi.fws.gov/bha

National Marine Fisheries Service www.nmfs.noaa.gov

National Oceanic and Atmospheric Administration www.noaa.gov/floods.html

"National Survey of Fishing, Hunting and Wildlife-Associated Recreation" www.fws.gov

"Status and Trends of Wetlands in the Conterminous United States 1998 to 2004 http://wetlandsfws.er.usgs.gov/status_trends/index.html

Constanza, R. R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O"Neill, J. Paruelo, R.G. Raskin, P. Sutton, and M. van der Belt. 1997. "The value of the world's ecosystem services and natural capital." Nature 387:253-260.

Acreman, M.C., Fisher, J., Stratford, C.J., Mould, D.J. & Mountford, J.O. 2007. Hydrological science and wetland restoration: some case studies from Europe. Hydrology and Earth Sciences. Vol. 11(1), p.158-169.

Alexander, S., et al. 2011. Opportunities and challenges for ecological restoration within REDD+. Restoration Ecology. Vol. 19(6), p.683-689

Bullock, J.M. et al. 2011. Restoration of ecosystem services and biodiversity: conflicts and opportunities. Trends in Ecology and Evolution. Vol. 26, No. 10, p.541-549.

Erwin, K.L. (2009). Wetlands and Global Climate Change: The Role of Wetland Restoration in a Changing World. Wetlands Ecology and Management 17: 71-84.

Finlayson, C. M., Davidson, N., Pritchard, D.E., Milton, G.R. & Mackay, H. 2011. The Ramsar Convention and ecosystem-based approaches to the wise use and sus tainable development of wetlands. Journal of Wildlife Law and Policy. Vol. 14, p.176-198.

de Groot, R.S., Stuip, M.A.M., Finlayson, C.M. & Davidson, N. 2006. Valuing wetlands: guidance for valuing the benefits derived from wetland ecosystem services, Ramsar Technical Report No. 3/CBD Technical Series No. 27. Ramsar Convention Secretariat, Gland, Switzerland & Secretariat of the Convention on Biological Diversity, Montreal, Canada. 46pp.

Kumar, R., Horwitz, P., Milton, G.R., Sellamuttu, S.S., Buckton, S.T., Davidson, N.C., Pattnaik, A.K., Zavagli, M. 2011. Assessing wetland ecosystem services and poverty interlinkages: a general framework and case study. Hydrological Sciences Journal. Vol. 56(8), p.1602-1621.

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

Moreno-Mateos D. et al. 2012. Structural and Functional Loss in Restored Wetland Ecosystems. PLoS Biol 10(1): e1001247.doi:10.1371/journal.pbio.1001247

Rey Benayas, J.M. et al. 2009. Enhancement of biodiversity and ecosystem services by ecological restoration: a meta-analysis. Science 325, 1121–1124

Secretariat of the Convention on Biological Diversity, 2004. The Ecosystem Approach (CBD Guidelines). Montreal: Secretariat of the Convention on Biological Diversity. 50 p.

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

The Economics of Ecosystems and Biodiversity (TEEB). 2010. The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis. Retrieved August 15, 2011, from http://www.teebweb.org.

http://wetlands.org/WatchRead/Currentpublications/tabid/56/mod/1570/articleType/ArticleView/articleId/2467/Default.aspx.

http://corporate.unitedutilities.com/scamp-index.aspx.

http://www.wetlands.org/WatchRead/Currentpublica
ions/tabid/56/mod/1570/articleType/ArticleView/articleId/1640/Default.aspx.

http://publications.environment-agency.gov.uk/PDF/GEHO0308BNST-E-E.pdf.

http://www.epa.gov/heatisld/resources/pdf/BasicsCompendium.pdf.ftp://ftp.fao.org/docrep/fao/006/y4773e/y4773e00.pdf.

http://www.habitat.noaa.gov/pdf/tncnoaa_shellfish_hotlinks_final.pdf