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The Future of Coastal Wetland: A Critical Analysis of Impact of Climate Change and Global Warming

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Abstract:

The inter-linkages between water, food and energy have been recognized as one of the most fundamental relationships and challenges to human survival. The importance of this inter-linkage has been re-emphasized at the 'UN Conference on Sustainable Development', (Rio+20) in June 2012. Wetland ecosystems are a fundamental component of biodiversity and are at the heart of this relationship. They are considered a great natural asset for a productive, safe and sustainable environment. Their value is increasingly being recognized and appreciated due to a direct link between human health and environment. At global level, wetlands are being threatened by the global changes that are affecting all of the Earth's biomes. Climate change, sea level rise, change in land use pattern are some important factors which affects wetlands at global level.

Keywords: Wetlands, coastal wetlands, sea level rise, climate change.

1. Introduction

Wetlands, the hotspots of biodiversity are the world's most productive ecosystem having rich and diverse natural wealth and cultural heritage. They not only provide water and primary productivity to countless species of plants and animals but also to communities living in nearby areas that depend for their survival on these wetlands. Wetlands also influence lifestyles and livelihood of these local communities.

Ramsar International Wetland Conservation Treaty defines wetlands as:

areas of marsh, fen, peat land 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 meters (Ramsar 1971: Article 1.1).

Wetlands are unique terrestrial biomes. Unlike other terrestrial biomes of the earth they are not restricted in a particular region. They are scattered throughout the world. They are most abundant found in the equatorial zone. This zone has abundant rainfall therefore provide favorable conditions for wetland. Northern temperate zone and oceanic climate are other important area of presence of wetlands. Wetlands are also found in arid part of world. But they depend on topographic condition and supply of water in arid region. Wetlands in these arid lands are almost fed by flowing water. One the other hand in wetter climate condition wetland depend flowing water as well as collected water.

Scattering wetlands in diverse latitude and climatic zone provide them immense biodiversity of flora and fauna. Some of wetlands are dominated by Arctic lichens, bog mosses; woody dwarf shrubs while others bear tall tropical trees. The northern mires are grazed by reindeer, while the tropical marshes support antelopes and water buffaloes. Arctic foxes and wolves prey on tundra mire wildlife, but in the tropical forested wetlands tigers and jaguars are the top predators.

Apart from geography, geology of continents is one of dominating factor of wetland. Geology of particular place determines the chemistry of wetland. This factor controls types of wetlands. Several wetlands are rich in plant nutrients, while others are poor. Various wetlands have an abundant supply of calcium carbonate. Such as wetland in Yugoslavian region which is very rich in limestone rocks. These things affect biodiversity of wetland in great manner. The supply of nutrients to wetlands is also dependent on the nature of human land use in the surrounding.

Farming and forestry often involve soil disturbance, which leads to soil being eroded into low-lying wetlands. The application of fertilizers usually results in an excessive runoff of nutrient elements that find their way into the wetlands. Consequently, the nature of a wetland is affected by the activities of the people who surround it.

2. Value of Wetlands

“Destroying wetlands is rather like burning an art gallery in that it involves the loss of things that cannot be re-created, but, unlike works of art, it is impossible to place a monetary value on a wetland” (Moore, P.D.:2006:05)

Wetland had been fueled the Industrial Revolution and took human cultures to new planes of development through their coal. Peat is a type of wetland. It had been converted into coal in carboniferous period of geological history of earth. Coal has been still playing vital role in economic growth of world since industrial revolution. It is main source of energy for most of fundamental industries such as iron and steel industry.

Peat extraction for energy or horticulture has had a considerable effect on the peat lands of the temperate zone. Peat accumulates very slowly, so it is effectively irreplaceable, which means that any form of harvesting is not sustainable. Peat is a nonrenewable resource. Peat contains energy, so it can be used as an energy source, being burned in power stations to generate electricity. Peat also has important properties as a soil conditioner, increasing the water-holding capacity of soils, enhancing their ability to hold nutrient elements. Peat has long been used for both energy production and horticulture.

Wetlands serve other functions besides their production of energy-rich materials, however. Wetlands contain water, and freshwater is one of the most important requirements for human life. They contain reserves of water and the supply of freshwater for growing global human population. Increasing urbanization and population will make it precious in the future. Without wetlands, rainwater would soak through to streams and go rushing toward the ocean with no brake on its progress. In wetlands the rate of water movement is slowed down. Therefore, water is conserved in reservoirs within their basins. Wetlands can act like giant sponges. They are absorbed excess water and releasing it slowly into the rivers. These water is being extracted for use in agricultural irrigation, industrial processes and domestic consumption. Draining wetlands is equivalent to punching holes in a water storage tank. By storing water, wetlands can also act as flood controls.

Wetlands are retained flood water which might be dangerous for people and agricultural crops. Along shorelines, mangrove wetlands can absorb some of the energy of storms at sea and prevent coastal flooding. It can also protect low-lying land from floods in time of high precipitation or snowmelt. The drainage of wetlands results in soil shrinkage as water is lost and carbon is oxidized. It means that rivers need to be elevated and enclosed by levees to prevent overflow into surrounding lands. This practice creates a very fragile and dangerous situation. Wetlands are just not only protecting lands from flooding, but they also cleanse the water that passes through them, extracting many of the excess nutrients that cause eutrophication.

Wetlands are also a source of food for many people. Fish provide a staple source of protein to many of the world's people. The people around Lake Victoria in East Africa heavily depend upon the fish stocks of abundant wetlands of that region. The mangrove habitats of many tropical coastal areas are also an important source of fish. Wildfowl can also provide a sustainable supply of food from wetlands. Various wetland sites have also a long history of management for hunting. Perhaps the greatest value of wetlands lies in the animals and plants that inhabit them. Many wetland species are found in no other type of habitat. Subsequently the loss of the world's wetlands would entail the extinction of many highly specialized organisms. It is impossible to place a monetary value on this biodiversity, but it is not difficult to appreciate that financial loss could result from extinctions.

Certain wetlands have strong resistance against waterlogging and flood. These types' wetlands are very fruitful for agriculture. The high salt content of saline lakes may help agriculturalists to develop new types of crops that can deal with waterlogging and flood conditions. Many of the drugs used to combat disease are derived from the poisons contained in plants. Biodiversity is an indicator of health of ecosystem. Biodiversity is also most precious resources of earth. The wetlands contain an important and distinctive component of the world's biological richness. This richness provides immense profit to human in term of economy as well as environment.

Wetlands have often been regarded as wastelands. Their conversion to agriculture has usually been referred to as reclamation. Such reclamation has meant that the wetlands can no longer perform their natural function of water control and purification. In some areas the climate or the soil conditions have meant that agricultural development is difficult even when a wetland has been drained. Under such conditions it may prove possible to use the site for growing trees.

Therefore, the drainage of wetlands for forestry has been widespread. Trees that can cope with wet soil conditions and harsh climates have been transported around the world for use in forestry projects in drained peat lands. Some of the trees from the Pacific Northwest of America have proved extremely valuable in this respect, including Sitka spruce and lodge pole pine

Wetland ecosystems provide a range of services which benefit people, society and economy at large; these are known as ecosystem services. They are essential in providing water-related ecosystem services, such as clean water for drinking, water for agriculture, cooling water for energy sector and regulating water quantity. In conjunction with their role in erosion control and sediment transport, they also contribute to land formation. Land cover in turn affects water-retention and water-flows and hence the availability of surface and groundwater. Many of these ecosystem services are dependent on water. Therefore, wetlands via water provision, regulation, purification, and groundwater replenishment are crucial in addressing the related issues. These main issues are water security, climate change, food security and job security. These issues are also linked to a range of cultural benefits, including knowledge both scientific & traditional, recreation, tourism and formation of cultural values (TEEB Local and Regional Policy 2012: 04)



Figure 1

Source: [Online: web] accessed 27 JAN, 2014, URL:<http://www.everglades.national-park.com>

Wetland and water have very close link. Wetlands play very important role in hydrostatic balance of environment. Wetlands prevent flow of running water and recharge groundwater. Consequently, wetlands provide drinking water to local people and also very helpful to solve water security problem. Water security is another major and increasing concern today in many parts of the world, both in terms of availability and quality of water. Increasing industrialization and urbanization has been pushing up the demand for water. Climate change is turning water security into an increasingly complex challenge.

However, the roles and values of water-related ecosystems and wetlands in providing key ecosystem services need to be fully appreciated and integrated into decision making at local, national and international levels. An incomplete understanding of these can result in favoring of ecosystem services whose values are well reflected in the market economy e.g. food, timber and medicines etc. In the process, those which are largely invisible i.e. water purification, flood protection and nutrient cycling will get neglected (TEEB National and International Policy Making 2011:21)

3. Present Scenario of Wetland

Degradation of wetlands has been a global problem. Due to rapid urbanization, industrialization, over-exploitation, and other anthropogenic activities have resulted to changes in land-use pattern. Significant land-use changes have been reported during the last century both on spatial and temporal scale, mainly due to economic development and population growth. Anthropogenic changes in land use and land cover being increasingly recognized as a critical factor influencing wetlands. Growing population pressure, changing human population-land ratio and increasing land degradation are various variables which affects to wetlands. Therefore, change in land use pattern is one of influencing factor of wetland which modifies its ecosystem services and its sustainability.

Area	Global Review of Wetland Resource (1999)	Global Lake and Wetland Database (2004)
Africa	121-125	131
Asia	204	286
Europe	258	26
Neotropics	415	159
North America	242	287
Oceania	36	28
Total Area	~1280	917

Table 1: Estimates of Global Wetland Area by Ramsar Region (Million Hectares)

Source: UNEP Report: Wetlands and Water Synthesis -2005:25[online: web] accessed 16 Oct, 2015, URL: <http://www.unep.org/maweb/documents/document.358.aspx.pdf>

The global extent of wetland is estimated to be 1,280 million hectares. However, the area under wetlands is decreasing at a faster rate than other ecosystems. For example, the surface area of Mesopotamian marshes has decreased from 20,000 square km. in the 1950 to less than 400 square km today due to tremendous water withdrawals, dams and industrial development. Likewise, the volume of water in Aral Sea basin has been reduced by 75 percent since 1960 due to large scale upstream diversions of Amu Darya and Syr Darya river flows for irrigation. [Millennium Ecosystem Assessment (MA) Wetlands and Water Synthesis 2005: 45].

4. Coastal Wetlands

The Convention on Wetlands (Ramsar, Iran, 1971) is an intergovernmental treaty. Its mission is the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world. This convention has more than 2168 wetlands around the world. Coastal wetlands are depleting much faster rate than inland wetlands. It has been estimated that at least 60% of the world's human population live in the coastal strip from the shoreline to 60 km inland. Many coastal zones are attracting economic development faster than many inland areas. These activities are putting immense pressure on coastal wetlands. Main human activities are land-claims for housing, industry, port-related development, tourism, increasing pollution loads, and depletion of natural resources which affecting coastal wetlands. (Ramsar International cooperation 2010:29)

A number of coastal wetland types, especially coral reefs, atolls, and mangroves, are considered to be especially vulnerable to the effects of climate change and sea-level rise. Natural landward movement of coastal wetlands in response to the rising sea levels, impeded by development, coast protection and flood defense will severely restrict the size and width of coastal wetlands. It will also alter their adaptive capacity. (Ramsar Managing Wetland 2010:14)

There are a number of potential adaptation options that can contribute to the conservation and sustainable use of coastal wetlands to mitigate the impacts of climate change and sea-level rise. These include: managed landwards reinstatement of coastal wetland habitats through removal of sea defense structures and designing multiple-use reserves. Conservation processes also include creating protected areas to incorporate corridors. It would allow for migration of organisms as a response to climate change; specific management in some ecosystems and integrated resource management. (Ramsar Strategic Plan 2010:21)

Principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management Policies were adopted in sixth Conferences of parties (2002). This guideline provides a wider perspective for conservation of coastal wetlands. This framework has eight guiding principles further divided into four sections: Recognizing the role and significance of Ramsar Convention and wetlands in the coastal zone; Ensuring full awareness of the values and functions of wetlands in the coastal zone; Using mechanisms for securing the conservation and sustainable use of wetlands in the coastal zone; Addressing the integration of the conservation and sustainable use of wetlands in broad-scale integrated ecosystem management. (Ramsar Coastal Management 2010:15)

These principles set out the key issues that provide the basis for ensuring that integrated coastal zone management (ICZM) fully incorporates the conservation and wise use of coastal wetlands through Ramsar Convention. For each principle, guidelines are provided for their application by Ramsar Contracting Parties through specific actions. (Ramsar Wise use of wetland 2010:23)

5. Climate Change and Wetlands

Climate change is a global phenomenon. It includes a rise in temperature, change in rainfall, ozone depletion, etc. Wetland will influence viciously due to climate change. However, the impact on wetlands is not considered seriously. Junk mentions that:

- The predicted changes in global climate will, among other impacts, increase temperature, modify the precipitation regime, raise the sea level and increase extreme climate events. All these changes will have a large impact on wetlands. But wetlands are not considered adequately in many climate change scenarios. (Junk 2011:115)

Impact of climate change on wetland varies according to their location. Tidal wetlands are more vulnerable to climate change compared to non-tidal wetlands. Raper (2005:98) exactly predicted that Climate change directly affects tidal wetlands, primarily through changes in the rate of sea-level rise, and most, but not all, tidal wetlands have accumulated enough sediment to keep pace with recent rates of SLR of 1-3 mm year. Kirwan (2010:179) also points out the impact of sea level rise on tidal wetlands. He specifically mentions that if the sea level rises one meter or more by 2100 then the ability of tidal wetlands to survival is doubtful.

Every ecological biome has its own ecosystem. Every biome responds differently to climate change. Change in sea level will also enlarge the frequency of tropical cyclones. Therefore, it will severely affect the coastal biomes. It has been predicted that the resultant ecological shifts across coastal biomes will be expedited by sinking deltas, more intense cyclonic activity and storm surges (IPCC 2007:34). However, Church (2010:20) argued that the projections of sea level rise could differ, ranging from 20 cm through to several meters and up to 25 m within the coming century. Change in sea level will harshly affect the coastal wetland

- There is a concern that many Ramsar-listed wetlands (which include rivers, swamps and marshes, wet grasslands and peat lands, estuaries, deltas and tidal flats, near-shore marine areas and mangroves) will be affected by such changes. (Raper 2005:123)

In the scenario of climate change and sea level rise, coastal wetlands need more care and conservation. Conservation of wetlands is not a new practice. However, in the present scenario, traditional practices are not sufficient for their protection. Rohling appropriately mentions that:

- Many Ramsar sites in the tropics are coastal, thus the conservation and cultural implications of global change on these cannot be ignored., He also put emphasis on the conservation of the coastal ecosystem indeed change will occur, and any attempt to simulate such changes in the context of adaptive wildlife management will allow prevention of species extirpation events. (Rohling 2008:298)

Wetland plays an important role in the ecosystem. They also perform various services in the ecosystem. Therefore, they are very important for socio economic development of the population. Small change in sea level will affect the wetland ecosystem adversely. It will also influence the socio economic condition of the local population. Bradshaw (2005:78) studied impact of climate change on tropical region. He found that the tropical regions will suffer much more than any other part of the world. IPCC (2007) in its fourth assessment report supported the findings of Bradshaw.

- The geographic and socio-political impacts of climate change will be asymmetrical; tropical regions are likely to experience a relatively greater loss of biodiversity than other regions and many of the world's developing economies are situated within the equatorial belt. Climate change will include rising oceans, increased concentration of CO₂, rising temperatures and altered rainfall regimes. (IPCC 2007:123).

6. Conclusion

Wetlands are extremely valuable for a very wide range of reasons. It has financial as well as aesthetic value. They supply food, work as a means of transport, stabilize water supplies, and provide a means of recreation. But they are also highly threatened ecosystems. Wetlands have been menaced at local as well as global level. At local level, they are being faced the threat of drainage and conversion to agriculture, pollution by communities. Various communities, both in developing countries and developed countries, use wetland as a means of waste disposal. Incorrect general perception of people about wetland is being disturbed the ecosystem of wetland. At global level, wetlands are being threatened by the global changes that are affecting all of the Earth's biomes. Climate change, sea level rise, change in land use pattern are some important factors which affects wetlands at global level.

Wetlands, unlike the other major terrestrial biomes of the world, are scattered over many latitudes and climatic zones. They are often fragmented into small areas. They often lie in regions, such as valley floors. These regions generally have human settlement and agricultural practices. As a consequence, wetlands are extreme threat from human population expansion and demand for land. They have huge risk from climate change. Climate change, especially global warming, will have its greatest impact on the high latitudes. Warmer polar region will put negative impact on the tundra and boreal wetlands. Increase in temperature will enrich microbial activities which escalate decomposition process. It will provide more auspicious condition to lower latitude vegetation. Consequently, biodiversity of region will suffer extremely.

Sea levels will rise as a consequence of global warming. It is major a threat to coastal wetlands, especially salt marshes and mangrove swamps. Coastal defenses, such as seawalls, levees, and barriers, have been erected in many developed parts of the world to protect towns and agricultural land against incursion by the sea. In case of the sea level rise marshes on the seaward side of these defenses will become crushed into increasingly narrow strips. Mangrove swamps are tropical and subtropical coastal wetlands. Their survival will depend on their ability to move inland with the retreating shoreline. In Southeast Asia, some tropical bogs lie close to sea level. It will also be placed under threat.

Human drainage and destruction of wetlands has been proceeding for many thousands of years. The process has accelerated very rapidly in recent decades as agricultural demand has increased

faster. Only very recently have people begun to realize the value of wetlands as mechanisms for water control and to appreciate the advisability of conserving them. The history of the Everglades in Florida provides a clear illustration of the errors that have been made in wetland management. However, the opportunities still available to rectify these errors.

Wetlands have long provided a convenient way of refuse disposal. Most contain flowing water, which has been perceived as the ideal medium for carrying sewage and other waste away from human settlements. As societies became increasingly industrialized, the wetlands were considered the simplest solution to the problem of chemical waste disposal. Consequently, the lowland wetlands of the world became increasingly polluted as a result of human activity. The intensification of agriculture added to the problem as fertilizers and pesticides were added to the effluent. The dangers of these processes are now appreciated. It is realized that pollution of wetlands results in human health being put at risk as well as the survival of the wetland.

Air pollution is also responsible for the erosion of some upland peat lands, especially those downwind of industrial activities and dense urban areas. Pollutants kill some sensitive plant species, especially the bog mosses. With the growing populations, the development of sophisticated technical equipment has allowed drainage to proceed outcome is the loss of surface vegetation and the erosion of underlying peat by drainage water. Sheep grazing can add to the pressure and encourage the development of erosion gullies. Wetlands that have been damaged by drainage or erosion can be restored to their former state if they are properly managed. The rehabilitation of mires demands careful control of their hydrology by manipulating water levels, usually raising them by establishing dams. Early stages in wetland succession, such as marshes and fens, are relatively easy to reestablish. The ancient peat lands, including raised bogs are very much more difficult to recover. For this reason, the remaining of these types of wetland need to be protected carefully.

7. External and Internal value of Wetlands

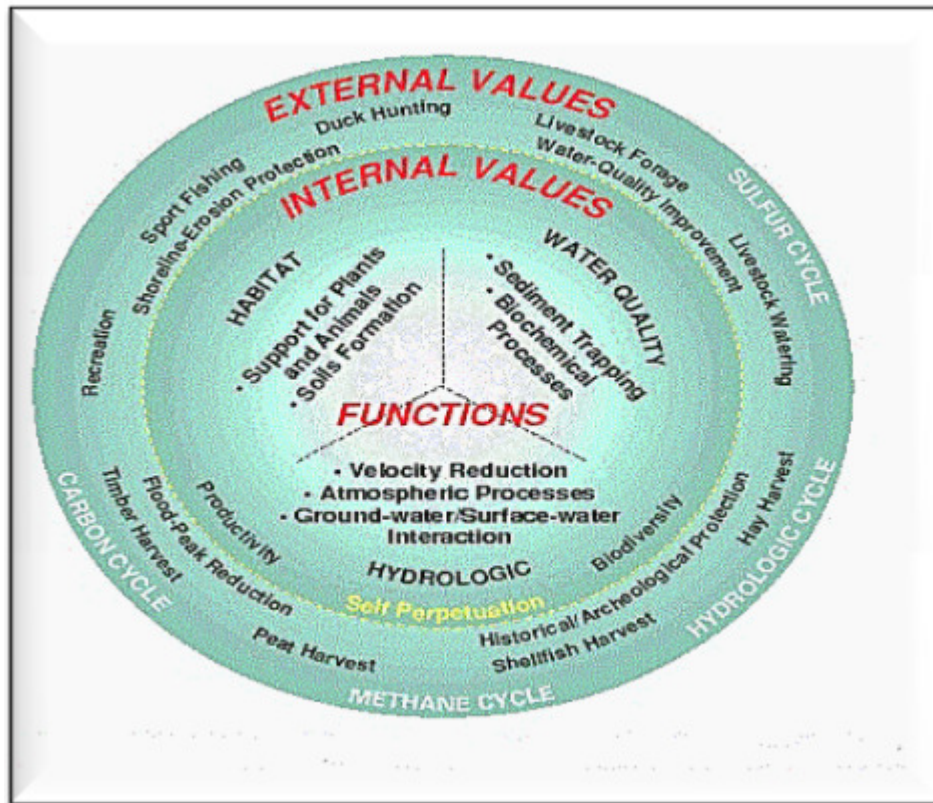


Figure 3

Source: [Online: web] accessed 17 JAN, 2016, URL:<http://www.everglades.national-park.com>

Undoubtedly, wetlands do have a future. Enlightened people are now aware of just how dependent human communities are on the wetlands. The processes of destruction and pollution that have accelerated in recent decades hopefully can be controlled. Some of the damaged wetlands can be restored to something approximating their former state.

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