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# THE EFFECT OF CLIMATE CHANGE IN/ON THE COASTAL AREAS

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Climate change is an important issue nowadays various human activities are making the world hot to hotter. The ultimate result is global warming, i.e. climate change (Obeysekera & Park, 2012:4). The humans are the main cause of global warming, and major changes are already being observed. Globally mean temperature is 0.8°C above pre industrial levels; oceans have warmed by 0.9°C since the 1950s and are acidifying, sea level rose by about 20cm since pre-industrial times and is now rising at 3.2cm predecade. Despite the global community's best intentions to keep global warming 2°C increase above pre industrial climate, higher levels of warming are increasingly expected. Scientists agree that countries current UNFCCC emissions pledges and commitments would most likely to result in 3.5 to 4°C warming. And the longer those pledges remain unmet, the more likely a 4°C world becomes. (World Bank Report, 2012: V). The Environmental Protection Agency (EPA) now predicts a global sea level rise of about 10 to 15 inches by the year 2025 and an additional 20 inches to more than six feet by 2100. Continued growth of greenhouse gas emissions and associated global warming could well promote sea level rise of 1m-3m in this century, and unexpectedly rapid breakup of the Greenland and West Antarctic ice sheets might produce a 5m sea level rise. Sea level rise poses a greater threat to countries with heavy concentration of population and economic activity in coastal regions. Until recently, studies of sea level rise (SLR) typically predicted a 0.1-meter rise during the 21$^{st}$ century (Dasgupta et.al. 2007:3). Rising sea levels have a major impact of climate change and are likely to impact many million of people by the year 2100 (Church et al., 2008:3). According to the IPCC's Fourth Assessment Report, there is strong evidence that global sea level gradually rise in the 20$^{th}$ century and is currently rising at an increased rate and it appears that the changes occurring in ocean system today are broadly consistent with the effects of warming due to anthropogenic climate change (http://www.irgc.org/wp_content/uploads/2012/04/ emerging_risks.pdf as assessed on 10$^{th}$ September, 2013).Sea level has been rising slowly over the past 100 years. Even if the concentration of green house gases in the atmosphere can be stabilized by 2100. Sea levels will continue to rise for many centuries. The thawing of the

Greenland ice sheet which is likely to set in with an increase in temperature of more than 2°C would continue for even thousands of years and cause sea levels to rise by about 5 meters (Butzengeiger & Horstmann, 2004:3). As a result of global warming, the total volume of sea water is expanded in the following three ways, which further raise the sea level. Firstly, though scientists expected thermal expansion more responsible for sea level rise, but it accounts for only about 10 percent of the current rate of sea level rise. Second, increase in the volume of water converged from lakes, ground water and mountain glaciers which flow to the sea because of global warming make up about 35 percent of sea level rise. Third, the sea level rise mainly resulting from accelerated ice, melting of the ice sheets in Greenland and Antarctica, contributes about 50 percent of the total sea level rise (Chen, 1997: 925).

Rising temperature causes sea level rise and affects low lying coastal areas and deltas of the world (Sarwar, 2005: 4). Coastal areas and small islands are among the most densely populated parts of the world and they would be most threatening with rising sea level. Sea level rise could have a number of physical impacts on coastal areas, including loss of land due to inundation and erosion, increased flooding, and salt water intrusion. These could adversely affect coastal agriculture, tourism, freshwater resources, fisheries and aquaculture, human settlements and health. Rising sea level threaten the survival of many low-lying island nations such as the Maldives and Marshall Islands (Chahal et al., 2010: 77). Many million people are projected to be flooded every year due to sea level rise by the 2080s. Those densely-populated and low-lying areas where adaptive capacity is relatively low and already facing other challenges such as tropical storms or local coastal subsidence are especially at risk. The number of affected will be largest in the mega-deltas of Asia and Africa while small islands are especially vulnerable. Nearly 75 percent of Americans live on or within 50 miles of the coast (www.ipcc.ch). In Oregon, Coos Bay would be one of the estuaries with potential for serious harm. Even as we bear down on the 21$^{st}$ century, there's no high-tech solution to these problem (http://www.oregon.govt/dsl/SSNERR/docs/EFS39risesea.pdf as assessed on 11 September, 2013).

Current prediction for sea level rise over the next 100 years indicate that human settlements in the Gulf of Guinea, Senegal, Gambia and along the East African coast, including the Western Indian Ocean islands would be at high risk of flooding and land recession. Bangladesh, a country crowded around the subsiding delta of the Ganges, Brahmaputra and Meghna rivers, is one of the most vulnerable to sea level rise. A 1m rise in sea level could displace more than 13 million people from their homes (Nunn, 2005: 60-61).

In 1999, two uninhabited islands, Tebua Tarawa and Abanuea in the South Pacific were submerged under rising water. Small islands nations such as the Maldives, a chain of 1200 islands in the Indian Ocean, are considered highly vulnerable to a rise in sea level. About 80 percent of the Maldives is less than 1m above sea level, and the country's highest point is only 2m above sea level. As sea level rise, storm surges could easily sweep over entire islands (Raven et al., 2012-391). Rising sea level also serious concern in South Corolena. Low-lying regions and heavily developed coastal zones with dense population are particularly vulnerable to extreme sea levels. It estimated that about 40 million people, 0.6

percent of the global population, are exposed to coastal flooding every year (Obeysekera & Park, 2012: 1).

**Oceans at Risk**

The oceans are major component of the climate system. They cover about 71 percent of the earth and absorb about twice as much of the radiation as the atmosphere of land surface (Chahal et al., 2010: 75). The oceans played an important role in regulating the climate change and moderating weather system around the world. Climate change also impact on the functioning of ocean, coastal and inland ecosystem. (Boojh, 2010: 9). The oceans currently absorb about 80 percent of the heat added to climate system by global warming. As the temperature of water increase, water expands. This is one of the reasons for rising sea level and changing intensity of storms, especially hurricanes (Chiras, 2012: 453-54). Ocean warming may result in increased stratification and changed circulation patterns of ocean currents; decrease the amount of sea ice, increase coral bleaching and mortality (Boojh, 2010: 9). As a consequence of sea level rise due to global warming, the environmental scarcity may be more severe, resulting in frequent disasters like cyclone, storms and floods (Gaan, 2012: 15). Climatologists believe that the oceans currently absorb about 30 to 50 percent of the $CO_2$ emissions created by the burning of fossil fuels. Current atmospheric levels of greenhouse gas would be much higher, probably between 500 and 600 ppm, if the ocean were not a large $CO_2$ sink.

The reaction of $CO_2$ with seawater reduces the availability of carbonate ions that are used by various marine biotas for skeleton and shell formation in the form of calcium carbonate (World Bank Report, 2012: 11). Disruption of the ocean ecosystems because of warming and ocean acidification presents many emerging high-level risks. It will severely impact the tropics by 2030-2050 when all reefs of the world will be under increasing acidification stress (World Bank Report, 2012: 60).

**Glacier Melting**

As overall temperature of earth increased, a major thawing of glaciers and the polar ice caps has occurred. There is a lot of concern about the impact of global warming on glaciers. Two leading glaciologists have estimated that the entire West Antarctica ice sheet, the largest marine-based glaciers could enter the ocean in 200 years according to one estimate and 500 years by the other estimate, raising the mean sea level by seven meters (Asthana and Srivastava, 1993: 137). Greenland is now losing ice rapidly, and Antarctica is beginning to lose ice at a rate of about 150 cubic kilometers a year. Eventually the situation will reach a point, where the dynamics of the system begins to take over. When the ice sheets begin to collapse, the tipping point will have passed, causing ice sheets to end up in the ocean (Ray, 2011: 7).

In most part of the world glaciers is retreating; some glaciers are retreating rapidly more than 20 meters per year. In the past 50 years, many Himalayan glaciers have retreated more than 10 meters per year; In the last 25 years the Gangotri glacier has retreated by around 500 meters it is retreating at the rate of 4cm a day. In the Himalayas, small glaciers have been retreating rapidly (Srinivasan, 2010: 33). According to the World Watch Institute, 113 of Glacier National Park's 150 glaciers have completely melted since 1850; the

remaining 37 are retreating so rapidly that they will probably be gone by 2030. At the current rate of retreat all of the glaciers in Glacier National Park will be gone by 2070. (Raven et al., 2013: 390). If all the ice in Antarctica melted, due to global warming, it would raise the level of the world's oceans by over 200 feet (60 mtrs). Over the longer term higher global current temperatures are expected to generate higher ice cap flow rates and more ice-bergs, which are expected to raise sea level by 3 feet, or about a meter, in the next century. (Dhillon & Bath, 2010: 357). Warming related damage in Antarctica glaciers is happening faster than even scientists have predicted. If Antarctica ice sheet melted, the world oceans would rise by 60 to 65 meters (200-210 ft) (Dhillon & Bath, 2010: 358). One-meter ice melting in polar area is sufficient to raise the global sea level 40mm higher.

**Global Warming and the Coastal Areas**

Rising temperature in the atmosphere causes sea level rise and affect low lying coastal areas and deltas of the world. Long term global warming creates major implications along the coastlines. About half of the population of the world lives in coastal zones and about 50 million people each year experience flooding due to storm surges. As the sea level rises and the population increase, more and more people become vulnerable to coastal flooding. The rising sea level particularly threatens island nations. (Botkin & Keller, 2012: 412).

Those densely-populated and low-lying areas where adaptive capacity is relatively low, and are already facing other challenges such as tropical storms or local coastal subsidence, are especially at risk. The number of affected will be highest in the mega-deltas of Asia and Africa while Small Island are especially vulnerable (IPCC, 2007: 12). Sea levels in Asia will rise by at least 40 cm by 2100, resulting in flooding of vast areas on the coastlines, including of the most densely populated cities, whose populations will be forced to migrate inland (Chahal et al., 2010:66).

**ENVIRONMENTAL REFUGEES OR (CLIMATE REFUGEES)**

Climate change by displacing settled populations is creating a new kind of refugees also known as environmental refugees. Any climate change induced rise in sea levels, displaces people from low-lying areas. The IPCC concluded in 2007 that expanding ocean water, driven by climate change would drive up sea levels, on average 18 to 59 cm by 2100, depending on the level of greenhouse gas emission in the atmosphere. Climate change also contributes to increasing number of typhoon erosion in coastal region and salination of inland freshwater and aquifers. These all contribute to displacing people in large number from coastal or low-lying regions and have already led to an increase in the number of involuntarily displaced population known as environmental refugees (Ray, 2001: 70). It is already occurring in some parts of the world, such as the Pacific Island nation of Kiribati and remote villages in Alaska, two uninhabited islands disappeared under water in 1999. One more reason for forced migration is that rising sea levels resulted in the loss of agricultural land due to permanent submersion, or to frequent flooding causing salinity of the water table and making the soil unproductive. Such effects are likely to be particularly bad in developing countries in south and south-east Asia. It is feared that rising sea level could create large number of environmental refugees which could possibly to significant domestic and

international tensions (http://www.irgc.org/ wp-content/ uploads/ 2012/04/ Emerging_Risk_Sea_Level_Rise.pdf as assessed on 10 September, 2013.

The catastrophe facing low-lying coastal communities was first highlighted in November, 2003, when a total evacuation of the Carteret islands was authorized and funded by the government of Papua New Guinea, referred to as the world's first environmental refugees. In 2005, more than 5,00,000 inhabitants of Bhola island in Bangladesh became homeless and moved into slums in Dhaka, as about half of the territory was submerged into sea because of flood. The Bangla coastal areas would be expected to inundate 3 million hectares, displacing another 15-20 million people (Balakrishnan, 2009:7). Sixteen of world's twenty mega-cities and over 10 million people are at sea level, thus vulnerable to sea level rise. It also leads to homes and communities being destroyed and people seeking for safer places to settle down. Floods and tidal waves in North Korea from 1995-2000 lead to 3,00,000-4,00,000 people migrating to China's urban centers (Yoskowitzet al., 2009: 9-10).

Four million, three hundred thousand people migrated from the Philippians lowlands to the center uplands from 1970-90s due to flooding, land slides and pack of useable water. Uzbekistan and Kazakhstan around the Aral Sea since 1970s has experienced lead to the migration of 65,000-1,00,000 people annually. Inundation and flooding in the Caspian Sea region of Kalmykia has led to 2,200-81,000 people migrating to Russia in the 1990's. Hurricane Katrina led to the migration of about one million people (Gaan, 2012:10-11). It important to note that not only will house holds and families be displaced by rising sea levels but a significant amount of infrastructure specifically buildings will be impacted as well (Yoskowitz et al., 2009: 12).

**Impacts on Agriculture**

The net result of sea level rise on agriculture is likely to be negative. Salinity intrusion due to sea level rise will decrease agricultural production. Salinity also decreases the terminative energy and germination rate of some plants (Sarwar, 2005: 19). Food shortages are likely to be exacerbated still further by sea-level rise through permanent flooding of prime agricultural lands (Myers, 1993: 754).The coastal zone is very favorable for pulses, oil seeds, rice and vegetables production, which will fall gradually. Sea level rise with adding more salinity to the water and soil of the area will decrease production of the mentioned various other crops. Sea level rise affects agriculture in three ways, i.e. by salinity intrusion by flooding and by increasing cyclone frequency and its depth of damage. Combined effects of these three factors decrease agriculture production in the coastal zones. Decreased agriculture will cause decreased GDP.

More than 30 percent of the cultivable land in Bangladesh is in the coastal area. Agriculture is the single largest component of South's economy. It depends heavily on agriculture making a significant contribution to its GDP. The rising sea levels when combined with increasingly erratic patterns of rainfall will have a direct impact on food security. It will inundate fields near the coastlines. Additionally, the threat of flooding from swollen rivers due to the melting of glaciers in the short run but subsequently leads to its drying up. Rise in sea level leads to salt water ingression in the coastal lands and makes it unsuitable for conventional agriculture (Ray, 2011: 42). Agriculture in low-lying areas is

likely to become increasingly difficult to sustain. The increases in degree of salinity due to saline water intrusion, normal crop production become very risky.

**Border Disputes**

For all the heat generated by discussion of global warming in recent time, it is an often-overlooked fact that climate change has the potential to create border disputes that in some cases could even provoke clashes between states. Yet such a scenario is becoming increasingly likely as a glacier around the world melt, blurring international boundaries. The phenomenon is already pushing European and Africans to redraw their borders, Switzerland and Italy were forced to introduce draft resolutions for fresh border demarcation after Alpine glaciers started melting at greater pace. For instance, the Siachen Glacier the largest glacier outside the Polar Regions, which is the site of a major bilateral dispute between India and Pakistan. It melts at the rate of about 110 meter a year among the fastest of all glaciers in the world. Himalayan glaciers will inevitably induce changes to the McMahan Line (Sharma, 2010: 1-2).

**Impact on Ecosystem:** Coastal ecosystems are one of the highly productive dynamic and fragile ecosystems on the earth. The effects of rising sea levels will lead to a loss of ecosystems such as wetlands, loss of coastal vegetation and habitats (Noronha, 1993: 233-34). Mangrove ecosystems are valuable asset on our long coastlines. The Sunderbans, situated is the east in the largest mangrove in the world, extending over 5,77,356 hectares. Climate change affects the saline content of water thereby also affecting flora and fauna. The rise in sea level leads to permanent submergence of roots and pneumatophores (Lokanathan, 2013: 41). Bangladesh, a large section of the country is low-lying and will be drowned by the predicted rising sea levels. Already some islands in the Sunderbans area in the Gangetic delta, the largest single block of tidal halophytic mangrove forest of the world, and in southern parts of the country have disappeared. A recent World Wildlife Fund report forecasts that sea level would rise 11.2 inches by 2070. This would result in shrinkage of the Bangladesh's Sundarban by 96 percent within a half century, thus reducing the tiger population (Ray, 2011: 43). In Coral reefs ecosystems are broadly covered by the IPCC report to their high sensitivity to slight changes in parameters affected by climate change, such as a water temperature and ocean acidity. As a result of climate change, thermal threshold could be exceeded, resulting in bleaching and high mortality in many of these ecosystems. The deterioration of these environmental assets may cause a decrease in the number of visitors to nearby coastal or island regions. (Sanchez, 2010:155)

**(i) Physical Impacts**

Most of the world's sandy shore line retreated during the past century, erosion and sea level rise is one underlying cause. One half or more of the Mississippi and Taxas shorelines have eroded at average rate of 3.1 to 2.6 m/yr since the 1970s while 90 percent of the Louisiana shoreline eroded at a rate of 12.0 m/year. In Nigeria, retreat rates up to 30m/yr are reported. Coastal squeeze and steepening are also widespread as illustrated along the eastern coast of the United Kingdom, where 67 percent of the coastlines experienced a landward retreat of the low-water mark over the past century (Nicholls et al., 2007: 324). An

acceleration in sea level rise will widely exacerbate beach erosion around the globe. The combined effects of beach erosion and storms can lead to the erosion or inundation of other coastal systems. Although inundation by increases in mean sea level over the 21st century and beyond will be problem for unprotected low-lying areas, the most devastating impacts are likely to be associated with changes in extreme sea levels.

**(ii) Salinity Intrusion**

The main impacts of sea level rise on water resources are fresh water availability reduction because of salinity intrusion. Both water and soil salinity along the coast will be increased with the rise in sea level, destroying normal characteristics of coastal soil and water (Sarwar, 2005: 15).Saltwater intrusion is a serious environmental issue since 80 percent of the world's population live along the coast and utilize local aquifers for their water supply. International organizations have identified saltwater intrusion as one of the major environmental issues faced by several coastal cities in India, China and Mexico; if the sea-level rise becomes greater than 48 cm over the next 100 years then several local well fields would be vulnerable to chloride contamination. It is widely assumed that this rise will have adverse impact on saltwater intrusion processes in coastal aquifers. (Chang et al., 2011: 1284). Native palms in the Waccasassa Bay state preserve on Florida's gulf coast are being killed off by exposure to salt water associated with sea level rise. Pine trees in the Florida Keys have been damaged by saltwater intrusion into the ground water (Fiedler et al., 2001: 7). Salinity is a matter of great importance in Bangladesh as the coastal zone is extensively affected by salinity. The direct sea level rise will be intrusion of salinity with tide through rivers and estuaries. Fresh groundwater supply for human and industrial consumption is also affected by salinity (Gaan, 2012: 19).

**(iii) Biodiversity and Coral Reefs**

The impact of climate change on the biodiversity of marine, coastal and island will have very devastating consequences. The coral reefs will likely become early victims of global warming. The small island nations like Maldives are already facing huge problem in term of loss of coral reefs and another marine biota (Boojh, 2010: 7). Coral reefs as bedrock of the marine ecosystem. Coral reefs can survive only with in a narrow range of temperature, salinity, and water quality. The predicted changes over the next 100 years will likely exceed that limited range, and coral and associated tropical marine organisms will probably not survive under the new conditions. Reefs are already dying off from a combination of factors, including warmer water temperature (Fielder, 2001: 8).

Coral cover had more than halved due to storms, predatory starfish out breaks and bleaching linked to climate change over the past 27 years in the Australia's great barrier reefs (The Hindu, 2013). Coral reefs are systems that include the corals, symbiotic organisms living within the reefs, and other organisms. Coral are impacted by climate change in the two ways, acidification and temperature increases. $CO_2$ reacts with water to form carbonic acid, $H_2CO_3$; it has made the ocean more acidic. Coral researchers expect that many of earth's corals will die from the combined effects of ocean warming and acidification. In 1998, scientists documented the most geographically extensive and severe epidemic of coral bleaching over observed; about 10 percent of the world's corals died that year, in many cases

from viral, bacterial, or fungal infections. (Raven et al., 2013: 393). About 27 percent of the world's coral reefs have already disappeared. Researcher fear 70 percent of the reefs close to large population centers will disappear in the next 50 years (Garrison, 2002: 480).

**Economic Impacts**

Climate change has affected the global world in many different ways, its effects on coastal areas can be seen in the form of sea level rise; which alters the whole system in coastal areas. Its economic impacts pose great challenges for the coastal area's future. In today's globalized economy cities and those coastal areas are critical to international trade and commerce and any disruption to important port cities would have widespread ramification alongside port infrastructure, inland infrastructure such as road, railways and airports in low-lying regions are vulnerable to loss on damage. Travel and tourism, would also severely affect the GDP (http://www.irgc.org/wp_content/uploads/2012/04/Emerging-Risks-Sea-Level-Rise.pdf as assessed on 10 September, 2013). Almost without exception, international airports, roads and capital cities in the small islands of the Indian and Pacific Oceans and the Caribbean are sited along the coast or on tiny coral islands. Sea level rise will exacerbate inundation, erosion and other coastal hazards threaten vital infrastructure, settlements and facilities and thus compromise the socio-economic well-being of island communities and states (IPCC, 2007: 689). Fisheries make an important contribution to the GDP of many island states. Changes in the occurrence and intensity of events are likely to have severe impacts on commercial and artisanal fisheries (IPCC, 2007: 690).

The fourth assessment report of the IPCC concludes that climate change vulnerabilities are greater in "certain high-risk locations, particularly coastal and riverine areas, and areas whose economies are closely linked with climate sensitive resources such as agricultural and forest product industries, water demands and tourism (Khan and Awal, 2009: 30). The loss of coral reefs, coastal estuaries and associated fisheries will also harm the state's economy.

**Impacts on Tourism**

New studies confirm previous findings that the effects of climate change on tourism that can to be direct or indirect. (Sarwar, 2005: 22). Tourism is the major contributor to GDP and employment in many small islands. Sea-level rise and increased sea water temperature will cause accelerated beach erosion, degradation of coral reefs and bleaching. In addition, a loss of cultural heritage from inundation and flooding reduces the amenity value for coastal users. Whereas a warmer climate could reduce the number of people visiting small islands. Water shortage and increased incidence of vector borne diseases may also deter tourist (IPCC, 2007: 689). Tourism is a major economic sector in many small islands, and its importance is increasing. Since economies of many developed and under developing countries or regions depends highly on tourism, the impacts of climate change on tourism resources especially in small islands will have significant effects.In Bangladesh tourism sector of Kuakata will suffer the most because all the facilities are very close to the coastline and the area is more vulnerable. Malaysia may also face larger infrastructure loss due to rise in sea level. The sustainability of island tourism resorts is expected to be compromised by

rising sea level beach erosion and saline contamination of coastal wells, a major source of water supply for islands resorts (Cooper et al., 2005: 22).

Coastal regions are the major tourist destinations in Europe and more specifically in the Mediterranean. Despite the common opinion of a growing importance of cultural and nature-based tourism, closeness to the sea remains as a major selection criterion. Climate and scenery are the predominant motives for choosing the holiday destinations. The IPCC and the UN World Tourism Organization has also pointed to tourism in the Mediterranean region as a major vulnerability hot spot to climate change. It is concluded that the increase in temperature is one of the major threats to Mediterranean tourism (Sanchez, 2010: 53). The Balearic Islands autonomous community is situated on the east coast of mainland Spain, in the Mediterranean Sea. The Balearic Islands are increasingly facing new challenges that jeopardize the economic sustainability of the tourism industry. Impacts associated with increasing temperature, changing precipitation patterns and sea level rise will very likely to have important consequences for the tourism industry (Sanchez, 2010: 135).

**Human Health**

Coastal communities, particular in low income countries, are vulnerable to a range of health effects due to climate variability and long-term climate change, particularly extreme weather and climate events such as cyclones, floods and droughts. Marine ecological processes linked to temperature changes also play a role in determining human health risks, such as from cholera and other enteric pathogens, HABs and shellfish and reef fish poisoning (Nicholls et al., 2007: 334). Most of the germs that cause water-borne disease, such as viruses, bacteria and protozoa, survive longer in warmer water. Bacteria also reproduce more rapidly in warmer water. Some water borne diseases, such as hepatitis, that can cause serious and long-lasting illness. Vector-borne diseases, as the mosquito transmitted west Nile Virus, which has recently caused several deaths in Florida (Fiedler, 2001: 12). Cholera is an infectious disease of the small intestine of human beings and is common in the coastal area. Increased salinity in the coastal zone will decrease food production in the area, causing malnutrition in the coastal people. So, sea level rise will accelerate water born diseases and malnutrition in the coastal areas. The degree of probability of cholera and the depth of malnutrition is a matter of further research (Sarwar, 2005: 23).

**Impact on Salt Industry**

Salt mills are also located very close to the coastline. A one-meter sea level rise will inundate all the salt fields and will ruin the sectors. Salt farmers can't move upward lands for the purpose because, physical properties of the soil of the present salt field will not move backwards with sea level rise. Bangladesh is one of the salt producing countries of the world. Cox's Bazar coast of Bangladesh coastline is suitable for salt production. All the activities of salt production that are carried out by farmers i.e. reservoir, condenser and crystallizers are performed in the close area of the coastline, therefore sea level rise pose high risk to the salt industries as well as farmers financial condition. About 20 million people are directly or indirectly revolved in salt production. Sea level rise, by inundating salt fields will render huge number of people unemployed. A large population will try to find alternative profession, which is very hard or even impossible (Sarwar, 2005: 22).

**Impacts on landmass and settlement**

Land loss leads to loss of agricultural land, homestead, road and other communication infrastructures and loss of wide range of biodiversity. One of the major causes of land loss is erosion. Sea level rise initiates erosion by raising water level. Raised water level wash out the loose top soil of the coast, making the coastal regions steeper. Back water effect is accelerated by sea level rise that also cause erosion. Silt or other particles eroded from the surrounding areas are deposited when the lowlands of the coastal areas are filled with water. Sea level rise will play important role in erosion processes in the coastal zone (Sarwar, 2005: 21). Sea level rise will make coastal development, infrastructure and residents increasingly susceptible to inundation, erosion, storm-induced flooding. It is estimated that from 12,950 $km^2$ to 22,900 $km^2$ of coastal land is in danger of permanent inundation in the United States assuming a 1m rise in sea level. It is also estimated that 1 to 3 percent of the land area of New Jersey, or between 170-442 $km^2$, will be inundated over the next century. Approximately 19.5 $km^2$ of developed shoreline lie below 0.61 m of current sea level and 60 $km^2$ lie within 1.22 m. There is 50 percent chance that nearly 20 $km^2$ of developed shoreline will be appreciably affected by permanent inundation during the $21^{st}$ century. Flooding associated with storm events has produced devastating effects along the coast. It is predicted that 25 percent of homes and other structures within 152 m of the US coast and the shores of the Great Lakes will be taken by the effects of coastal erosion during the next century. Intense storm events can cause dramatic shoreline erosion and recovery process can last multiple decades (Cooper et al., 2005: 14-15).Sea level rise is a significant and growing threat to the coastal areas. Increasing rates of sea level rise caused by global warming are expected to lead to permanent inundation, episodic flooding, beach erosion and saline intrusion in low-lying coastal areas. Sea level rise has altered the physical and ecological composition of the coast. Shorelines have long accreted and eroded, barrier islands have disappeared and reformed, and wetlands have migrated inland (Cooper et al., 2005: 26).

**Conclusion**

Climate change now presents a significant threat to coastal and marine ecosystems. This will result in a range of impacts including increased flood risk and submergence, salinization of surface and ground waters, and morphological change, such as erosion and wetland loss. Coasts are experiencing the adverse consequences of hazards related to climate and sea level rise. Coast is highly vulnerable to extreme events such as storms, which impose substantial costs on coastal societies. Annually, about 120 million people are exposed to tropical cyclone hazards, which killed 2,50,000 people from 1980 to 2000. The timescales of ocean warming are much longer than those of surface air temperature rise. As a result, sea level rise due to thermal expansion is expected to continue at a significant rate for centuries, even if climate is stabilized. Continued growth of greenhouse gas emissions and associated global warming could well promote sea level rise by 1m - 3m in this century, and unexpectedly rapid breakup of the Greenland and West Antarctic ice sheets might produce 95m sea level rise. Sea level rise will affect coastal habitats such as estuaries, Creeks, marshes, managed wet lands, hammocks, sand dunes and beaches by modifying patterns of sea water encroachment, flooding, erosion and deposition.

Main strategies that need to be put in place to ensure security of coastal regions, First, construct the embankment in vulnerable areas, stabilization of embankment slope, and create drainage through the embankment to drain out high tide water. To prevent the intrusion of saline water construct sluices and also planned desalination project of river water in coastal areas. But there are minimal solutions at an individual level that can minimize suffering and loss of life and income streams. Both decisions at global and local level are needed to mitigate the global warming. Lack of mitigating efforts pointed out that to combat global warming no country has a self-interest because it will have negative impact on its current economic development. Rising earth's temperature is not a hoax, so we need to adopt mitigation and adaptation policies as soon as possible so that we can protect our coasts and fragile ecosystem because disastrous can't wait for any safety efforts. For too much delay means that the option of adaptation is no longer exist. So, global initiative should be taken, as it is a global problem, to a greater extent.

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