



Impacts of Climate Change on Coast Line of Arabian Sea: A Case Study of Indus River Delta, Pakistan

N. H. CHANDIO*, M. M. ANWAR**, Q. H. MALLAH**

Department of Geography, Shah Abdul latif University, Khairpur

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Abstract: Indus delta is facing lot of troubles since last twenty years due to climate change and sea level rise of Arabia Sea. The sea water intrusion is continually moving towards the coastal belt of Sindh Province. It is observed that sea water intrusion is moving sub-surface also. Fertile soil of the area is converting infertile land. Agriculture, fruits, vegetables, flora and fauna and ecosystem of the Delta is disturbed. Mangroves forest is slowly washed away from the area. It is reported that rate of Sea water intrusion is 80 acres per day and 38 percent mangroves forest has been removed in last twenty years. Increased stormy circumstances at the coast line of the Arabian Sea have given rise to the increased tidal activity. Along the coast line, increased to- and fro motion of tides and waves continue encroaching the shoreline posing threats to agricultural land, infrastructure and development activities. In summer, generally southwesterly winds prevail along the coastal areas of Sindh which bring monsoon rains to the area. Dynamics of south westerly has increased significantly producing enhanced precipitation over southeastern parts of the Sindh province. As that wind act the coast from south therefore their increased force has been rapidly eroding the soil/land along the coast due to the tides and strong waves. Continuity of storm acts with sea surface depressions cause significant damage. The latest research shows that fresh water availability in the River Indus, Tidal Link canal and mangroves forest may push backward the sea water intrusion and will help for the restoration of the Indus delta and its economy.

Keyword: Climate change, Coast line, Arabian Sea, Indus River Delta, Pakistan

1. INTRODUCTION

Climate change and sea-level rise

Climate change and its impacts are originating overall the world; especially its impact on developing countries can measure clearly. It is perilous for life of the Earth that average temperature of the Earth is slowly increasing, about 01⁰c is increasing after 30 years. Current average temperature of the earth is 15⁰c but between 1961 and 1990, the annual average temperature of the globe was 14.0⁰C. (Clark, *et al.*, 2004) Key impact of climate change is melting of Glaciers and its related problem is sea level rise. It is not problem of pacific, Atlantic or Indian Ocean, but almost enormous water bodies of the world are connected to each other, so that all oceans are facing this problem. Glaciers are spread on 10% area of the world and their dominancy is able to see on the peaks of Mountains. The best evidence of the melting Glacier is Mountain Kilimanjaro in Africa; it is near the Equator and highest peak of any continent at equator as shown in (Fig. 1).

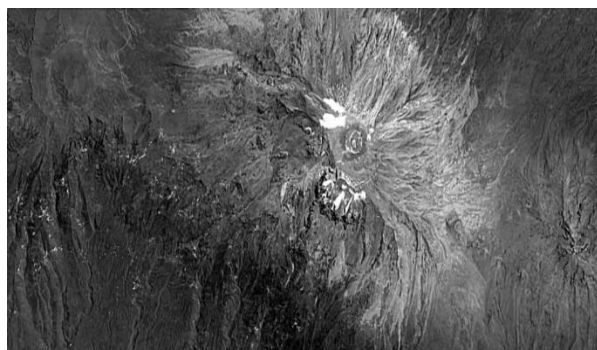
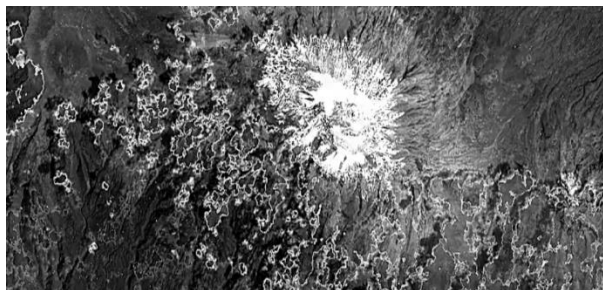
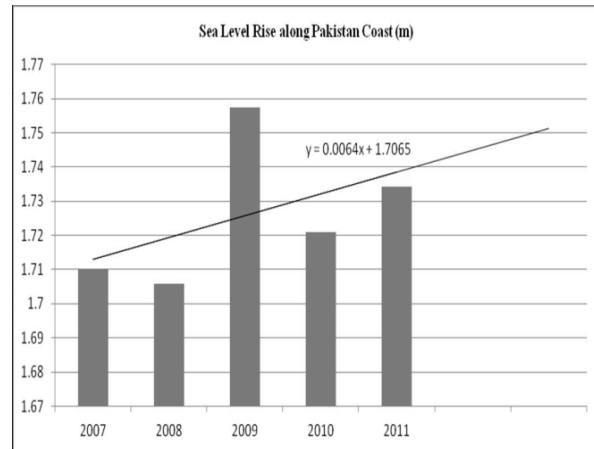
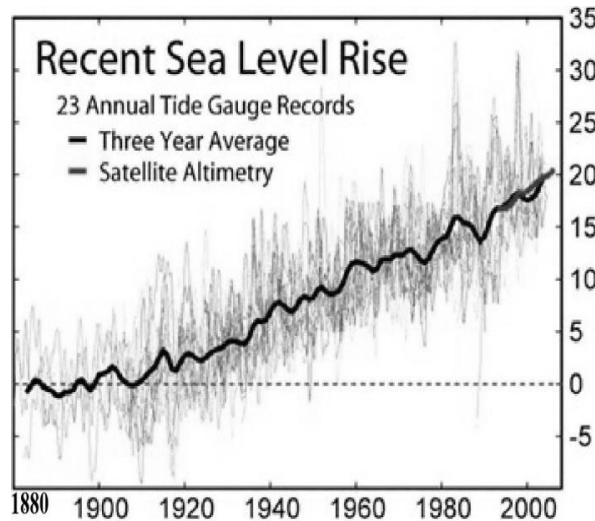


Fig. 1, Showing the peak of Mt. Kilimanjaro is covered by snow in 1984 and the snow has been removed in 2016

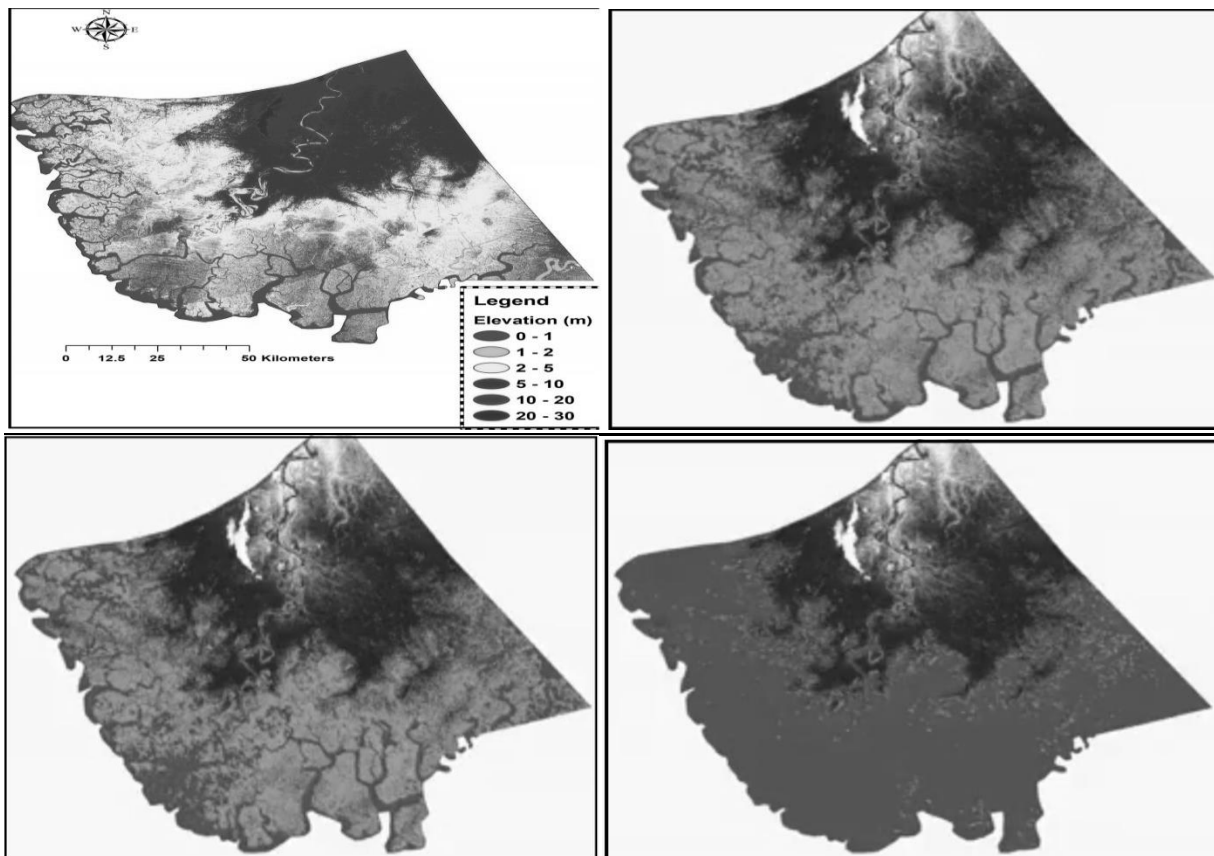
In last decades Mountain Kilimanjaro was hidden by Glacier ice but now situation is entirely changed about 80% glacier ice is disappear from the mountain, if this melting of ice continues, glacier ice will removed within next coming decades. (Michael, 2006). This situation is not only at the Kilimanjaro, but Himalayas and Andes Mountains are also facing these types of problem. As the human population increased in mid of 19th century, sea level has risen due consumption of population. It is reported that in the 20th century, 15-20 cm sea level rose (1.5-2.0 mm/year) as shown in figure 3, but current satellite measurement is showing dangerous increasing in sea level rise, it is reached at 3.1 mm/year and continually rising year by year as shown in (Fig: 2), (Bruce 1997).

Small climate changes at coastal areas can change the coastal environments. More than 600 million population of the world are settled at coastal belts and that are living less than 10 meters above sea level. Therefore, that population directly has been impacted by sea-level rise. Apart from that 2/3 of the world's largest cities are also located at these dangerous areas. (Fig: 2).



Vulnerable of Sea water level for 1880 to 2000

The Indus delta is listed under the *Ramsar* convention on wetland, 1971, and is classified as the fifth largest delta of the world (Abbasi, 2002). It is situated at latitude 23. 59. 34 N, longitude 67° 24.34°E. The apex of delta has shifted its position southward several times. Once it was close to *Hyderabad*. At present it is South of *Thatta* (Mahar 2010), with seventeenth major creeks, it has extensive mud flats. Indus Delta consists of clay and other infertile types of soils, and it is very swampy. (Fig: 3).



Source: Siyal A.A, 2017

Intrusion of the Arabian Sea at Indus river delta, the vulnerable of sea-level rise (from 1992-2025)

The delta receives between 200-400 millimeters (mm) rainfall in a normal year. The rainfall is associated with the July to September Southwest monsoon, which brings an only 100-500 millimeters of precipitation. Climatic conditions are extreme, the average temperatures of the deltaic region, ranging from 70–85°F in July, and minimum temperature of the region is between 50-70°F in January (PMD, 2012). Maximum temperature recorded is 22°F (Brohi, 2004).

A report submitted by the IPCC that sea level rising impacts on environment of the coastal areas, like coastal soil erosion, sea water intrusion, flooding, degradation of mangroves forests, soil contaminations, fish productions and plants etc. It is very attentive that 26,000 sq:kms of land would be lost and sea level rise by 0.66 meters high, whenever the IPCC observed that as much as 33% of coastal land and wetland habitats are likely to be lost in the next hundred years if this situation will be continues at its present rate. In the world, (especially in developing countries) many countries have weak Geographical position such as Bangladesh, Maldives, India, Pakistan, Vietnam and China. Large numbers of populations of above countries are at high risk due to low lying coastal region like deltas, where river water enter in the huge water bodies. Toady's island of Philippines and Indonesia (Tuvalu and Vanuatu islands) are high risk due to its elevations. Apart from that islands of Maldives in Indian Ocean and Marshal Island in Pacific Ocean are facing this problem, but except the Indus delta, Geographical location of Pakistan is totally different to above mentioned countries.

Ocean water salinity

Because of rapid increase in human population equivalent of a third of human waste carbon dioxide mixed in ocean water. The increasing of carbon dioxide emissions from fossil fuel combustion have led to an exponential increase in the net amount of CO₂ being dissolved in the ocean. Over the past 200 years, the increase of carbon dioxide in ocean water reduces the ocean pH level.

Intrusion of Arabian Sea

It is reported that fresh water of Indus River irrigated to a few creeks and other creeks are filled with saline water of Arabian Sea. An area of delta is reducing from its original estimated area. The whole shoreline stretch over two districts of Sindh, *Thatta and Badin* districts has been badly affecting due to non-availability of fresh water. An area of the *Keti Bandar, Shah Banndar* and *Kharo Chhan* Sub-divisions are the most horrible. People of *Keti Banndar* and *Kharo Shhan* bringing drinking water from *Ghahro town*, about 15 kilometers away from the area. (Chandio, .2011).

According to a survey conducted by department of Revenue, Government of Sindh, over the 1,200,000 acres of fertile land is now under the sea water intrusion, in which eight coastal sub-divisions of the *Badin* and *Thatta* districts are mostly effected. Round about 3, 00,000 farmers of the Delta taking Rs 100 billion financial losses in agriculture sector so far. About 460,000 acres of fertile land in 72 dehs (villages) spread over 08 talukas of *Thatta* and *Badin* districts. These include 06 talukas in *Thatta* district, namely *Shah Bannder, Ghora Bari, Khoro Shhan, Mirpur Sakro, Jati and Keti Bander*. And 02 tehsils (Taluka) *Badin* and *Golarchi* (*Badin* district) are now under influence of the saline sea waters. Currently about 550,000 acres of fertile land of both the coastal districts are under effect of saline water. The population of the area migrated from the region toward the surrounding area (Memon, 2006).

Statistical data, after the construction of *TARBELA DAM*, shows decline of River water below *Kotri*. It has been decided between Pakistan and India by the composite dialogues over water dispute. Both countries decided that minimum 17 MAF water released below *Kotri Barrage* into Arabian Sea for the survival of Indus Mangrove forest. But this ratio was reduced to 10 MAF in 1991 accord (Rajpur, 2006).

Coastal Erosion:

Increased stormy circumstances at the coast line of the Arabian Sea have given rise to the increased tidal activity. Along the coast line, increased to- and fro motion of tides and waves continue encroaching the shoreline posing threats to agricultural land, infrastructure and development activities. In summer, generally southwesterly winds prevail along the coastal areas of Sindh which bring monsoon rains to the area. Dynamics of south westerly has increased significantly producing enhanced precipitation over southeastern parts of the Sindh province. As that wind act the coast from south therefore their increased force has been rapidly eroding the soil/land along the coast due to the tides and strong waves. Continuity of storm acts with sea surface depressions cause significant damage.

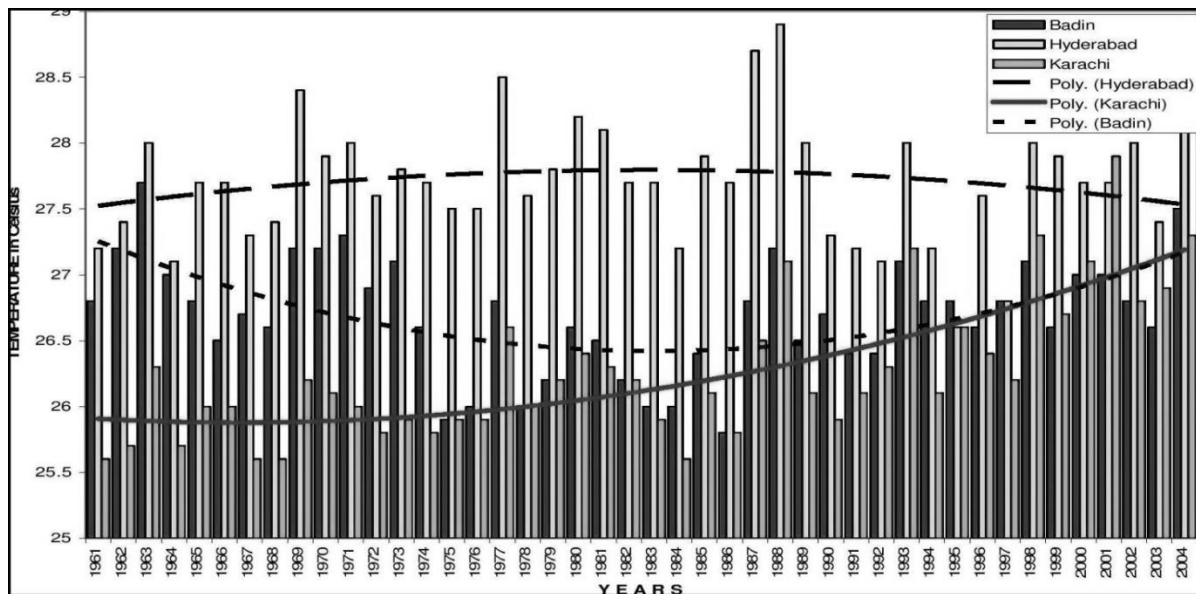
The effect of sea-level rise is able to see at Indus River Delta. The rate of sea- level rise along the coastal belt of Karachi is 1.1 mm per year. But it is predicted that this ratio will be double in coming century and will result in 200 to 500 mm rise in sea level of Arabian Sea (Tabrez *et al.*, 2008). The present trend continues the Indus Delta will modify as transgressed beach similar to San Francisco due to lack of sediment input and impact of erosion due to high energy waves (Haq, 1999). Indus River Delta is very fertile piece of land which helps all type of vegetation, crops and fruits for growth. But climatically, it is arid zone with high intensity of

temperature and rainfall. Pakistan enjoying all type of climate, like arid to humid and from sea-level to K2 mountain peak (Gohar *et al.*, 2010). The delta is facing lot of abnormal situations; flood and drought are main aspects of the region respectively. Flood occurs when heavy rain falls Northern Mountains of the country on the contrary droughts found during shortage of water and rain. Coastal rain found here during the season of tropical depressions and tropical cyclones (hot months) originated at Arabian Sea or Indian Ocean (Rasul *et al.*, 2005). Both flood and drought have increased considerably since the last decade. There is a complete consensus of the scientific community that frequency and intensity of such extreme events will further increase with the passage of time due to ongoing trend of global warming (Rasul, 2012).

2.

MATERIALS AND METHODS

The temperature data from 1961 to 2004 was recorded at three nearest metrological stations Badin, Hyderabad and Karachi. The collected data have furthermore been composed and arranged for the present surveys. Polynomial trend lines have been used to graphically indicate slants in data and to research issues in association with last 44 years climate circumstance and to predict future movements. In fact, Polynomial lines are curved type line that is used when weather data plotted. In this study, the temperature data of is extraordinarily fluctuating, that demonstrates the alteration in atmosphere change. In view to get to the general variability examples of air parameters in the Indus delta and its nearest area, the yearly midpoints of the temperature have been shown for the year to year clever connection concerning time and space as shown in (Fig. 4).



Fluctuation of temperature . Source: Mahar G.A 2010.

3. DISCUSS AND CONCLUSION

The acquired data of the study area shows the rising of temperature year to year. This change of the temperature has change the Geomorphology of the Delta. As global change of temperature is a main cause of the Sea level rise. So that Arabian Sea is also affected by this world scenario. The 44-years yearly normal patterns of the temperatures, reveal ascend in temperature as for recorded temperature at Karachi, Hyderabad and Badin.

There is a need to plan adaptation strategy that accommodates climate change, this will be based on the short term and long term monitoring studies as well as modeling projections of expected climate changes in Pakistan over the coming decades to evaluate the

corresponding impacts on the water inflows of our rivers and productivity and health of various ecosystems. Replantation of mangroves plant can reduce the risk of cyclones, tornado and other climate related disasters. A part from this, mangroves forest can reduce the environmental issues of the Karachi city, which is facing every year.

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