An overview of the opportunities and challenges in the Ganges-Brahmaputra Delta and the Bay of Bengal in reference to climate change impact

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Abstract

Ganges-Brahmaputra Delta and its extension in the Bay of Bengal is genetically related to delta progradation. Sediments of the Ganges-Brahmaputra Delta have been the principal source of opportunities in the perspective of georesources and ecosystem. Simultaneously the same sediments have been the major cause of many challenges this delta is facing since its formation. Terrestrial sediments from the Himalaya, deposited over the oceanic floor of the Bay of Bengal are the major source of oil, gas, gas hydrates, metallic and radioactive minerals in addition to all kinds of nutrients being supplied to the living organisms. Supply of more than one billion tons of sediments in the offshore delta every year provide opportunities in building prograding delta by accretion wherein one of the largest continental shelf advancing seaward through accumulating sediments to form numerous sand-bars and islands. However, all these opportunities are countered by the major challenges due to the recurring adverse events viz., massive siltation, inland and coastal flooding, deterioration of navigation routes, large scale land loss by bank erosion, submarine landslides, high pressure mud formation, free natural gas escape, cyclone, storm surge, saline water encroachment, security and pollution. These opportunities and challenges are not associated with climate change impact. Climate change is a natural phenomena that occurs in about hundred thousand years cycle of glacial and interglacial periods while the present Earth is passing through the interglacial period. The notion of climate change is an idea that circulates international diplomacy and domestic politics, and not the climate change in reality of the anthropocene time frame. Opportunities and challenges are associated with the variable physical and anthropogenic process operating in decadal to millennium time scale. The opportunities need to explore and nourish for the benefits of sustainable economic development. While, challenges are needed to face and manage by the good governance and by the proper professional human resource development and management.

Keywords: Opportunities; Challenges; Climate Change; Ganges-Brahmaputra Delta; Bay of Bengal

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1. Introduction

Ganges-Brahmaputra Delta, known as G-B delta, is one of the largest deltas in the world. This delta characterizes an unique combination of both geological and geographical character. Formation of the Bay of Bengal goes back to 185 million years that has led to the initiation of formation of the Ganges-Brahmaputra Delta in the Paleogene about 50 Ma ago. Gradual exhumation of about 2400 km east-west elongated Himalayan orogenic belt since Cretaceous about 65 Ma ago started delivering rich Tethyan sediments from this orogenic belt to the Bengal Basin over which Quaternary Ganges-Brahmaputra Delta started to form by the rapid sedimentation. The G-B delta with its ample opportunities has also been facing enormous challenges. Opportunities and challenges both are the characteristic attributes occur in composite form in this delta, of which, some are linked to the natural processes and some are linked to the anthropogenic processes. Climate, in general, the most fundamental natural element that controls life. All the forms and activities of human life are dependent on climate and environment. Equatorial activities of human life can not sustain in the polar region and vice versa. Adaptation to climate by the human generations is direct and indirect. When humans from their home climatic environment are moved to a new climatic environment simply they can not adopt to the new climatic environment. They are exposed to their new conditions which is clearly manifested in spite of all resources and knowledge available to their home climatic environment to apply in a new climatic environment. The basic ingredients of climatic environment are the temperature, rainfall, snow-fall, wind, water, sediments those regulate weather pattern. Variations in frequency and magnitude of these events between extreme high to extreme low do not represent a climate change. Climate change only occur between glacial and inter-glacial periods, hence would be referred to climate change when global climatic environment is changed from glacial to inter-glacial and vice versa. This requires about hundred thousand years to complete cycle (Fig. 1) (Kawamura et al., 2007).

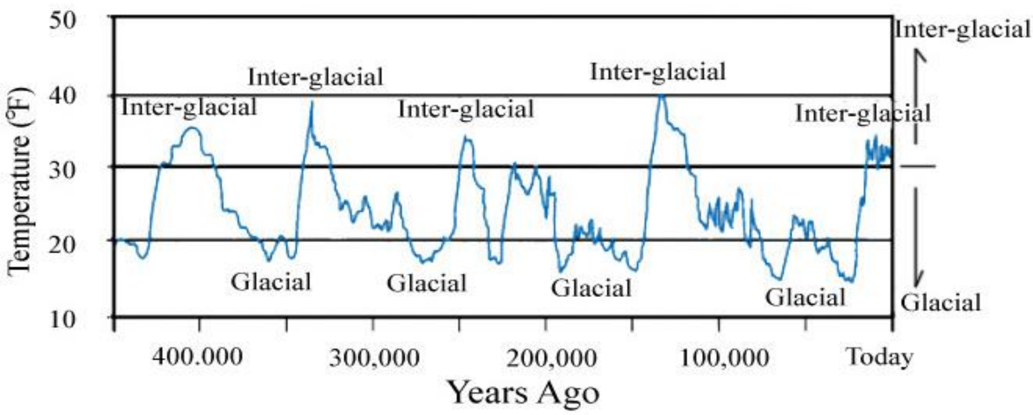

Figure 1: Global warming and cooling of climate system, intrinsically related to the glacial and inter-glacial period having distinct variations in temperature and other related weather components within each period. (Source: Kawamura et al., 2007)

Opportunities and the challenges are the integral part of the Ganges-Brahmaputra delta. Hence, this delta has been enriched by the various resources and many challenges. Holistic development and blue economy in the maritime sector of Bangladesh encompasses distinct two domains viz., the human domain and the natural domain including geologic one. Food, water, sediments and energy are the basic ingredients for human development (soft part of the development) that depend on sustainable development of blue economy, while, earthquake, tsunami, submarine mass avalanche, cyclone, storm surge, sea water encroachment and flooding are the hard part of the development those definitely hinder all economic development. But, all the challenges are needed to be transformed into opportunities in the Ganges-Brahmaputra Delta and Bay of Bengal region. This study is an attempt to focus on to the various opportunities and challenges that Ganges-Brahmaputra Delta and Bay of Bengal region may face, and to suggest mechanisms of transforming challenges to opportunities.

2. Climate and Climate Change

Before enumeration the opportunities and challenges, it is necessary to understand scientifically the United Nations Framework Convention on Climate Change (UNFCCC) that demands stabilization of greenhouse gas concentrations in the atmosphere at a level to prevent anthropogenic interference in the climate system. However, this study revealed that global climate system bears very insignificant or no anthropogenic interference. The very definition of climate change does not support that it is changing. Climate system defined in the third IPCC Working Group I Assessment Report (Stocker et al., 2013) is an interactive system consisting of five major components viz., the atmosphere, the hydrosphere, the cryosphere, the land surface and the biosphere. These components are regulated or influenced by the external forcing agents the most importantly is the Sun.

Climate system interacts with the changes in the atmosphere, ice, ocean, land surface and vegetation. These changes are due to the external forcing such as plate tectonics, Earth's orbital force and Sun's strength. CO_2 has wrongly been identified as the most dangerous greenhouse gas. In contrary, it is the water vapor which is responsible for heat trapping in the atmosphere and whatever warming the earth is being experienced. Study and ample data revealed that the Earth actually heading towards a mini-ice age and is not warming (Fig.2). The graph in the Figure 2 is posted in the following blog

(https://commons.wikimedia.org/wiki/File:Holocene_Temperature_Variations.png).

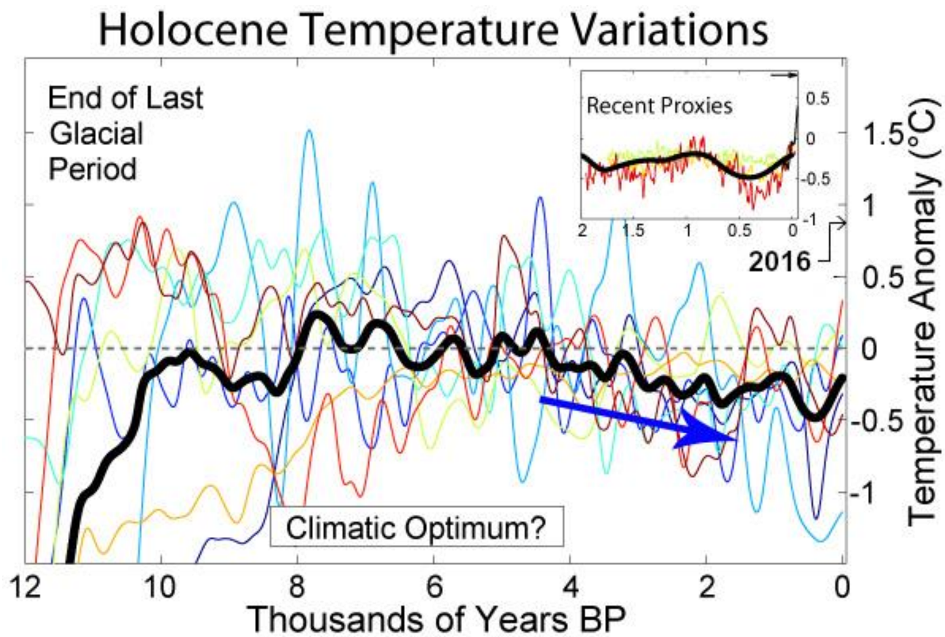

Figure 2: The figure shows eight records of local temperature variability during the Holocene. The average of the temperature variability is represented by the thick dark line for the period from 10000 BC to 2000 AD. (Eight different data sources of the graph are : 1. dark blue, sediment core ODP 658, Ref. Zhao et al., 1995; 2. blue, Vostok ice core, Ref. Petit et al., 1999; 3. light blue, GISP2 ice core, Ref. Alley, 2000; 4. cyan, Ref. Thompson et al., 2002; 5. yellow, sediment core PL07-39PC, Ref. Lea et al., 2003; 6. orange, pollen distributions, Ref. Davis et al., 2003; 7. red, EPICA ice core, Ref. EPICA, 2004; 8. dark red, composite sediment cores, Ref. Stott et al., 2004)

Further, climate is determined by the atmospheric circulation and by its interactions with the large scale ocean currents. The global atmosphere is a chemically complex and dynamic system, interacting both internally, mostly within the troposphere and stratosphere, and with the oceans, land, and living organisms. An understanding of climate system requires an amalgamation of astronomy, solar physics, geology, geochronology, geochemistry, sedimentology, tectonics, palaeontology, palaeoecology, glaciology, climatology, meteorology, oceanography, ecology, archeology and history. The Köppen climate classification divides climate into five main climate groups viz., tropical, dry, temperate, continental, and polar with each group is divided based on seasonal precipitation and temperature patterns (Köppen, 1884). Climate change can not be referred and defined unless and until one climate group is changed to another climate group. Until then climate change is an idea that circulates domestic politics and international diplomacy. It is an idea that circulate to mobilize forces in the business, law and international trade. Without proper differentiation of climate, weather, environment and pollution; climate change will continue to remain as an idea.

Study of the Earth's atmosphere alone tell us nothing about the future climate. Just over forty years ago in 1975, Geochemist Wally Broecker from Lamont-Doherty Geological Observatory, now Lamont-Doherty Earth Observatory in New York published a paper entitled "Climatic Change — Are We on the Brink of a Pronounced Global Warming?" in the journal 'Science'. But terrestrial data of pollen and glacial records around the globe are in direct conflict with the view of global warming indicating much colder temperature. "Climatic change" and "global warming" both are used by and large interchangeably. There is no information about the past history of global temperature. The graph of surface temperatures from GISS Surface Temperature Analysis (GISTEMP) that ends in 1974 does not correlate with Broecker (1975). Broecker (2017) predicted an overall 20th Century global warming of 0.8ºC due to CO_2 concentration and the consequences in agriculture and sea level. However, no adverse consequences occurred to agriculture and sea level rise after twenty years of declaration in 1998 of global warming and sea level rise. Hence it is not prudent to relate opportunities and challenges of Ganges-Brahamaputra Delta with the climate change impact.

3. Opportunities and Challenges of the Ganges-Brahmaputra Delta

3.1 Making a Delta

A delta is a geomorphologically low lying land surface that form over the land interior and progrades to the coastal belt. Sediments are transported from the source (highland) region to the river mouth and deposited in the continental shelf. Rivers are the main source of transportation of terrigenous sediments trapped at the continental margin as lower flood-plain, delta-plain, shelf, and slope deposits. Delta build-up starts when river with high sediment load meets at the sea and deposited through hyperpycnal flow, a flow of river water which is denser than the water in the sea (Zavala et al., 2011) before entering to the sea. This occurs during the high flow regime. The denser water flows beneath the sea water, as a density current, carrying sediment beyond the shore and inhibiting the progradation of a delta. Deltas are formed by the deposition of sediments carried by the river network as it enters to the sea. Delta is built by the deposition of sediments dominantly of sand, silt and clay. Tectonic activities and the geology of the source to sink region would regulate the environment of deposition of these major three products in the formation of a delta. Delta can extend in the sea if the sediments influx is high and deposition continues in the sea making delta a prograding in nature. Over long periods, this deposition can build a dynamic and characteristic geographic, ecological and social pattern of the delta and its features.

3.2 Opportunities

Delta generally characterizes many opportunities to explore and utilize, and many challenges to face. Deltas are commonly enriched with the resources like oil, gas, coal and metallic minerals. Other natural resources can provide habitat of the animal, plant, and other organism, and ecological support for a wide variety of flora, fauna, and aquatic species those are the integral part to the health. Deposits of salt, peat coal, biogenic gas and native clay soil are exploited for the use by successive generations of human inhabitants of the delta. Agricultural productivity of delta is a direct reflection of fertile alluvial soils. All these opportunities and challenges are not affected by any climate change impact. However, it is the variations in the weather pattern promoted by temperature, rainfall and wind those effect livelihood of a delta.

Sand plays the most dominant role in forming underground reservoirs (aquifers) of the potable and fresh water. These underground reservoirs are recharged continuously by the surface water bodies like catchment dominantly by the active rivers. Among these sediments, high energy sediments mostly sands are deposited first in the river beds then low energy sediments clay are deposited mostly in the flood plain environment. According to Wilson and Goodbred Jr (2015), Ganges-Brahmaputra Delta is characterized by an upland fluvial fan delta, a lowland, backwater-reach delta, a down-drift tidal delta plain, and an offshore subaqueous-delta clinoform. The subaerial portion of the delta covers ~100,000 km^2 and extends ~400 km to the south and southeast covering the Bengal Basin and Bay of Bengal. Another 20,000 km^2 of the active delta lies offshore as a prograding delta built over the continental shelf in the Bay of Bengal. According to Kuehl et al (1997) this propgrading delta also intersects with the nearshore Swatch of No Ground canyon system. Ganges-Brahmaputra river system carry sediments more than 2.4×10^9 t/yr and discharge about 10^9 t/yr in the Bay of Bengal (Milliman and Syvitski, 1992). Borehole data from the Ganges–Brahmaputra delta reveals Late Quaternary (Holocene) history controlled by immense tectonism, sediment discharge and eustasy (Goodbred Jr and Kuehl, 2000). Large sediment influx and load deposited over the ~ 20 km thick basin-fill caused basin floor made of the continental crust to subside isostatically compensating by the uplift of the basin floor made of the oceanic crust. This resulted sea level to intersect a major portion of the lowstand surface of sedimentation around 12,000 BP, marking the delta growth. Apparently, sea level went upto 5m above the present level in 5500 years in response to the subsidence and sediments load of the continental block. But in reality sea level did not change, neither by rise nor by drop. Figure 3 is the demonstration of the geological process that enabled sea to enter (encroach) 300 km inland during mid-Holocene around 10000 to 12000 years BP without actual sea level change (Khan et al., 2000). It is revealed that despite apparent relative sea-level rise (~1 cm/yr) due to subsidence of the continental crust during mid-Holocene, sediment influx that kept raising the surface of the G-B prograding delta to advance delta front sea-ward maintaining its shoreline to advance slowly marking relative sea level drop since last 10000 to 12000 years.

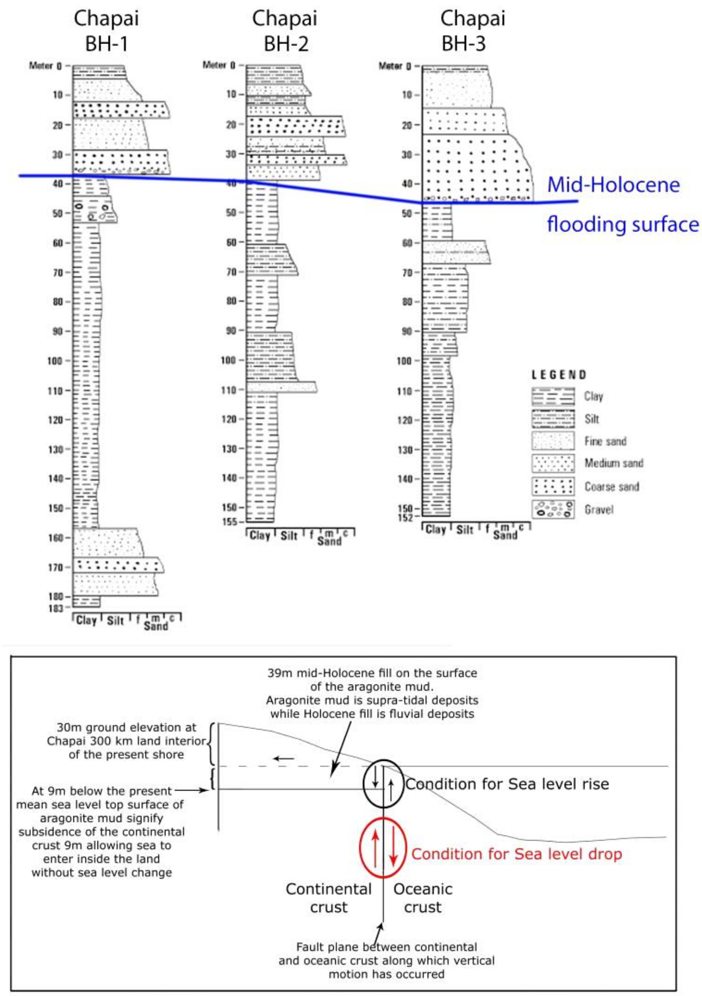

Figure 3: To the top three wells drilled at Chapai Nawabganj 300 km from the present coast of Bay of Bengal encountered hyper-saline aragonite mud at depths ~39m to ~148m and benthic foraminifera (benthic foraminifera is a major component of deep-sea communities, play an important role in ecosystem). At the bottom a sketch (not to the scale) represents a 9m sea level rise (not actual) from present level at 12000 years ago which is due to the subsidence of the continental crust and upliftment of the oceanic crust (Explanation in the body of the main text).

Mid-Holocene marine transgression (relative sea level rise) of the sea commenced along well defined Ganges-Mahananda depression resulting in the deposition of about 110m thick hypersaline aragonite mud with benthic foraminifera (Fig. 4), and benthic foraminifera is a major component of deep-sea communities.

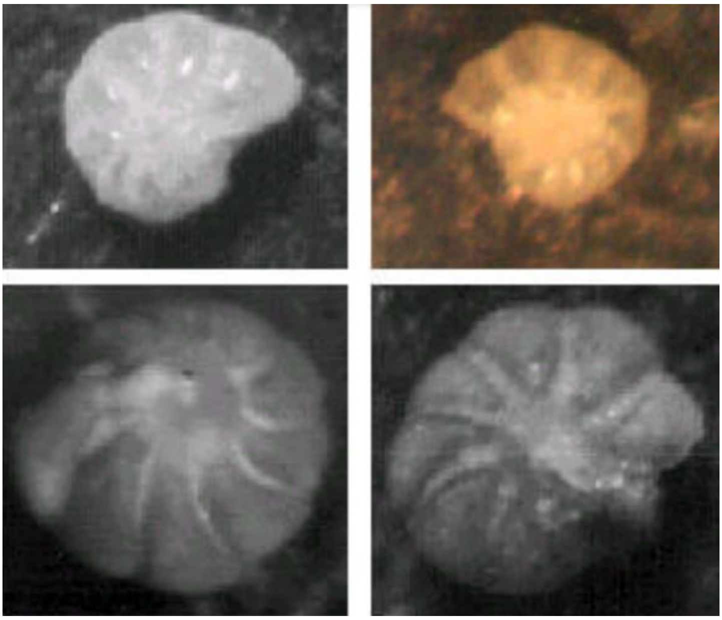

Figure 4: Occurrence of foraminifera (benthic) in aragonite mud at 61m and 91.5m depths.

Occurrence of aragonite mud and benthic foraminifera strongly signify that sea with water depth at least 110m was extended upto Chapai Nawabganj. This encroachment of sea was due to the major subsidence of the continental crust and isostatically equilibrium uplift of the oceanic crust (Fig. 3). Sea started to retreat since then to present time. Presence of high energy sediments such as gravel and coarse sand in all the wells of Chapai Nawabganj is a clear demonstration of an upland fluvial fan delta that was formed as mentioned by Wilson and Goodbred Jr (2015). This lead to upstream channel burial with new channel migration and widespread sediments influx, dispersal of sands leading to the progradation of delta alongwith numerous incised channels. A large channel of about 27 km wide and 737m deep buried at a depth of 750m is detected in the continental shelf of the Bay of Bengal (Khan, 1984). This channel was formed during Pleistocene glaciation about one million years back when sea was approximately 200m below the present level. Subsequently due to the massive sediments influx the above channel became incised and sediments accumulated in delta building and in advancing delta front towards the sea. In view of the width, length, depth and trend of the Pleistocence channel, it is inferred that the channel was linked to the Swatch of No Ground (SoNG) that lies 150 km down-drift of its main sediment source, the Ganges–Brahmaputra–Meghna (GBM) river mouth. Most of the Quaternary sediments of the G-B Delta in the Bay of Bengal might have routed through this channel and SoNG to the present Bengal deep sea fan beyond shelf break. The Swatch of No Ground (SoNG), a shelf-incising deep sea canyon in the Bay of Bengal, is actively undergoing deposition in the upper reaches due to gravity-driven transport of sediments. Rogers et al (2015) have determined the high sedimentation rates to the tune of 5cm/yr to 50 cm/year in the Bay of Bengal that lead to maintain both progradation of the subaqueous delta into the canyon head and the conveyance of shelf-generated hyperpycnal flows to the canyon floor. This rapid accretion appears to be largely balanced by mass failures triggered by regularly occurring storms, and less frequently by major earthquakes.

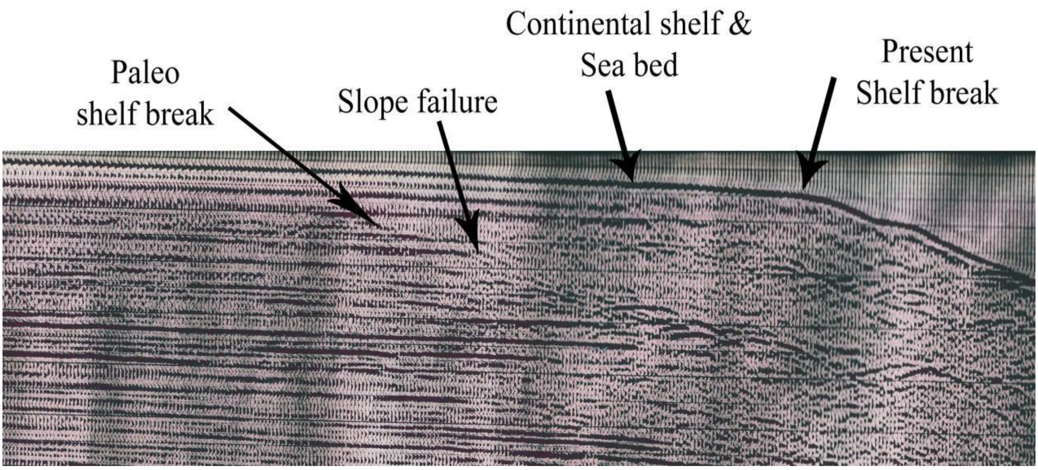

Figure 5: Sea-ward progradation of offshore G-B Delta and relative sea level drop.

Seismic section in the Bay of Bengal reveals distinct delta progradation and slope failure. Interpretation of seismic section suggests that the offshore G-B Delta has prograded from the last paleo shelf break imprinted by the slope failure upto the present shelf break with a Quaternary deposits of about 150m in approximately 550 years time (Fig. 5). Seismic section is a clear demonstration of delta progradation and sea retreat. Paleo shelf break approximately 550 years back occurred about 150m below the present continental shelf and sea bed implies that the present coast was much inland but with gradual sediments deposition present shelf break is advancing much sea ward at much shallow water depths. The north-south trending channel originated at the upland of the delta and formed during the Pleistocene glaciation cutting away Pleistocene deposits. This type of numerous buried channels subsequently were filled by the Quaternary-Holocence sediments occurring in the Ganges-Brahmaputra Delta.

3.3 Challenges

Natural flow of the rivers are dramatically slowed down and the flow regime of the rivers are greatly different during rainy season and during winter season. If this process is continued for long recurring periods then the rivers are ultimately become dead, incised and buried due to abrupt sedimentation during lean period. Such burial of the rivers in a delta would result the closure of groundwater recharge source, deterioration of the navigation routes and saline water intrusion in the coastal freshwater aquifers. Generally, rivers of the delta are characterized by river-bank erosion at one end and an extensive siltation at the other end resulting in loss of inhabited and cultivated lands. Reduction in river flows and intensive shrimp farming cause severe saltwater intrusion in the coastal belt degrading the ecosystem, and ultimately making the land uninhabitable (Mahmuduzzaman et al., 2014). Natural hazards such as earthquake, subsidence, river flooding, flash flood, urban flood, storm surge, cyclones, droughts, erosion are the major challenges. Ganges-Brahmaputra Delta was characterized by dense stream network about 300 years before present (Fig. 6) that is markedly different from the present river network. Most of the rivers shown in the Rennell's map are now filled and buried leaving only Ganges, Padma, Jamuna, Old Brahmaputra and Meghna to maintain an intermittent flow alongwith few tributaries and distributaries. Map below (Figure 6) is redrawn from Rennell (1776). The most remarkable features to observe in this map is that the dense network of streams and rivers during the time of Rennell's mapping of 1776 that has greatly changed in the present time river network. Almost all the rivers and streams are now completely dead or/and buried and became seasonal due to enormous siltation. Siltation process has been much more aggressive due to the unilateral withdrawal of water and reduction in the natural flow of the rivers during the greater part of the lean period and every year during the rainy season abrupt allowing upstream water to move to the downstream with exorbitant sediments load of more than 2 billion tons/yr of high energy sediments to deposit on to the previously formed sand bars.This cyclic phenomenon every year is continuing for long period of time causing deterioration of groundwater recharge sources drastically, changes in the river geometry, obstruction to the natural water flow, incision of rivers, greater river-bank erosion, greater saline water encroachment and increased intensity of flooding in the Ganges-Brahmaputra Delta. The notion of climate change referring to increased intensity of flood globally do not justify because intensity of flooding increases if evaporation of ocean water increases that subsequently enhance water vapor concentration in the atmosphere to have increased condensation and precipitation. Water vapor is the most dominant greenhouse gas that concentrates in the atmosphere about 69 percent, while CO_2 concentrates only 23 percent. Sudden influx of sediments and water through the continuously deteriorated channel volume can potentially increase the risk of river bank erosion and people migration. It is well understood that during Rennell's mapping (Fig. 6) there was hardly any river-bank erosion, people migration and land loss to blame climate change impact or global warming. Siltation is not a result of climate change impact rather siltation can cause deterioration of channel geometry, flooding, river bank erosion and people migration. Another interesting aspect to observe in the Rennell's map is the non-existence of Jamuna river. Jamuna river formed after 1776 water diversion from Old Brahmaputra river due to a major earthquake of magnitude greater than 7.5 known as the Bengal Earthquake of 1885 whose epicenter was located in the Modhupur en echelon fault zone to activate mid-Holocene Jamuna depression. The term 'en echelon' refers to the closely-spaced, parallel or subparallel, over-lapping or step-like faults. Movements in the fault zone uplifted Modhupur tract in response to the tilt of Jamuna depression that lead Old Brahmaputra river to find its new route as Jamuna river and met straight down to the Meghna confluence, while Old Brahmaputra maintained its route through Meghna. This shifting of Old Brahmaputra river suggests that Ganges-Brahmaputra Delta is vulnerable to earthquakes that may change the morphology of the delta.

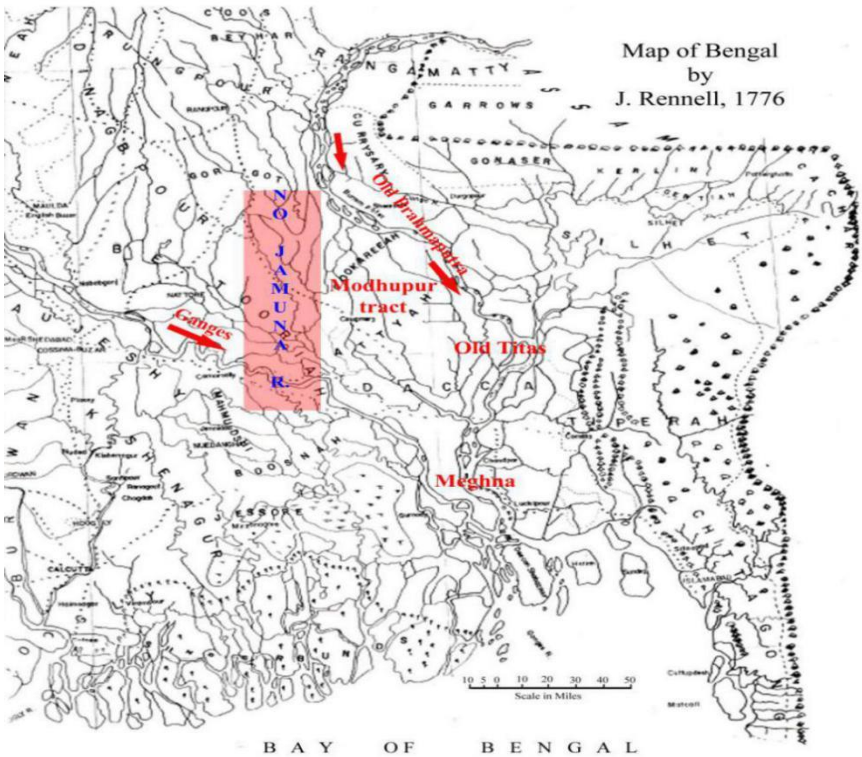

Figure 6: Map showing all the rivers in Bengal prepared by Rennell (1776) where existence of present Jamuna river was absent. Main course of the river was Old Brahmaputra around Modhupur Tract.

There are records of several major earthquakes in this delta region. A major earthquake can change the course of a river forming new river and eroding river bank and flood plain. Further, siltation may emerge as an opportunity in the coastal belt where several visible islands are likely to form apart from shallow submarine erosion and slope failure. Char Alexander and Ramgati in the Meghna estuary have emerged due to siltation in the last 70 years (Fig. 7A & 7B). According to the Figure 7C, the most remarkable example is the Teknaf main land and the SahPori island. These two land were separated by a marine channel about 50 years back but at present these two are connected with habitation. Similarly, St. Martin island and Chera deep to the south used to remain detached both during high tide and low tide times about 20 years back but now the two are connected by the visible land bridge (Fig. 7D). Analysis of land set images of the Bay of Bengal coast between 1990 and 2019 revealed the reality of so called sea level rise alarm. All the evidences strongly support distinct sea level drop in the Bay of Bengal. Emergence of Vasan Char, Dhal char, Hatia, Kutubdia, Manpura, Nijhumdeep, Sandip, Sona Char, Urir Char and Char Alexander are the strong evidences of relative sea level drop. Global sea level change depends on the changes of the centrifugal force of the Earth. But the emergence of sandbars and islands are the strong evidence of land accretion, delta progradation and sea level drop which is the reality in the Bay of Bengal coast of Bangladesh.

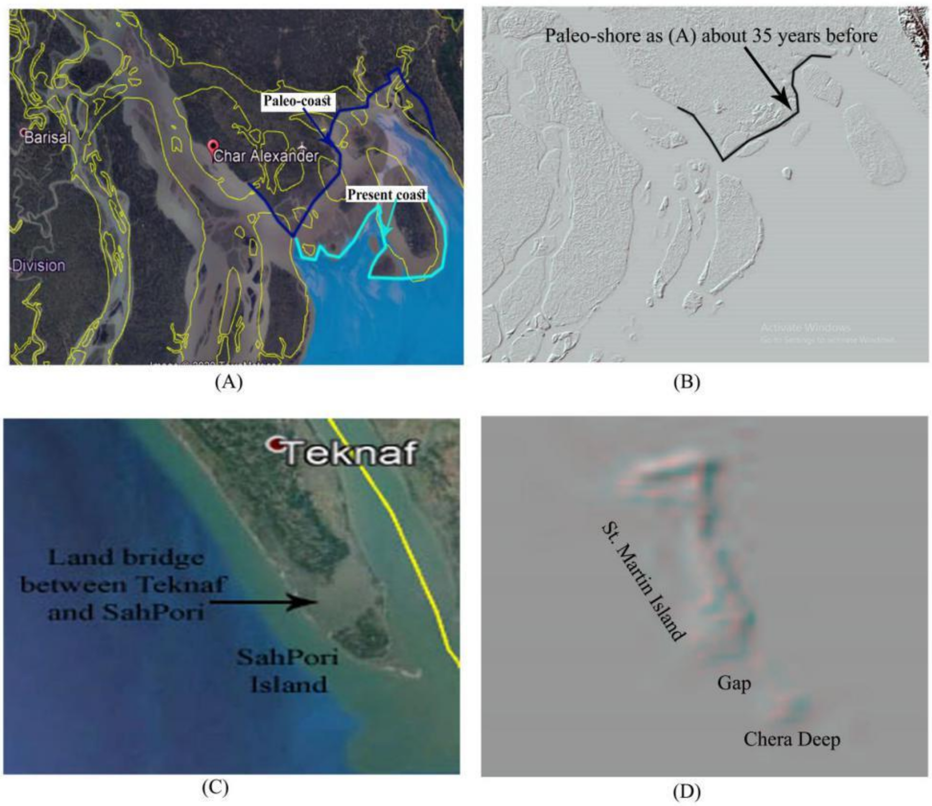

Figure 7: Figure shows several examples of land accretion and delta progradation strongly suggesting sea retreat and sea level drop in the northern Bay of Bengal.

There are two types of salinity problems in the coastal belt viz., salinity intrusion and salinity encroachment. Salinity intrusion occurs due to groundwater table lowering while salinity encroachment occurs due to the coastal flooding. Gradual salinity intrusion in the coastal belt of Bangladesh is an additional problem that threatens fresh water underground aquifers to be contaminated immensely. On the otherhand, sudden saline water encroachment due to cyclone, storm surge and breakage of polders can threaten primary production system, coastal biodiversity and human health. The total amount of salinity affected land in Bangladesh was 83.3 million hectares in 1973, which increased to 102 million hectares in 2000, 105.6 million hectares in 2009 and continuing to increase (Mahmuduzzaman et al., 2014). The principal cause of salinity intrusion in the coastal belt of the Ganges-Brahmaputra Delta is due to the rapid lowering of groundwater table in the coastal belt. Dramatic reduction of the flow regime of the rivers of the GB Delta during the major period of the year due to the massive withdrawal of surface water in the upstream region of the neighbouring country is responsible for such saline water intrusion. Unsustainable and unplanned coastal polders, cyclone, storm surge, back water effect, precipitation and shrimp culture are also the causes of saline water intrusion. While, water is mainly used for agricultural purposes, domestic water demand is increasing, driven by socioeconomic and demographic changes. Groundwater is growing in importance as a resource, accounting for around 80% in G-B delta. Groundwater has become an important requirement for irrigating agriculture. Reduction in groundwater recharge and water storage capacity can limit dry-season irrigation.

4. Conclusions

Opportunities and challenges are the integral part of the holistic development of the Ganges-Brahmaputra Delta and in the Bay of Bengal. Both opportunities and challenges are classified in natural and anthropogenic groups. Opportunities in natural group enumerated are: a) natural resources under non-living category such as sediments (ingredient of nutrient) for eco-system and bio-diversity, oil and gas (methane), gas hydrates, calcium carbonate and sea bed economic minerals; b) development of biological resources specially both marine and estuarine fish of living category; c) very active prograding G-B Delta that maintains stable and progressive continental shelf; d) high influx of sediments supply to the tune of more than two billion tons per year depositing in the continental shelf that develop number of islands counter balancing the subsidence load to land accretion. Anthropogenic opportunities include great scope of development of marine and beach tourism, development of trading and shipping facilities, making deep-sea port.

In contrary, enormous challenges lie with the G-B Delta. Massive deterioration of inland and coastal navigation system by extensive sandbar formation through deposition of sediments by the major rivers entering G-B Delta way to the Bay of Bengal. More severe effects of the river water withdrawal are impacted on the increased saline water intrusion to contaminate entire groundwater in the coastal belt alongwith saline water encroachment to destroy freshwater ecosystem and biodiversity. Saline water intrusion and encroachment are the major threat to the mangrove ecosystem that Sundarban of G-B Delta is facing. Challenges pertaining to the geological hazards are quite insignificant in the G-B Delta region except with the rare major earthquake probability having recurrence period of around 150 years. But entire coastal belt of G-B Delta is potentially vulnerable to the atmospheric hazards such as cyclone and storm surge to devastate coastal livelihood occurring on regular time interval. Inland flooding is a pseudo-natural because flood occurs in the G-B Delta not due to the increased rainfall in the catchment area but due to the continuous imposed deterioration of river geometry to carrying capacity of river water and sediment load. Major anthropogenic challenges lying with the G-B Delta and the maritime region are the various kinds of pollution that urgently need to be controlled for better environment. This study revealed that none of the opportunities and challenges in the G-B Delta are associated with the climate change fantasy. All these opportunities and challenges of G-B Delta bear independent characteristics and demand independent solutions. An increased intensity of tropical cyclones associated with the storm surges and coastal flooding of the G-B Delta are not the impact of climate change.

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