

## Sea-Level Rise: Its Probable Impact and Mitigation In The Coastal Tracts of West Bengal

Dr. Sujib Kar<sup>1</sup>, Rinki Adhikary<sup>2</sup>

M.Sc. (Geography), M.Sc. (Ecology Environment) Ph.D (Science Cal.) Environment Management & ISO  
1400/1401

<sup>2</sup>M.Sc. (Geography)

Corresponding Author: Dr. Sujib Kar

---

**Abstract:** Global Warming and climatic change are very much related criteria of Global scale which normally indicates retreating snow lines of Polar areas and mountains areas. It also indicates, faster rate of ice melting in the affected areas increasing the level of ocean water. The tropical and sub tropical delta regions of the world are mostly facing such problems. Because, the economy of these areas are mostly depends on agriculture. The rising sea level not only inundate the surface but also rising sea level may cause huge salinization impact in the coastal tracts. As a result problems will occur in the field of drinking water and in agricultural sector on the other hand such rising sea-level may contaminate ground water and by this way it may enhance the percentage of Arsenic in the ground water. In last three decades due to the excessive global warming the ground water quality is degrading and at the same time crop failures are being experienced in these areas. So, to save sustainability of the people some mitigation measures should be taken otherwise economy of the common people should be destroyed.

---

Date of Submission: 04-03-2019

Date of acceptance: 20-03-2019

---

### I. Methodology

To analyse these problems we have adapted three steps methodologies. These are follows:

#### (1) Pre-field Methodology:

Before field excursion we have collected various information on global warming and rising sea-level mainly in the coastal tracts of West Bengal. At the same time we have also collected sub-surface lithological maps and the seasonal fluctuation of ground water level. After analysing these data we have seen that the area is continuously facing the bad impact of rising sea-level due to the continuous processes of global warming.

#### (2) Filed Methodology:

After analysing the data a field trip has been organised for the verifications of the problems and to collect necessary informations faced by the local people. During field study we have also collected informations regarding the contamination of ground water and it has been observed that local people are facing the problems of sea-level rise and climatic change.

#### (3) Post-field Methodology:

After the completion of field experiment we had adapted the techniques of analysis by applying statistical methods and processes. We had also adapted the processes of computation by computer analysis and at the same time we had also prepared mitigation techniques and processes to decrease the impact of sea-level rise and at the same time we have adapted some plan proposals for the sustainability of the area.

### ANALYSIS:

The coastal tracks of East Midnapore and South 24 Parganas are mostly vulnerable to sea-level rise. Large area of these two districts would be subjected to increased flood a salinization and ultimate abandonment in these two districts. Such a typical condition in term is linked to the potential displacement of the millions of people from their home. Inter-Governmental panel on climatic change (IPCC) suggest that sea-level in the Bay of Bengal may rise by 0.2 to 0.3 mt. by 2050 and by 0.4 mt. to 0.6 mt. by 2100. But recent incidents indicate it will be far greater than the suggested level of IPCC.

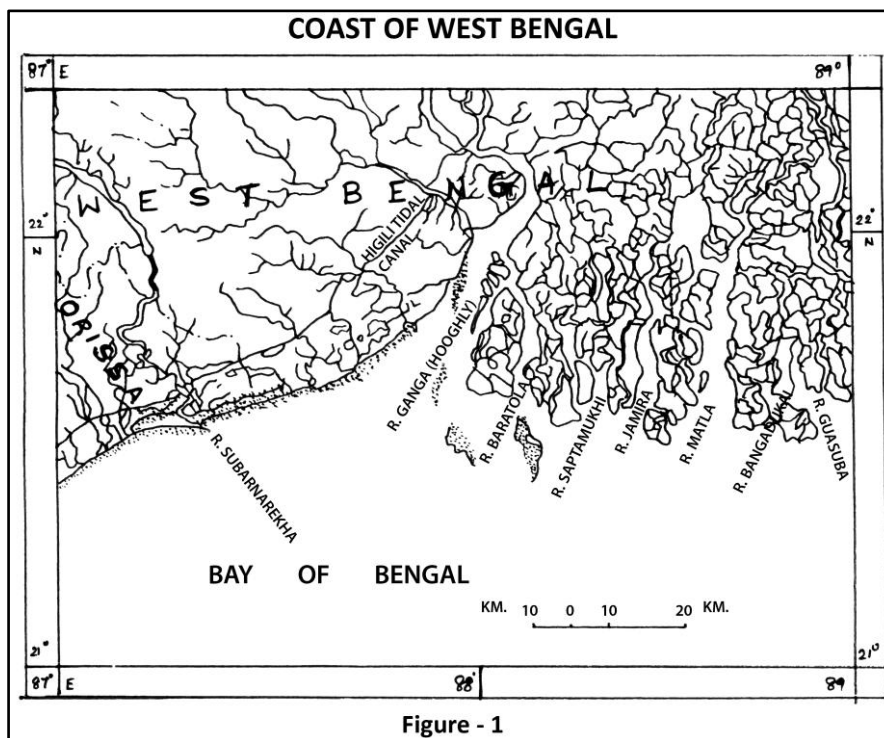


Figure - 1

The climatic change is playing a vital role in this occurrence because it is the common phenomena of global warming which has occur due to the global climatic change. In last three decades the rate of global warming is increasing by leaps and bounce due to the continuous processes of urbanisation, deforestation and changing nature of land-use pattern. The urban area of Kolkata within this area is also creating urban heat island and by this way increasing the climatic temperature to a greater extent not only Kolkata the continuous encroachment of land conducted by the local people for the increase of agricultural land, it is obvious that day by day the climatic balance is degrading in the Sundarban area also. The coastal tract of east Midnapore is very dry and sandy. This coastal area is also experienced by various sandunes and coastal vegetations. As a result coastal tracts of East Midnapore are prone to coastal inundation. As the West Bengal coast is very much complex in nature. So, rising sea-level will hamper the common livelihood pattern and as well as morphological conditions of the area. Not only these coastal tracts but this situation may also be applied to the coastal tracts of Bangladesh and in the coastal tracts of Tropical and sub-tropical deltas. Coastal tracts and its dynamics by the continuous processes of coastal endodynamomorphysm and ectodynamomorphysm have increased the complexity of the coast. As sea-level is rising that is why ocean currents are performing rivers activities and as a result changes in the sediment chronology becoming extremely powerful and the processes of coastal erosion becoming active mainly in the Sundarban region. The coastal tracts of East Midnapore will also be affected by such erosional activities and these areas may also be inundated within a very short span of time.

#### **DYNAMICS IN THE COASTAL ZONE:**

Coastal zones are very dynamic and changeable in nature and these are also ecologically very much sensitive areas. As a result for the developmental activities performed over the coastal areas should be managed properly otherwise the changing dynamics of the coast will hamper the coastal morphology and may also hamper the livelihood pattern of local area. In our study area we may distinctly identify the coastal regulation zones. But these zones are not arraigned as per the notification of the ministry of environment forest and climatic change. The identified zones are -

- (1) CRZ1 - These zones includes various types of sandius, mud floods and mangroves. These areas are biologically very much active. Various Forest lands and protected areas are lying here. False under the provisions of Forest Conservation Act 1980. Turtle nesting ground and the hasting ground of crabs are also observed in these areas because, inter tidal areas are very much prominent.
- (2) CRZ2 - Normally, CRZ2 represents the zones of development authorities and municipalities. Some important municipalities are also present in these areas.

- (3) CRZ3 - These zones are located in between CRZ1 and CRZ2. In the case of coastal tracts of lower gangetic plane, some areas experience CRZ3 prior to CRZ2 and coastal urban areas experience CRZ2 prior to CRZ3.
- (4) CRZ4 - These areas extends up-to 12 nautical miles in the sea from low tide level. These areas are very much sensitive and the existence of these areas normally tries to regulate coastal landform development processes.

**AREAS REQUIRING SPECIAL CONSIDERATION:**

Typically in the last decade there were some areas where special consideration was necessary. But in this decade it has practically increased to a greater extent rising sea level is threatening the CRZs. Because, the nature of the rising sea level is hampering the biological province and at the same time it has also hampered the landscape dynamics. As a result within two to three decades coastal tracts of West Bengal and Bangladesh may come under special consideration zone otherwise it will hamper coastal livelihood patterns. Coastal processes and at the same time the inundation activities will be much faster than the last century.

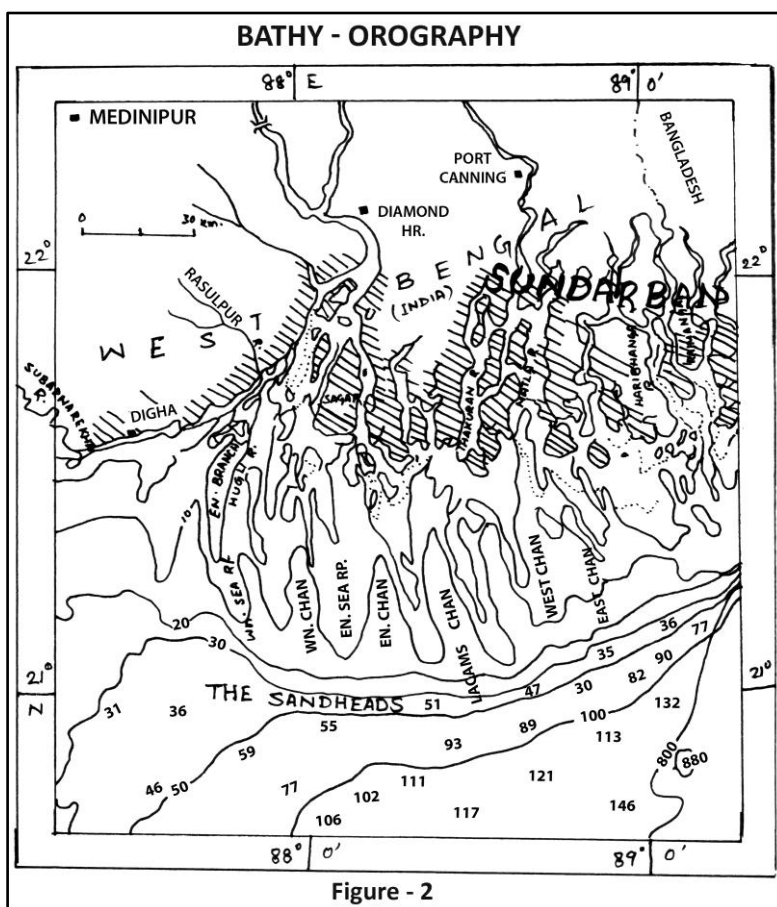
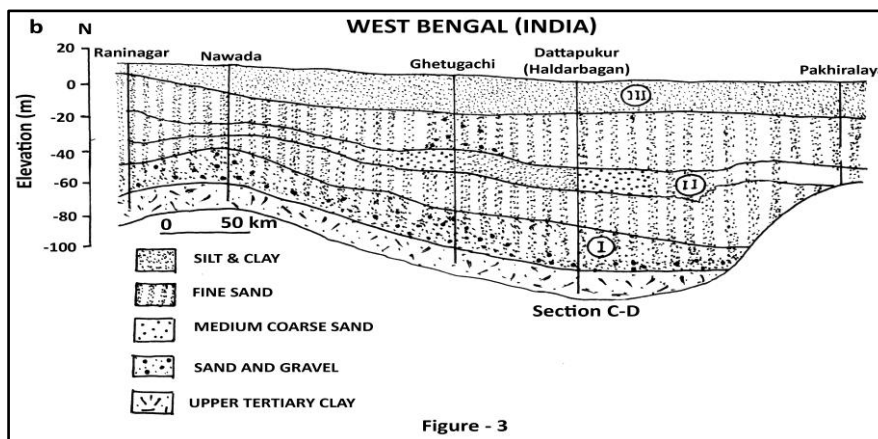


Figure - 2

**SALINIZATION IMPACT IN THE COASTAL AREAS:**

Due to the continuous processing of global warming the rising sea level of Bay of Bengal may hamper the production system mainly in the field of agriculture. The coastal dwellers are basically depending in agricultural activities and fishing. But there main source of income is agriculture. As per the global statistics within 30-40 years most of the agricultural lands upto 100 km. from the CRZ3, will be salinized. The ground water mainly utilized for agriculture should also be affected. Most of the water bearing stratas will be inundated as a result the ocean water will enter the sub surface condition by a rivers flow and will destroy the availability of drinking water in these areas. At the time of our study various farmers of Purba Midnapore, CRZ3 and farmers of South 24 Parganas, CRZ3 has informed that there productivity of the land is declining steadily. They had also informed that the quality of water and its taste will also degrading very rapidly. To analyse the changing nature of water quality we have studied the stratigraphy of these area.

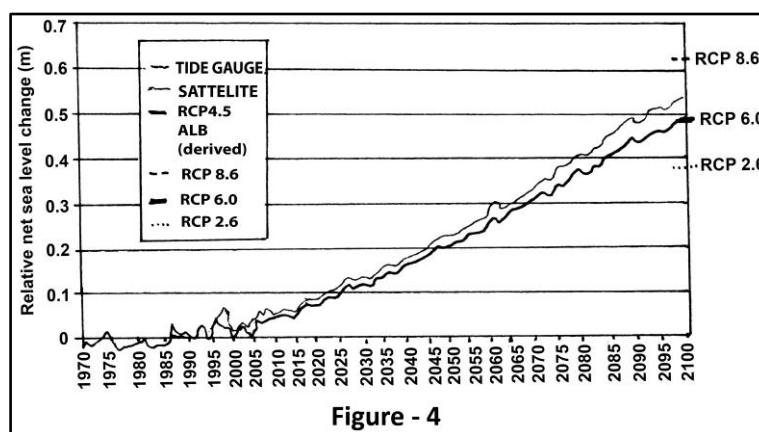


Source: Central Ground Water Board

Simplified upper cenozoic stratigraphy of the western (West Bengal, India) Bengal Basin (from Roy and Chattopadhyay, 1997 ; Monsur at al 2001 ; Ahmed et al., 2004 ; Ravenscroft at al., 2005)

Epoch	Age	Quarternary in Bangladesh	Quarternary in West Bengal	Lithology and Sedimentology
Holocene	Upper	Alluvium Material Clay / Barabo Formation	Aluvium Diara Formation Panskura Formation	Clay, Silt and fine sand with occasional peat and gravels floodplain and deltaic deposits; mostly fine sands.
	Lower Middle	Chandina Formation	Bethuadahari Formation	Gray colored fine to medium sands, with occasional coarse sands and organic mud and peat
		Dhamari Formation	Jwua Formation	Gray coloured, fine to medium sand, with clay and peat. Flood plain deposits and alluvium.
Pleistocene	Upper	Kalsi Bed	Upper Lalgarh Formation	Pale yellowish brown spotted sandy clay with iron concentration detrital nodular laterites.
	Lower middle	Barind clay medhupur clay	Lower Lalgarh Formation	Red-Brown to gray mottled clay and silt, residual deposits, kaolinite and iron – oxides lalgarh, contains pebble conflowmeter, laterite with deterial silicified woods, highly oxidized gravels.
Pliocene	Upper	Dupi Tila Formation Dihing Formation	Siwalik Sediments (Pinjor / Tatrot Formation)	Yellowish brown to gray, medium and coarse sand with clay, low in organic matters. Siwalik sediments consist of sand, conglo metratre and clay; deposited in fluvial environments.

Such a typical litho-logical and stratigraphic pattern of the sedimentation in this tectonically active area represents a variegated nature of sedimentation in this depositional environment. The typical environmental scenario is also reflecting the inclination of the rock strata and the probability of discharge of water to the oceans. The inundation of rock strata is also reflecting the probability of the sub-mergence of the surface due to rising sea level. In the initial condition due to the gentle uprising sea level. Ocean water may enter sub-surface condition and may cause salinization impact in the suppressed zones of the coast. Now we are presenting a table of depositional environment in Bangladesh and Kolkata.

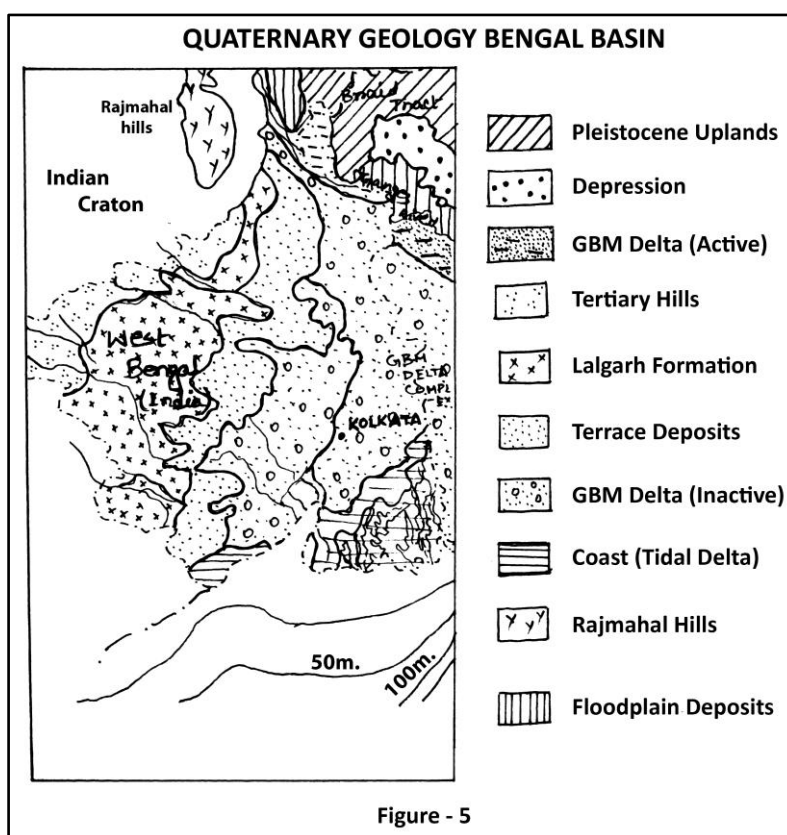


Source: Geological Survey of India

Quaternary stratigraphic units in Bangladesh and West Bengal, India with their depositional environment, sea level events and ground water arsenic conditions on associated aquifers (from Uits, 1993 ; Hait el-al, 1996 ; Goodbred and Kuehl, 2000 ; Acharyya et al, 2000 ; Ahmed el-al, 2004 ; Ravenscroft et al, 2005)

Time division	Bangladesh	West Bengal	Quaternary depositional environments
Upper Holocene	Upper unit : fine silt and clay with peat at top part but the bottom.	Upper Unit : fine sand, silts and clay with common peat layers.	Mostly deltaic. Coastline, advance into the sea to south, formation
Middle Holocene	Middle unit : Silts and clay in lower part, and sands in middle and upper parts. Fine sediments in lower part in coastal areas.	Middle Unit : fine to medium sand with clay intercalation.	Rising sea level condition. Deposition of sandy sediments, development of marshes and swamps.
Upper Pleistocene to lower Holocene	Lower Unit : Sand with gravel and coarse sand at top, but coarser sands with gravel beds at the bottom parts.	Lower Unit : fine to medium grained sand, pebbly sand with occasional gravel.	Low sea stand condition. Rapid fall in base level with deep incision in valleys.
Early to Middle Pleistocene	Madhupur clay formation : highly weathered and oxidized reddish brown deposit exposed in Madhupur, Barind and Lalmai Hill areas in Bangladesh.	This unit is found in Western Part of Barind Tract in West Bengal. Laterite Plains (Lalgarh formation) of West Bengal are equivalent of this unit located to the north west.	The Madhupur formation formed in humid climate, and probably under fluvial condition.

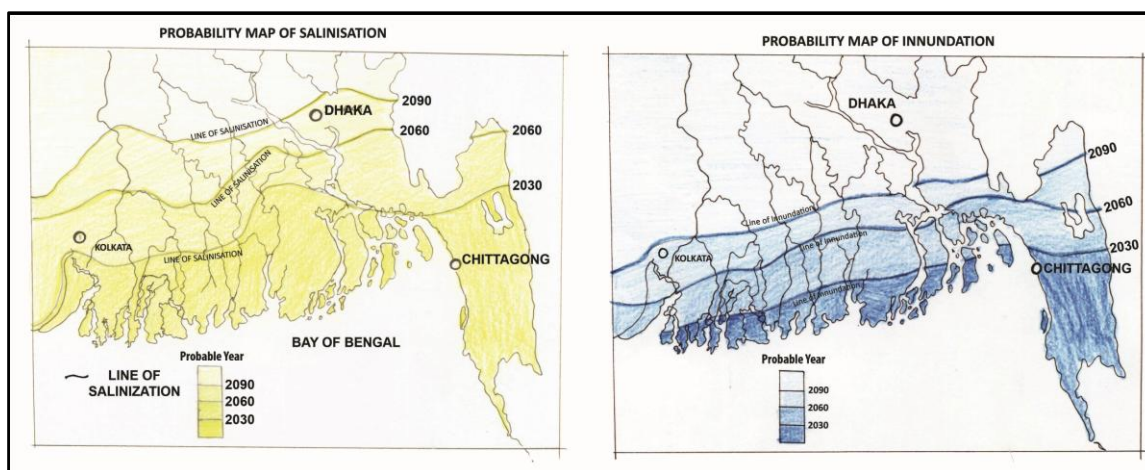
Presently if the rate of increase of sea level continues in the rate which observed at this time for near about 5 decades then the whole deltaic condition mainly the depositions of upper Holocene, middle Holocene and lower Holocene will be submerged under the ocean. The arrangement of the sub surface rock strata indicates the whole Ganges delta will be completely salinized. Continuous crop failure, land slumping etc. will destroy livelihood pattern and will also destroy the habitat. The typical bio diversity zone of Sundarban will be completely cur merged and tidal water may cross the bench mark level of Kolkata within two decades. A greater number of people will lose their residential areas and coastal livelihood pattern will be completely changed.



## **HYPOTHESIS:**

The rising sea level is not only a matter of research for Ganges delta only. But its continuous rise may change the global tropical and sub tropical areas. Depending on the previous analysis we may developed some hypothesis. Regarding this typical environmental zones these are -

- 1) The rising sea level may hamper the sustainability of delta. Because, it is also hampering the eco-logical balance, mangrove environment and erosional processes at the coast.
- 2) Rising sea level may also hamper the isostatic balance of the surface and by this way it may increase earthquake like incidence.
- 3) Socio economic conditions of the coastal people will be completely hamper and people may migrate from the coastal areas in search of alternative livelihood pattern.
- 4) The rising sea level may enhance the entry of ocean water in the sub surface condition at by this way salinization impact will be pronounced.



## **II. Suggestions**

Due to the continuous processes of global warming our civilization is in danger. The impact of it will be prominent in the coastal areas within a few decades. Millions of people will be homeless and landless. Show to protect such a typical condition and to create sustainable environmental scenario in this deltaic environment we may suggest some important aspects, these are follows -

- 1) There are so many fault lines under the surface of this delta. Through these lines if we detach the subsurface stratas by creating various construction under the surface then this water bearing stratas will be separated and such detachments may protect them from such impact of salinization.
- 2) Any type of construction in the coastal areas should be restricted and should be monitored by the Govt. authorities because rising sea level will hamper the isostatic adjustments and by this way the added pressure of the construction site may hamper our sustainability.
- 3) Subsurface flow should be restricted by the sub surface construction of dices and by this way various slumps in the urban areas, below the transport networks should be restricted. By this way we may also restrict mass fluction and ground water contamination.
- 4) To protect coastal habitat, economy and society we should prepare proper management plan which may also indicate resource distribution and its continuous degradation. But proper management plan may change the nature of resources by studying they are potential.
- 5) Various Govt. authorities along with various engineers along with Geologist and Geomorphologist should be included in these developmental activities because proper estimation of probable destruction is extremely necessary. Otherwise whole delta environment may be submerged under the ocean.
- 6) Drinking water should be well protected. The consumption of ground water may cause arsenic impact upon the local people.
- 7) To modify and change the coastal environment local people should be involved and they should be well versed regarding the probable destruction that is why awareness among the common people is necessary because by this way they may consider the alternate processes of livelihood.

## **III. Conclusion**

The overall discussion and analysis of the data indicates the rising sea level may cause high water events from the next decade and the frequency of extreme events will increase up to the end of 21st century. The changing climatic condition mainly Global Warming is associated with conditions of low atmospheric pressure

and as a result the increasing frequency of disaster cyclone may create huge water spouse and by this way inundation of the coastal tract will be experienced within next two to three decades. Rising sea level along with higher frequency of cyclonic disaster may create coastal flood events with high river flow level.

Millions of people may loss their life, livelihood, property etc. and huge number of homeless people may migrate from the coastal areas in search of dwellings. The urban areas like Kolkata, Khulna, Digha, Howrah, Haldia, Barishal, Dhaka, Chitaganj, Cox Bazar etc. may be inundated within next 4 decades. Through this research paper we are in search of the sustainable development plan otherwise we the people of southern part of West Bengal may me wholeness next 40 to 50 years.

### Acknowledgement

The author acknowledges Mr. Shyamal Bhattacharya, Prof. Arunabha Mishra, Prof. Dr. Ajit Sil, Prof. Dr. Asitendu Roy Chowdhury, Prof. Joy Mukhopadhyay, Prof. Dr. Ayan Ghosh, Mousumi Ghosh, Archana Saha, Priyanka Dhar, Samir Chatterjee, Tanmoy Biswas and Soumendranath De for their constructive suggestions and help. The author further acknowledge librarian of G.S.I. and Central Ground Water Board for their eminent research work in this field. The author further acknowledges various students of Vidyasagar Evening College who are working in this field.

### Reference

- [1]. M. Ahern, R.S. Kovats, P. Wilkinson, R. Few, F. Matthies **Global health impacts of floods : epidemiologic evidence**
- [2]. *Epidemiol. Rev.*, 27 (2005), pp. 36-46
- [3]. R. Akhtar, A. Dutt, V. Wadhwa **Health Planning and the Resurgence of Malaria in Urban India**
- [4]. R. Akhtar (Ed.), *Urban Health in the Third World*, S.B.Nangia and A.P.H. Publishing Corporation (2002)
- [5]. S.F. Altekruze, D.L. Swerdlow, N.J. Stern **Microbial food borne pathogens**
- [6]. *Vet. Clin. North Am. Food Anim. Pract.*, 14 (1998), pp. 31-40
- [7]. S. Altizer, R.S. Ostfeld, P.T.J. Johnson, S. Kutz, C.D. Harvell **Climate change and infectious diseases: from evidence to a predictive framework**
- [8]. *Science*, 341 (2013), pp. 514-519
- [9]. L.M. Beck-Johnson, W.A. Nelson, K.P. Paaijmans, A.F. Read, M.B. Thomas, O.N.Bjørnstad **The Effect of Temperature on Anopheles Mosquito Population Dynamics and the Potential for Malaria Transmission**
- [10]. R.A. Bissell **Delayed-impact infectious disease after a natural disaster**
- [11]. *J. Emerg. Med.*, 1 (1983), pp. 59-66
- [12]. M.J. Bouma **Methodological problems and amendments to demonstrate effects of temperature on the epidemiology of malaria. A new perspective on the highland epidemics in Madagascar, 1972–1989**
- [13]. *Trans. R. Soc. Trop. Med. Hyg.*, 97 (2003), pp. 133-139
- [14]. M. Bouzid, F.J. Colón-González, T. Lung, I.R. Lake, P.R. Hunter **Climate change and the emergence of vector-borne diseases in Europe: case study of dengue fever**
- [15]. *BMC Public Health*, 14 (2014), p. 781
- [16]. C.B. Bridges, M.J. Kuehnert, C.B. Hall **Transmission of influenza: implications for control in health care settings** *Clin. Infect. Dis.*, 37 (2003), pp. 1094-1101
- [17]. S. Bunyavanich, C.P. Landrigan, A.J. McMichael, P.R. Epstein **The impact of climate change on child health**
- [18]. *Ambul. Pediatr.*, 3 (2003), pp. 44-52
- [19]. **CDC Waterborne diseases**
- [20]. *Climate and Health Program: Centers for Disease Control and Prevention (2010)*
- [21]. J.P. Chretien, A. Anyamba, J. Small, S. Britch, J.L. Sanchez, A.C. Halbach, C. Tucker, K.J. Linthicum **Global climate anomalies and potential infectious disease risks: 2014–2015**
- [22]. *PLoS Curr.*, 7 (2014)
- [23]. S.R. Christophers **Aedes aegypti (L.) The Yellow Fever Mosquito. Its Life History, Bionomics and Structure**
- [24]. Cambridge University Press, Cambridge (1960)
- [25]. **Dr. Sujib Kar, Impact of Global Warming on Earthquake on The Bengal Basin area with respect to The Global Scenario**, *International Journal of Engineering Science Invention* ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726 www.ijesi.org Volume 2 Issue 71 July. 2013 | PP.20-28
- [26]. **Dr. Sujib Kar, Proper Environmental Management is the proper way to poverty Eradication ; A case study of South of West Bengal & Bangladesh**, *International Journal of Scientific and Research Publications*, Volume 3, Issue 9, September 2013 | ISSN 2250-3153
- [27]. **Dr. Sujib Kar, Don't Let Sundarban to be cry of Bengal**, *ILEE*, Vol. 33(2), December 2010
- [28]. **Dr. Sujib Kar, Apocalypse of Water Born Diseases in Kolkata**, *IOSR*, Vol. 13, Issue 1, Ver. 1, January 2019 PP 57-64, www.iosrjournals.org

Dr. Sujib Kar. "Sea-Level Rise: Its Probable Impact and Mitigation in The Coastal Tracts of West Bengal." *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)* 13.3 (2019): 01-07.