IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 17, Issue 11 Ser. 2 (November 2023), PP 04-08
www.iosrjournals.org

Kolkata The City On The Cradle

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Date of Submission: 13-11-2023 Date of Acceptance: 23-11-2023

I. INTRODUCTION :

Delta development is a typical process which has been activated by the ocean river interaction, on the Bengal fan. Since near about last 5000 years but the historical growth and origin of the delta nearer to Kolkata has occur within the last 2000 years. That is why the surface of the area is younger in nature. As a result huge structural growth and landscape building processes over this soft soil is not well managed. The various developmental activities undertaken in this urban environment is also hampering the nature and characteristics of urban landscape and at the same time it is also hampering the sustainability of the area. Different type of urban activities and anthropogenic activities performed over this area is also hampering urban environment aspects since long time.

The main aim of the study was to find out the ways to get Kolkata hazard free and to recover the sustainability of the area from a long span of time. So that we may get Kolkata a fantastic balanced and hazard free urban area.

II. OBJECTIVE:

The main objective of the study is

I. To study the present geomorphological condition for understanding urbanslumping.
II. To study the ground water fluctuation and its impact on urban slumping.
III. To prepare better direction plans for maintaining sustainability of the area.

III. METHODOLOGY

Kolkata the typical urban area has grown since last 300 years. But at present the growth rate of the city has increased to a greater extent after the shifting of administrative setup of India from Kolkata the city is facing so many problems.

Morphodynamics of the city is changing rapidly to analyse these problems I have adopted three fold methodology, these are

Pre-field Methodology:

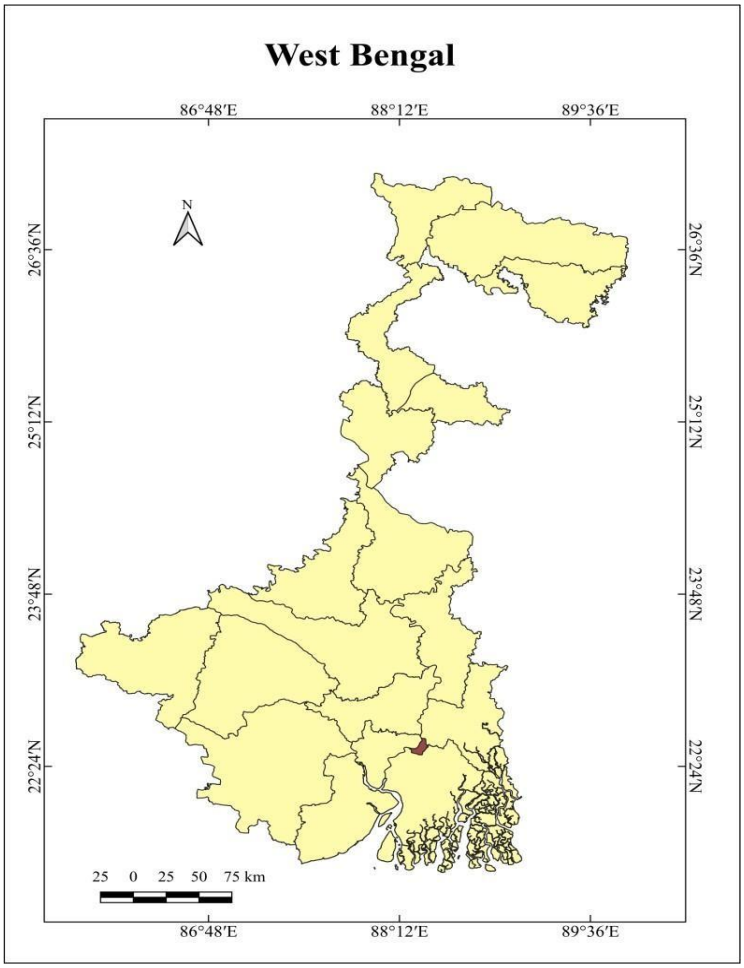
Before going to the field trip I have collected various informations regarding the problems of the city Kolkata and at the same time I had also collected various data and information regarding the changing nature of the city. various other organization for the collection of data and information regarding the morphodynamics of Kolkata.

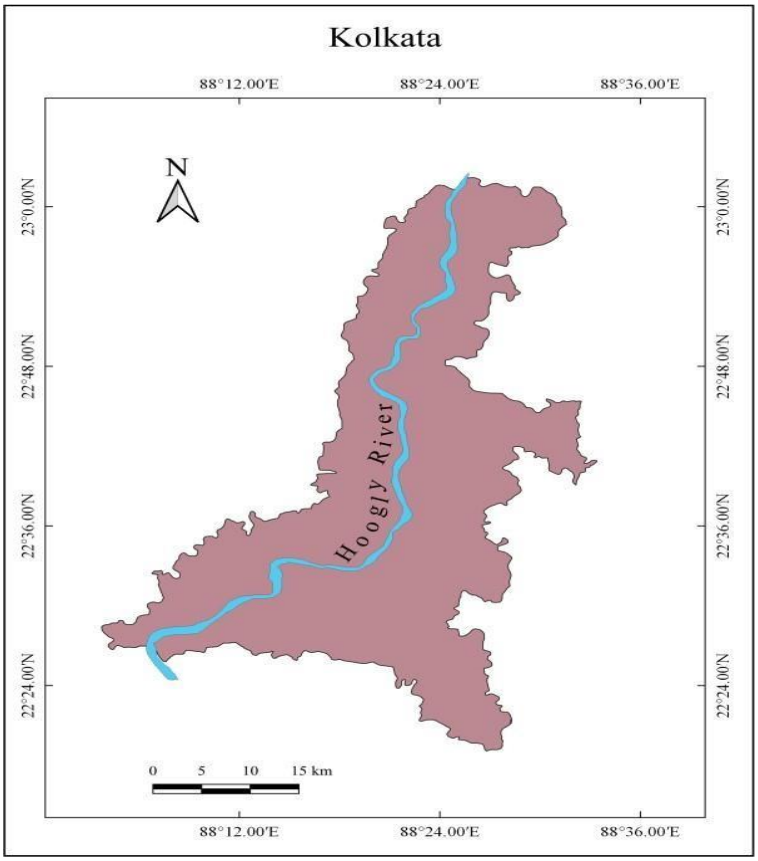
I visited

1. NATMO
2. NBSS (National Bureau of Soil Survey)
3. Central Ground Water Board
4. Geological Survey of India and various other organization for the collection of data and information regarding the morphodynamics of Kolkata.

Field Methodology :

LOCATION MAP





After collection of various information regarding the morphodynamic changes. I have arranged field trip and I have visited three places mainly in the pre-monsoon Period, monsoon period and post monsoon period. And have tried to get a relationship of the various aspects which are related to the morphodynamic changes of the city.

Post-Field Methodology:

After returning back from the field I have tried to get a co-relationship between various aspects of pre-field information along with the field experience and have generated a hypothesis and tested hypothesis to resolve various plans and development proposals for Kolkata.

IV. GEOGRAPHICAL SETTING

1. **Physiography:** The gentle rolling plain topography of Kolkata as basically formed over a typical saucer shaped underline alluvial terrain which has owes its origin from the Pleistocene alluviation over the typical Eocene hinge as a result the surface is not uniformed a variegated rolling plain – topography is mostly prominent is its various parts. Kolkata is the typical town which has been developed over this deltaic terrain. The upper most crustal points are very young and are gently sloping towards Bay of Bengal. As the river borne alluvial has expanded over the Bengal fan that is why the stratigraphy is also inclined towards Bay of Bengal. It is not only hampering urban eco – system but also increasing the rate of mass system towards river Ganga and Bay of Bengal if we follow the surface flow within the urban area then it is prominent that some parts will experience water logged situation. But within the urban area with the continuousgrowth of settlements water logging problems has been vetted and at the same time discharge has increased and recharge of ground water has ceased fall in the pizometric level but as the area is located in the lower Deltaic plain that is why recentalluvialand quaternary alluvial have caused excessively fertile plain.
2. **Geological Setting:** Ganges Delta basically emerged its shape and configuration on Bengal Fan. The Bengal Fan geo-tectonically is changing its nature and characteristics since Eocene period at phase of geological era a typical hinge has evolved through the East coast of India starting from South- West India ridge and has extended up-to the Dauki fault at the NE India prior to the development of such typical fault line at the end of Dharwar basin margin fault and Dauki fault has developed. Dauki fault was basically tectonically active shear at the north east India which has gave birth to the dissected flow of Indo-Bram or Shiwalik river system. Simultaneously another drainage divide has occured which is known as Potwar plateau prior to the origin of Himalayas . After the origin of Himalaya the newly originated streams named as Alaknanda, Mandakini, Bhagirathi etc, had joined with the dissected middle part of the ancient stream and has diverted the streams towards Bengal Fan. The river has met its debouching point just after Rajmahal Hills. At the period of Miocene and Cuddappa the surface of Bengal Fan has repeatedly captured and has developed various other fault like Padma, Pabna, Ghantal fault and various other faulted surface. The phase of Pliocene has just modified the bottom relief of Bengal Fan and has created a surface with low bathymetry which indicate the faster rate of sedimentation over this arcuate fan. Depending on this symatic structure as parent rock successive textural groups of formation has occured over Bengal Fanas the lithified layers due to the continuous processes of propagating deltaic environment.

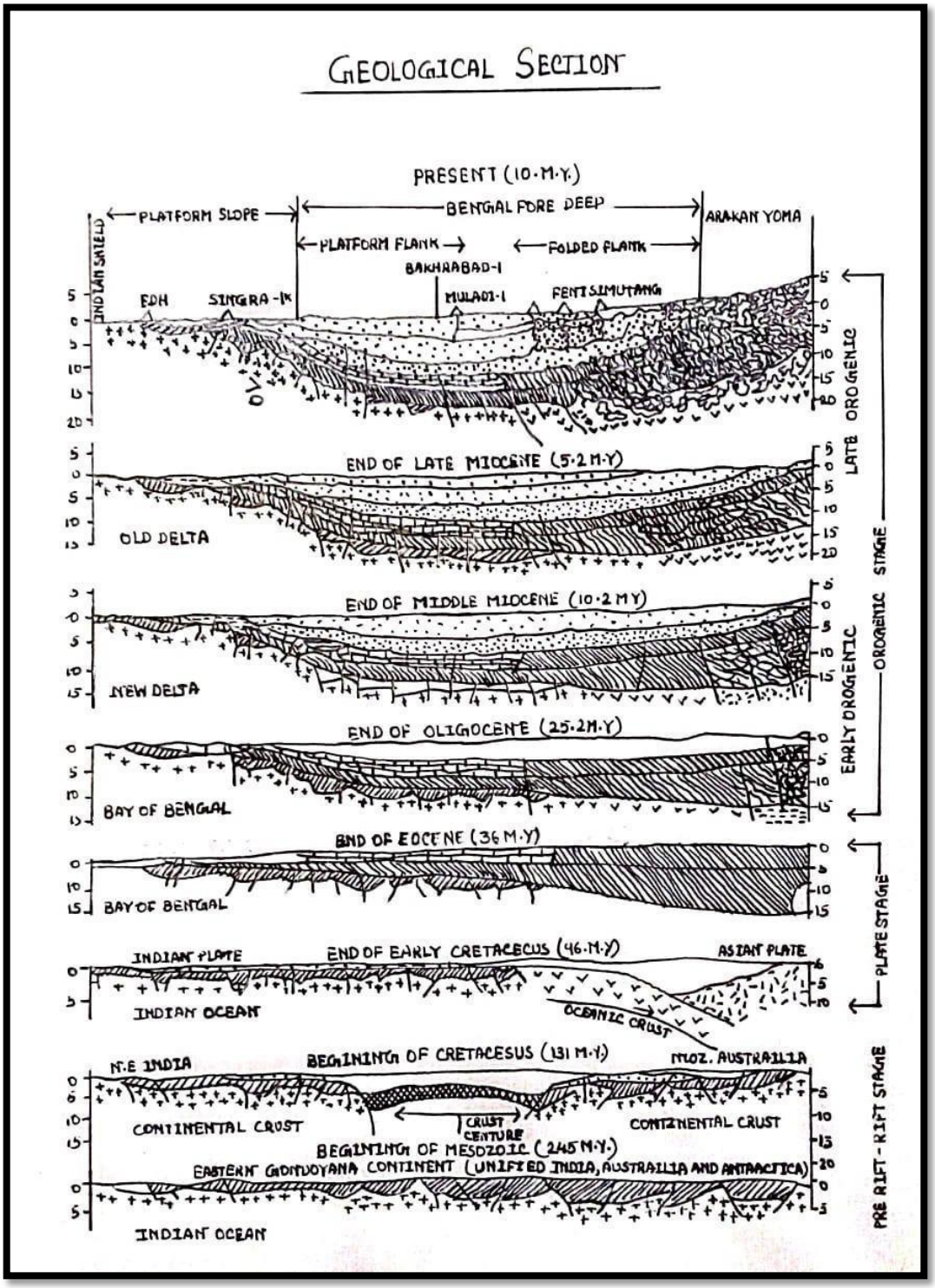
   If we considered the geological cross section of the area then the sequence will be as follows:

   (i) The upper most layer much more soft with fine grained sediments and a balanced textural composition with more or less granular round shape particles. Its water bearing capacity is maximum because of its textural uniqueness and various fine stratified layers arranged successively in this area. The depth of the strata is near about 40-50 mts, with extreme porosity and permeability. That's why these layers normally indicate aquifers of various depth with respect to the topographic variation in this area.

   (ii) A typical layer of extremely frazil grains, boulders, pebbles, cobbles andpottery materials which has deposited prior to the formation of Kalighat formation. The extension of the bed is near about 1600 mts. This layer has no aquifers because the variegated nature of composition doesn't permit the water to hold in this layer. In this layer not various activities performed over the surface. Not only that this layer create passages for the biotic elements

to penetrate towards the subsurface condition.

(iii) After these frazil layers to separate beds observed in the sub surface condition. The



extension of this two layers are 150-200 mts. These layersnormally indicate the occurrence of biotic elements which has passed through the porosity and permeability of the upper rock strata. These two layers are much more stable and are able to carry huge amount of ground water. But at these layers are present at a depth of more than 1800 mts. That's why this water is not easy to pump out for the uses of common people.

(iv) After these two layers a typical layers of calcium carbonate prevailed in this area. Through this layer extends upto 4 km. That's why it indicate its depth is near about 2 km. This layer is very much sensitive layer and below this karst layer some fossils are

present. This layer is extremely hard but chemically sensitive and below this layer the vast simatic platform of Bengal Fan extends.

3. **Geomorphology and its zonation:** Deltas are complex eco geomorphic systems where features such as channels and inter channel islands are present over a wide range of spatial scales. A quantitative description of the morphology of deltas is fundamental to address how they react to changes in climate forcing and human pressure. In particular, it is interesting to ask how the distributary patterns we observe in coastal areas around the world result from processes and external forcing acting on deltas, and how such patterns might be related to deltaic function, vulnerability, and nearest – edge distance show and resilience. Using the example of the Ganges – Bramhaputra – Jamuna Delta, we show that the statistics of island size, shape, factor aspect ratio and nearest – edge distance show distinct spatial patterns.

Delta distributary network span a wide range of spatial data and temporal scales: channel widths, for example, range in scale from hundreds to thousands of meters in the main network, down to a few meters for drainage distributors within islands channel migration and avulsions occur on periods up to thousands of years, while the reworking of channel bed and banks due to flood events can occur within a single year.

Deltas are threatened by several factors, including anthropogenic disturbance (e.g upstream sediment trapping due to dam construction , sediment mining, navigation structures , accelerated subsidence due to oil or water extraction), natural subsidence, and eustatic sea level rise. The response of a deltaic system to these forcing can be dramatic and result in loss of human lives, economic resources and environmental services.

Looking at delta distributary patterns it is natural to ask how the system's morphological organisation is the result of the processes acting on the delta and how the distributary patterns might be related to deltaic function, vulnerability and resilience.

Among the early quantitative studies of delta networks was that of Smart and Moruzzi (1972), who focused on topology and proposed representing the deltaic networks as a directed graph and analyzing various functions of vertex and link number. Among recent efforts, Syvitski (2005) and Saito (2007) illustrated empirically the scaling of the number of distributary channels with respect to river length and delta gradient.

The recent availability of satellite imagery over much of the Earth has greatly improved the quantitative analysis of geomorphic features. Examples of features mapped from satellite imagery include number and size of distributary channels, container valleys, flood plain depressions, oxbow lakes.

Here our goals are to identify key metrics and attributes of the network, analyze their statistical behavior, and explore their potential linkages to processes acting on the delta. In particular we are interested in understanding whether the spatial structure of the deltaic networks carries any signature of the processes responsible for delta formation and evolution.

4. **Structural Facilities with Respect to the Processes of Denudation:** If we considered the provided climatic data then it will be observed that change in the average condition is very negligible. But if we consider the climatic condition of last 10 years the climate is changing very rapidly and as a result consequences of climatic change are also experienced remarkably and as a result the either side of the river Hooghly mainly it's lower ridge.

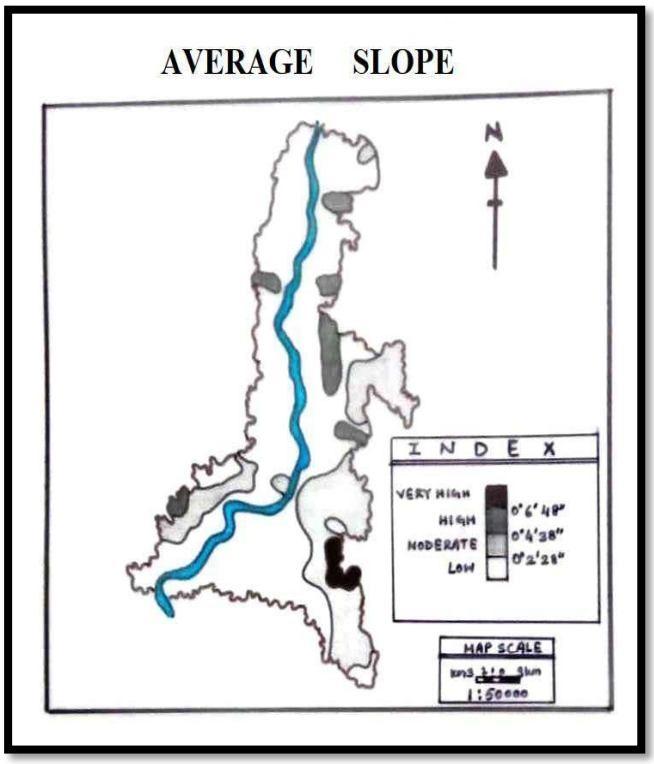
The increasing climatic temperature has indirectly increased sea level by melting of glaciers in the various parts of the globe. As a result the water level of Hooghly River as well as the tidal level are also increasing and at the same time frequency of the cyclone are also increasing very rapidly. All these aspects have pushed saline water through the main channel and the amount of salinity is increasing very rapidly.

The other most important thing is that river is flowing through a tectonically most affected area. Not only that through the river Hooghly, Eocene Hinge is passing and as a result it is very much sensitive since last decade as the sea level is rising steadily. The surface is losing its isostatic balance which have caused this area tectonically more active. Since last 2013 the area is experiencing powerful earthquakes and all these quakes are carried by Eocene Hinge is degrading the landscape gently. As a result the rising sea level is getting a chance to submerge the coastal areas easily. On the other hand as the river Ganga is carrying much more water seasonally its impact of river bank erosion is increasing very rapidly.

V. CHANGES OF GEOPHYSICAL CONDITIONS

1. Slope:

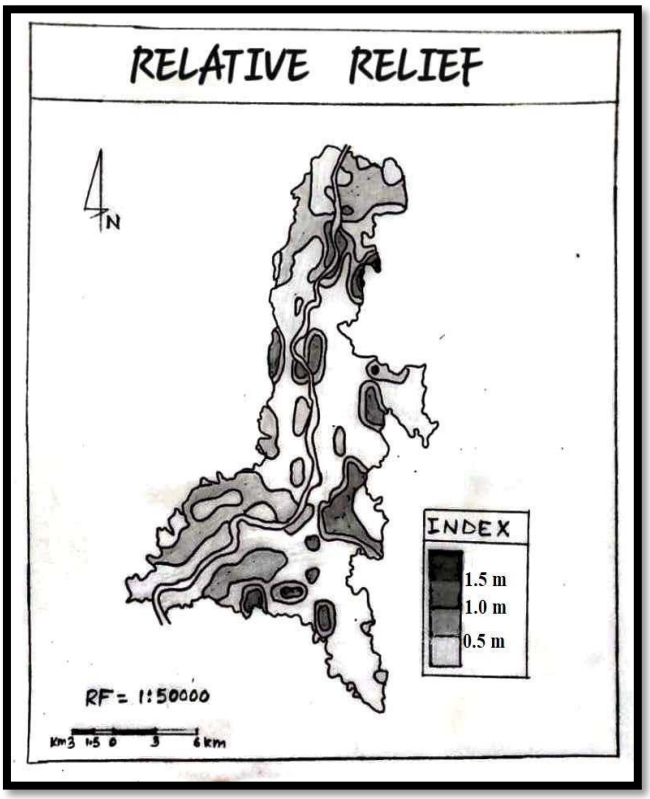
- In the study of average slope of Kolkata city, the higher landscape slope is followed in some typical areas like – Shyambazar, Sovabazar area , Garden Reach , Taratala and partly Sealdah and Tangra area.
- But the another side of Hooghly river shows a very gentle surface.
- The landscape slope indicates a Rolling plane topography due to the fluvial dynamic nature of the landscape.
- The side of Howrah and associated areas are also indicating landscape slope variation to a lesser extent.
- But the comparative greater and swel landscape of Dakhineswar , Bali area , Ramrajatala and Basara area, which are prone to erosion.



2. Relief: To analyse geomorphic characteristics as well as physiographic variation on the either side of river Hooghly. I have analysed relative relief variation of Kolkata. The relative relief map prepared by me considering spot heights and contour values as indicated in the topographical map no. 79B/6. It is clear that the relief of Kolkata is extremely variegated. Relative relief zones are also indicating the flow of paleochannels in the various parts of Kolkata. Though the channels have been completely encroached by continuous expansion of urban area.

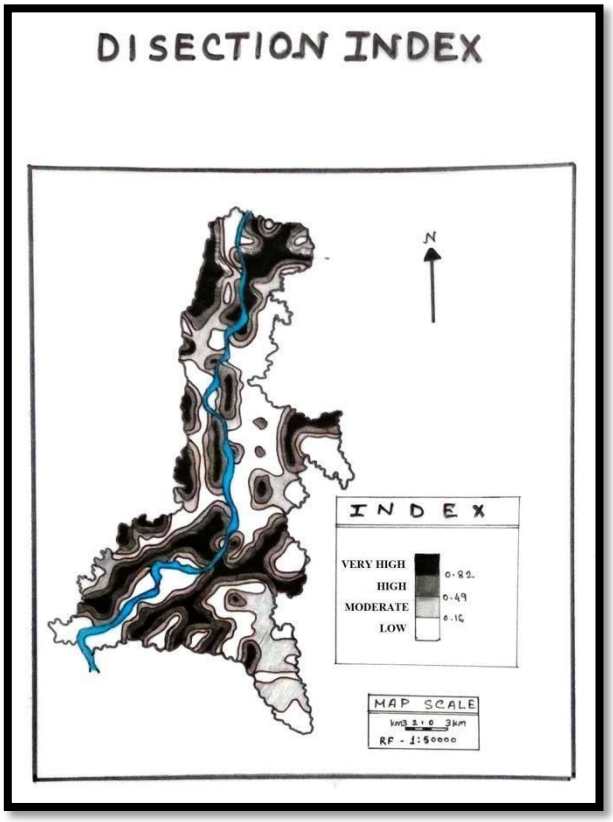
The physiographic variation is still remaining in the various parts of the area. The drawn map also indicates a greater physiographic variation is located in the Bon Hooghly, Dunlop area, Dumdum – Nagerbazar area , Sealdah – Maulali area and to some extent variations are also prevailing in Taratala and Garden Reach area. On the other hand such altitudinal variation is prominent in Shyamnagar area.

Such a typical landscape variation indicates the surface is extremely dynamic and have been changed temporally. Due to the intensive anthropogenic activities



performed by urban dwellers.

3. Dissection Index: The drawn map of dissection index directly or indirectly indicates the nature of dissection is comparatively greater where the higher relief zones are prominent. Here in his drawn map it is also observed that on the either side of the main channel dissection index is comparatively greater and not only that it's value is more than 0.82. No natural agents are able to create such a huge dissection only human activity may act such a typical devastating agent, it also indicate that the sustainability of Kolkata and Howrah is degrading day by day.



4. Changing Nature of the Surface: With respect to super imposition of physical characteristics in three stairs I have superimposed socio economic conditions in two stairs and depending on this superimposition I have find out common influence zone and depending on this zonation I have prepared a vulnerability map on the either side of the river Hooghly and also Kolkata. Such a typical map drawn by me indicates 5 zones . There areas follows :

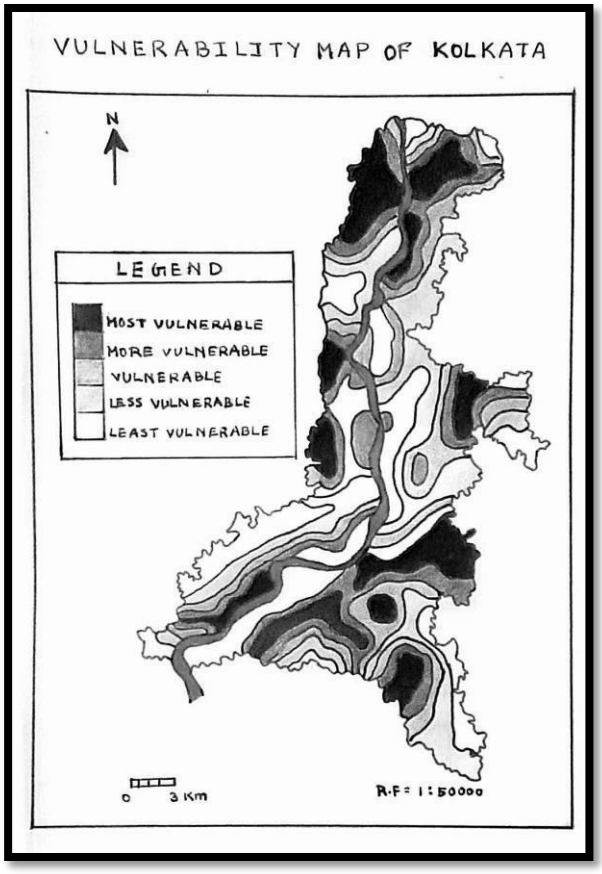
(i) Least Vulnerable Zone: This area is mostly observed in the furthest position from Hooghly. But the zone also observed near to Dunlop Ganga area.

(ii) Less Vulnerable Zone: Least vulnerable zone is prominent near to Kalighat, Tollygaunj Ganga area and nearer to Shyambazar, Sealdah and Dunlop area also prominent in and Shyambazar area.

(iii) Vulnerable Zone: This area is prominent nearer to Garden Reach and Bata Ganga area and at the same time this zone is also prominent in Manicktala, Bidhannagar area and nearer to Nabanna, Kona highway and towards Domjur area.

(iv) More Vulnerable Zone: This area is prominent in Shobhabazar, Udyanbati, Dakhineswar, Barabazar and nearer to Babughat area and on the other hand this area is prominent in Bali and in the Howrah township area.

(v) Most Vulnerable Zone: More than 40% of the landscape of Kolkata and 35% landscape of Howrah are under most vulnerable area. Such a



huge extension of most vulnerable area caused by intensive activities performed by human being along with fluvial dynamics occurred on the either side of the river Hooghly. The landscape is changing very rapidly due to the prolonged processes of urbanization and only for this reason the rate of vulnerability is increasing so rapidly.

VI. CHANGES IN THE VARIOUS SPHERE

1. Climate Change and Global Warming: Climate change is a problem which is the threat to Kolkata and threat to Hoogly River but has been generated globally. Presently Kolkata's urban environment scenario modifying the nature and characteristics of climate since long time. Global warming and various other aspects like cyclonic disaster, river bank Erosion and the variation in depth of the river are the indicator of such climatic change. This aspect is continuously increasing water salinity and is also restricting the debouching area of the rivers.

If we consider the provided climatic data then it will be observed that change in the average condition is very negligible. But if we consider the climatic condition of last 10 years the climate is changing very rapidly and as a result consequences of climate change are also experienced remarkably on the either side of the river Hooghly mainly in its lower reach.

The increasing climatic temperature has indirectly increased sea level by melting of glaciers in the various parts of the globe. In last three decades the rate of global warming in increasing by leaps and bounce due to the continuous processes of urbanization, deforestation and changing nature of land use pattern. The urban area of Kolkata within this area is also creating urban heat island. As a result of global climate change the climatic balance is degrading day by day. The water level of the Hooghly River as well as the tidal level is also increasing and at some time the frequency of the cyclones are also increasing very rapidly due to excessive temperature. All these aspects have pushed saline water through the main channel and the amount of salinity is increasing in the river water very rapidly. And on the other hand increasing level of salinity has caused the mangrove environment on the either side of the river Hooghly from its confluence to Barrackpur.

VII. ANALYSIS OF THE THEME

1. **Analysis of the Procured Data and Surveyed Data:** With respect to the analysis of procured data and surveyed data it is clear that the city Kolkata is developing rapidly and not only that the phase of its growth and development of the surface of the city is continuously losing its balance since last 2000 years, but in the last 300 years the growth and development of Kolkata as a urban center the balance is decreasing very rapidly. The saucer shaped city with its vast Esplanade the growth has occurred in an imbalanced manner. Basically for the city the growth and development plan is not wise and in some places no growth and development plans has been considered for the structural development of the city.

The lithological condition is also not suitable for such a huge growth and development because the upper most Kalighat layer has been considered the most important layer and beneath the layer the presence are imbalanced fragile textural layer, the city is losing huge amount of sediment along with the movement of subsurface water and ground water, seasonal movement in such surface is very much important because of the shortage of ground water in recent period, caused by excessive lifting of the ground water for the requirement of the multistoried dwellers and such excessive lifting of water is hampering the growth and development sustainability of the urban center.

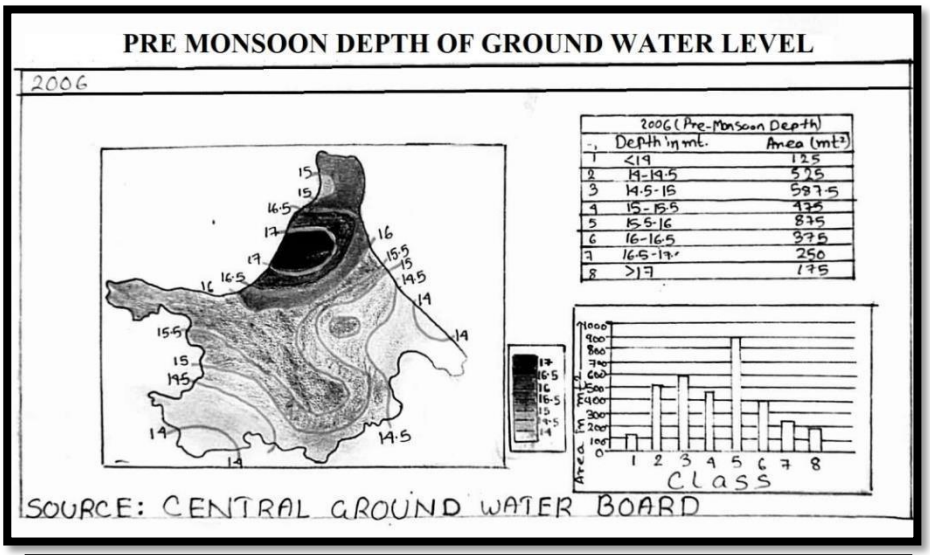
2. **Ground Water and its Fluctuation:** Unwise growth and developmentof Kolkata is leading the city towards a typical health crisis. The bio-physical environment of city is degrading very rapidly because continuous diagonal sub surface f l o w of water is increasing the amount of soluble sediment salt and clay along with huge amount of minerals. Thus these sub surface flow by generated voids and tunnels in the sub surface condition which are prominent in the other side of river Ganga and the other side of Adi-Ganga channel and Bagjola Canal.

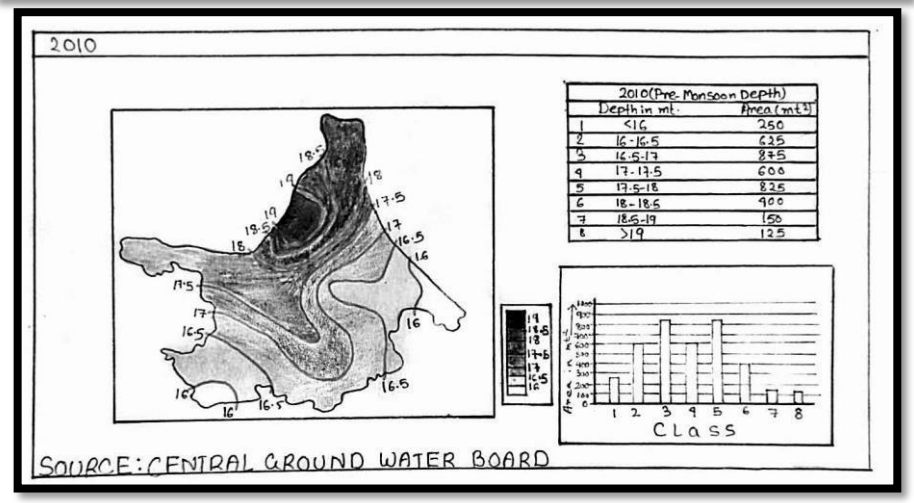
Unwise growth has also restricted vertical recharge and discharge of ground water. As a result when water is passing diagonally they are getting much more time end passage to pass and these polluted substances could easily reach to the level of ground water not only that when

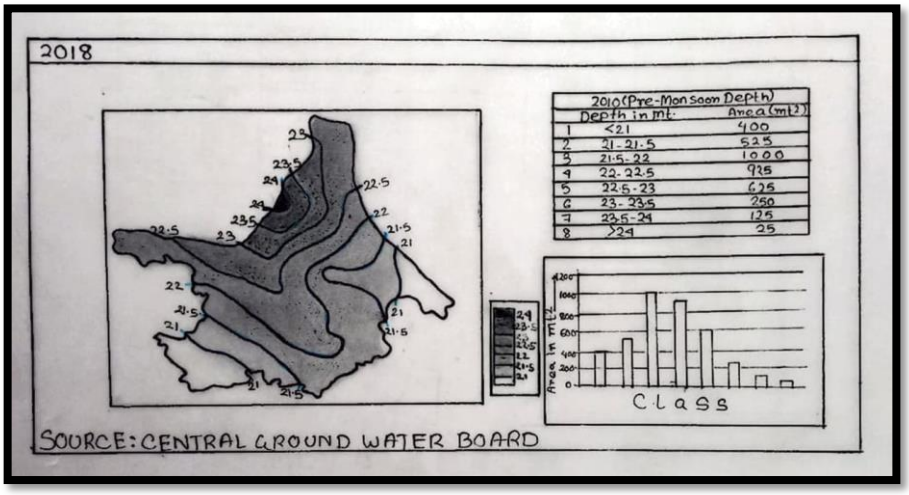
water flows diagonally they also getting much more time and passage length and by this way the rate of arsenic contamination is also increasing day by day. All these together are leading Kolkata towards huge health crisis in near future.

Scientific skill and technology became the destruction of the city is beyond our control . The city is actually hanging on a cradle because lower part of the city area has been washed out by the continues diagonal sub surface flow which has wearing out the cities sub surface sand silt and clay along with various types of minerals.

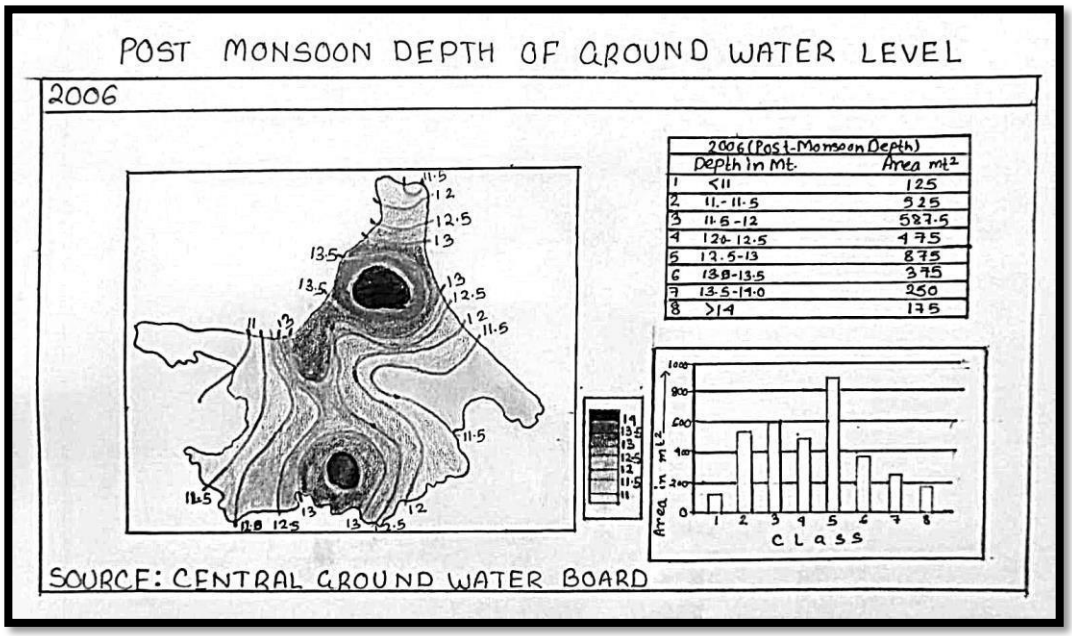
The pre-monsoon depth variation of water has been increased to a greater extent. It is due to







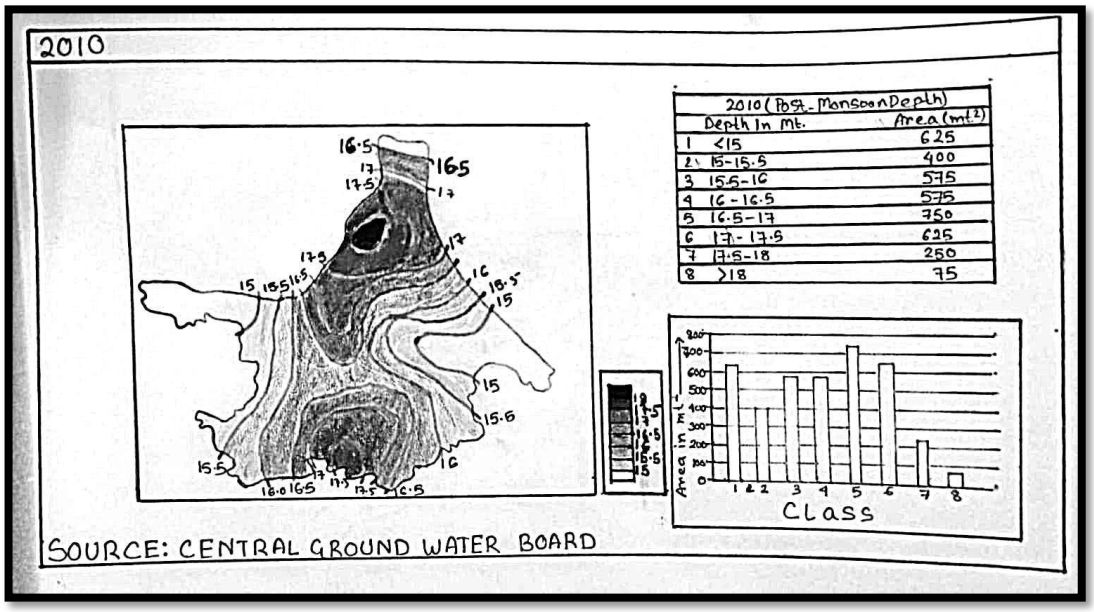
the continuous increasing rate of the utilization of ground water. The other most important cause is that day by day with the rate of increasing sub surface flow the sub surface tunnels formed by voids has extended their passage. As a result the saucer shaped sub surface lithology is attracting the sub surface flow towards the main river Ganga through the central part of the city. Due to such a typical flow condition of water contaminated water is spreading all through the city. Such a typical situation



has come to the city due to its unequal and unwise growth and development in its various parts.

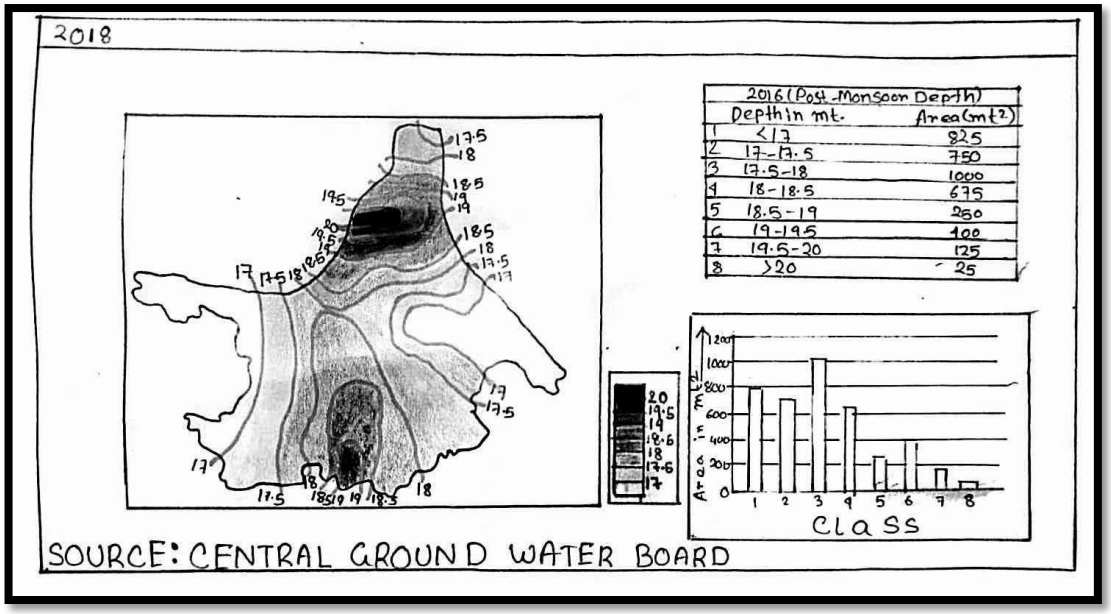
At the time of peak monsoon when water level raises upward they normally pump the ground water towards the sub surface condition with their huge energy. As a result the saucer shaped Kolkata normally receive excessive amount of water from the various water bodies surrounding Kolkata but the problem is that sub surface lithology indicates that the water is actually flowing towards Bay of Bengal because the rock stratas are inclined gently towards Bay of Bengal. As a result when this water pass away through the sub surface condition of the city they are normally creating huge amount of voids and vacuum spaces within the subsurface conditions of the city.

In the post monsoon period the ground water level reach to the surface. As the quantity of water



increases it normally dilutes pollutants and as a result percentage of contamination decreases. That is why quality of water tends to be normal in the rainy seasons. Furthermore it is also important that the depth of the ground water has also changed in the recent years it is because the surface is losing its stagnancy

because voids and tunnels formed in the sub surface condition has extended to a greater extent which is causing excessive ground water discharge towards Bhagirathi - Hoogly river and towards Bay of Bengal.



3. **Causes of Excessive Subsurface flow and Excessive Amount of Massfluction and Liquefaction:** Post monsoon as a subsurface flow has created sufficient amount of void that is why recharged water from its surrounding area could easily flow through the subsurface lithology without any restrictions. When this water flow down according to their gradient they normally carry huge amount of coli bacteria from the surrounding water bodies of the city. As this water flow horizontally within the sub surface condition they normally get lengthy passages for penetration of polluted water in the subsurface condition and by this way they are contaminating the ground water stratas. It is the main cause of diarrhea like disease spreading from the wells and tube well water in the various parts of the city. In future such contamination may increase to a greater extent. It is the main cause of diarrhea like disease spreading from the wells and tube well water in the various parts of the city. In future such contamination may increase to a greate r extent. Presently such contamination occurred in various seasons because it is related to the fluctuations of ground water level. But day by day as the level of ground water is declining very quickly that is why bacterial infection may be very common occurrence all – round the year.

   The other most important factor is that the urban space is mostly covered by cement and concrete. As the result the vertical flow of ground water has already been decrease since long time . That is why when the subsurface strata receiving water from the surrounding area. They normally generate diagonal flow through the passing and voids which has already been formed within the urban area . At the time of their diagonal flow they are also dissolving arsenic bearing rock strata and by this way the rate of arsenic contamination is also increasing steadily.

VIII. DEVELOPMWNT OF HYPOTHESIS WITH RESPECT TO THE ATTITUDE OF PROBLEM SOLVING

After complete analysis of the various aspects it is clear that the Kolkata is continuously loosing its balance and as per our methodology and various Information collected on various aspects of Kolkata, we can draw hypothesison the sustainability of Kolkata. These are as follows:

1. Kolkata is degrading rapidly due to the continuous processes of unwise growth and development.
2. Presently due to the continuous processes of the fluctuation of ground water level, diagonal flow of subsurface water from the surrounding areas are increasing rapidly. Such a condition is creating vacuum spaces below the surface of Kolkata and are causing huge amount of urban slumping in spaces.

IX. CONCLUDING REMARKS AND CONTINUOUS FOLLOW UP PROGRAMME AND PROBLEM SOLVING ATTITUDE

Dependency on the overall analysis we may conclude that Kolkata is degradingvery rapidly due to continuous process of unwise growth and development. To protect the city we may suggest some proper management plans for the sustainability of the city and the growth and development of the area. These are as follows –

1. Unwise growth and development should be restricted and eco- friendly development plan should be taken into consideration.
2. Any developmental aspects related to the geomorphological conditions of the area should be managed properly and seriously.
3. Lifting of ground water should be stopped immediately, so that fluctuation of ground water level should be minimised.
4. A standard building code should be prepared to maintain the load bearing capacity of the surface properly. Not only that the building code should be kept properly and meaningfully.
5. No construction should be grant over Kolkata which are not suitable to the soil of Kolkata.

ACKNOWLEDGEMENT

The authors acknowledges Late Professor Dr. Subhas Chandra Mukhopadhyay, Late Professor Dr. Ananda Dev Mukhopadhyay, Professor Dr. Prithwish Roy, Professor Dr. Arunava Mishra for their constructive suggestions and help. The authors further acknowledges their father, mother and family member for their suggestions and help and the author furthermore acknowledge the librarian of GSI and the eminent research work of Dr. D.R. Nandi and the librarian of Central Ground Water Board and various other researchers in this field.

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