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Climate Change

Climate change and its impact on the ecological system of the Indian Sundarban region

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ABSTRACT

The Sundarban is a part of the Ganga-Brahmaputra-Meghna delta spanning across an area of about 25,500 Km^2 over southern Bangladesh and West Bengal out of which about 9,630 km^2 forms Indian Sundarban Delta (ISD). This region is within the Central Asian shorebird flyway and the only mangrove wetland tiger habitat in the world. Here intricate estuarine and coastal processes are influenced by the dynamic interface amongst adjacent marine, terrestrial and meteorological systems. Economically and naturally the ISD is of extreme importance to the entire coastal region of West Bengal and also to the entire metro city of Kolkata by providing livelihood and acting as a barrier to the natural coastal disasters. With the advent of time the Sundarban Delta is threatened by the changing climatic condition. On the basis of the available climatological data it indicates that disturbance in the rainfall and temperature pattern has emerged as the major climatic and social threatening issues. Such changes have also accounted for the change in the green coverage of the region leading to the disturbance in the ecological balance of ISD. This influences the agriculture and livelihood of the population of the area. The present study demonstrates the potentiality of Secondary data for monitoring the climate change in the region by analysing the rainfall and temperature patterns. Since such kind of changes stand as

a testimony for the past and present coastal climatology, so the inferences drawn thereon were considered as benchmark tool for climate analysis. Satellite images have been utilized for the subsequent analysis of the land use mapping with special emphasis on mangrove characterisation. A proper correlation model was also attempted between climatic parameters and vegetation coverage to estimate the ecological disasters due to climatic variations. Such estimation may play a vital role towards developing a sustainable management option to protect the mangrove region along with the associated eco-system balancing the socio-economic condition of the region.

Keywords: Sundarban Delta, Climate Change, Rainfall pattern, Temperature Change, Vegetation Coverage, Ecological Disaster, Socio-Economic Change, Sustainable Management options.

1. INTRODUCTION

The morphodynamic of "forest beauty" Sundarbans with endless diversity of vibrating nature is a suitable habitat of world famous luxuriant mangroves and Royal Bengal tiger. Sundarbans is a part of deltaic plain of fluvio-marine deposits. Covering an area of about 25,500 sq. Km of both India and Bangladesh forms a part of the world's largest Ganga –Brahmaputra delta at the confluence of Bay of Bengal. Sundarbans is excellent for its amazingly quite nature and simultaneously it is awe-inspiring abode of Royal Bengal tiger, estuarine-crocodiles, king cobra or snakes.

Indian part of Sundarban is undergoing changes continuously. Indian Sundarban bearing the largest mangrove forest on earth with an area of 9,630 km^2 lies between 21˚32' - 22˚40' N and 88˚05' - 89˚00'E. It hosts a wide and diverse range of flora and fauna. The region is dominated by mangroves at periphery and also creeks with regular tidal influxes.

The region is rich in biodiversity. There are 64 species of mangroves and their associated species and 1586 species of fauna (Das,G.K.,2011). The UNESCO has declared the region as the World Heritage Site in 1997. Apart from these, the region is contributing in various ecosystem services like soil formation, soil protection and regulation of hydrological cycle, moisture contents, evaporation, climate and protection of the area from the natural calamities (Kathiresan and Bingham, 2001; Roy and Hossain, 2015).

But this ecologically enriched region is being threatened by the climatic changes which are impacting the meteorological aspects of Indian Sundarban Delta. Fluctuations in the minimum, maximum temperature and along with that the precipitation pattern is impacting ecological system by canvassing a coverage change in vegetation.

Present study intends to identify the impact of climate change on vegetation coverage and vice-versa. Under the present circumstances continuous monitoring of the vegetation cover becomes critically important element for sustainable management of such susceptible ecology. Remote Sensing can act as an effective tool here. For climatic factor analysis secondary data sources act as the most suitable option.

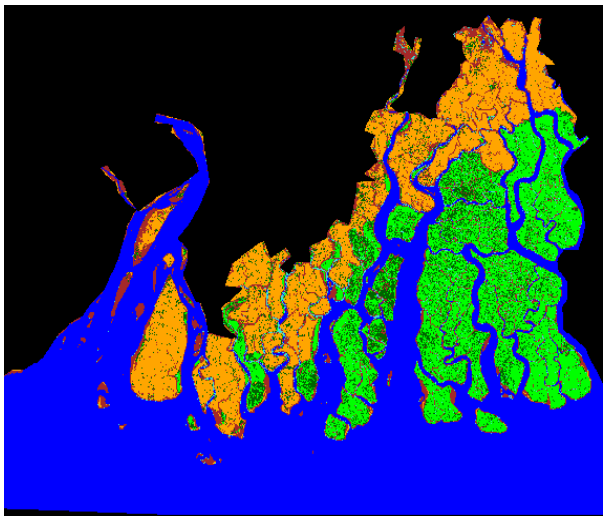


Figure 1 A Typical Classified image of ISD Region

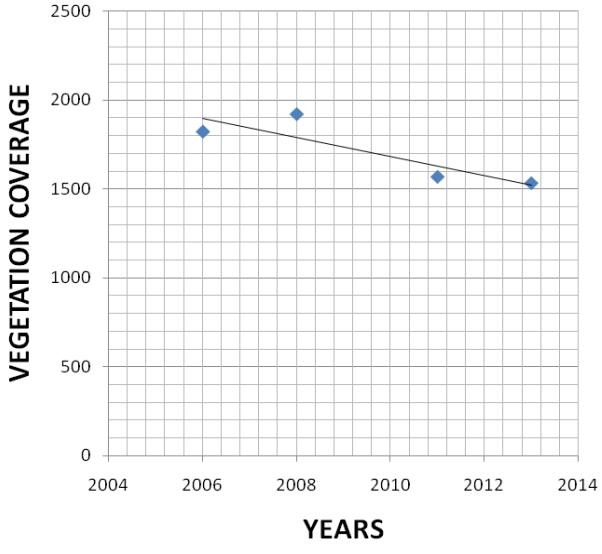


Figure 2 Change of Vegetation Coverage Area (in Km^2) with Time

2. METHODOLOGIES AND DATA ANALYSIS

The study was carried out at Indian Sundarban Region. For studying the change in the vegetation cover, cloud free images of Landsat 4-5 TM (Thematic Mapper) and Landsat L7ETM+SLC off – sensors – (Path 138/ Row 45) of the month of February of years 2006, 2008, 2011 and 2013 were being used. Study of the meteorological factors like – Maximum Temperature, Minimum Temperature and Precipitation pattern have been done on the basis of secondary data collected from the Director of Agriculture, Baruipur, Government of West Bengal.

2.1. Remote Sensing Data Analysis

Concerned geo-referenced satellite images of the respective sessions as mentioned earlier were processed by unsupervised classification with 50 unsupervised classes. From those classes only vegetation coverage classes were combined and highlighted and the area of those were calculated. A typical such classified image was presented in Figure 1. Identified and calculated vegetation coverage is then used for time series analysis using MS-Excel platform (Figure -2).

2.2. Secondary Data Analysis

The meteorological parameters, like rainfall and temperature, which were collected as secondary data, were analysed over time using MS-Excel platform and concerned time series charts were prepared and presented in Figures 3 to 5.

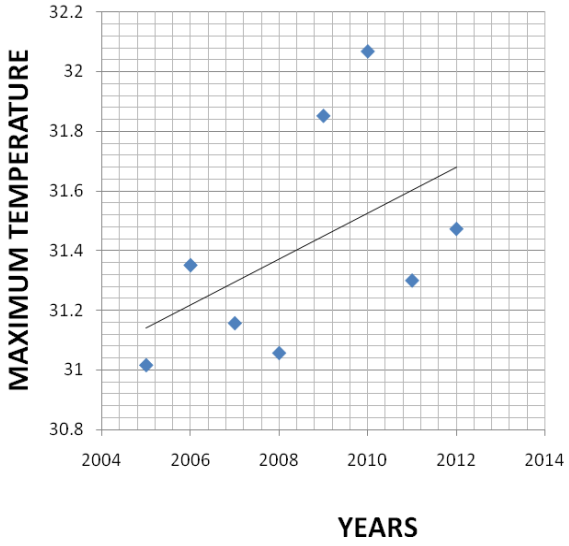


Figure 3 Variation of Annual Average Maximum Temperature (in °C) with Time;

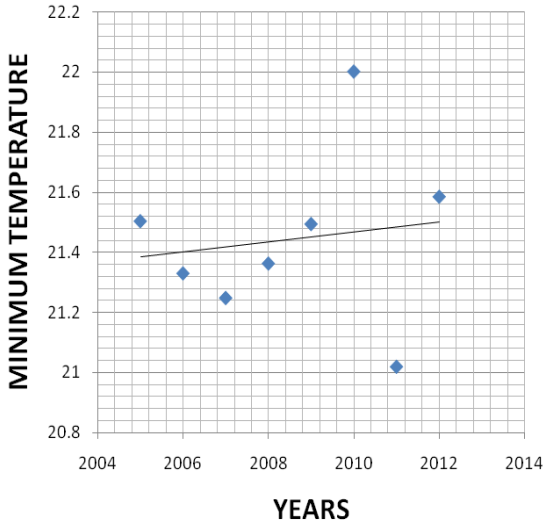


Figure 4 Variation of Annual Average Minimum Temperature (in °C) with Time

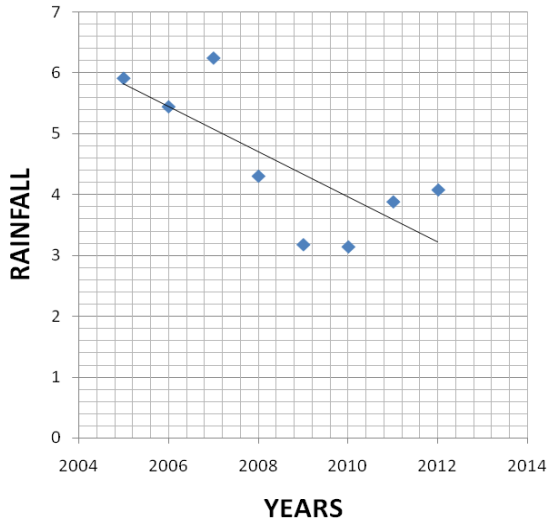


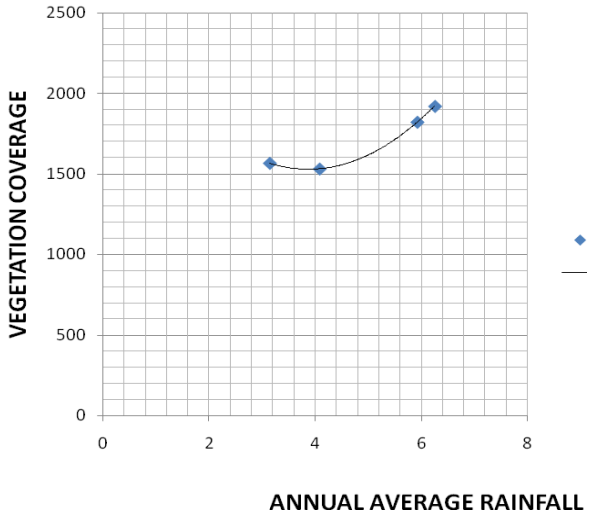
Figure 5 Variation of Annual Average Rainfall (in mm) with Time

2.3. Correlation between Vegetation coverage and Meteorological factors

At the penultimate stage the calculated vegetation coverage is being related with the respective meteorological data. Correlation between the above mentioned parameters are made under two broad categories, i.e., Impact of climatic pattern of previous one year on the vegetation coverage of a particular time and in other way the impact of vegetation coverage of a particular time on the climatic factors of next one year.

2.3.1. Impact of climatic pattern of previous one year on the vegetation coverage of a particular time

Impact of Annual Average Rainfall, Annual Average Maximum Temperature and Annual Average Minimum Temperature of previous one year on the vegetation coverage of a particular time were studied and presented in Figures 6 to 8.



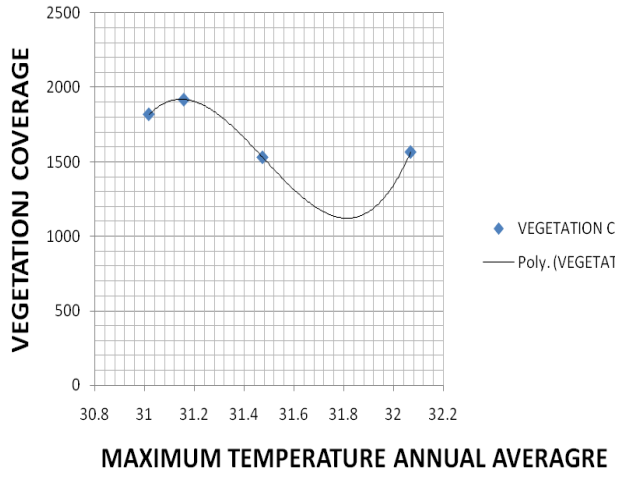


Figure 6 Impact of Annual Average Rainfall (in mm) on Vegetation Coverage (in Km^2); **Figure 7** Impact of Annual Average Maximum Temperature (in °C) on Vegetation Coverage (in Km^2)

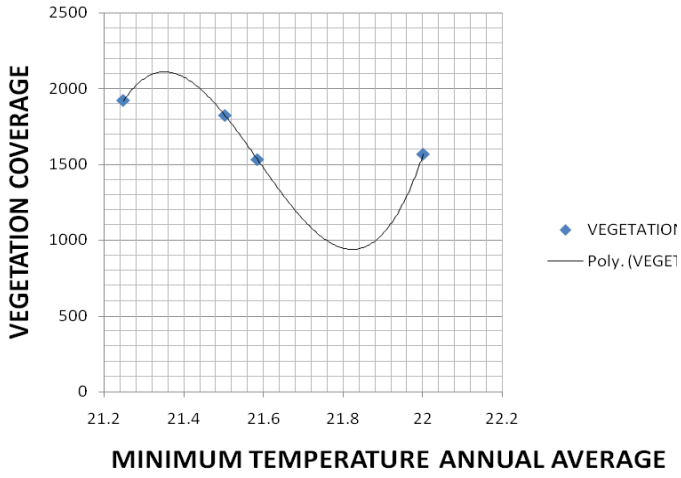


Figure 8 Impact of Annual Average Minimum Temperature (in °C) on Vegetation Coverage (in Km2)

2.3.2. Impact of vegetation coverage of a particular time on the climatic conditions of next one year

Impact of Vegetation Coverage on the Annual Average Rainfall, Annual Average Maximum Temperature and Annual Average Minimum Temperature of next one year was studied and presented in Figures 9 to 11.

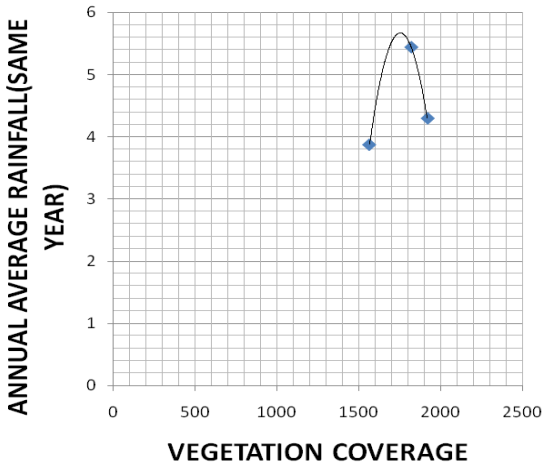


Figure 9 Impact of Vegetation Coverage (in Km^2) on Annual Average Rainfall (in mm)

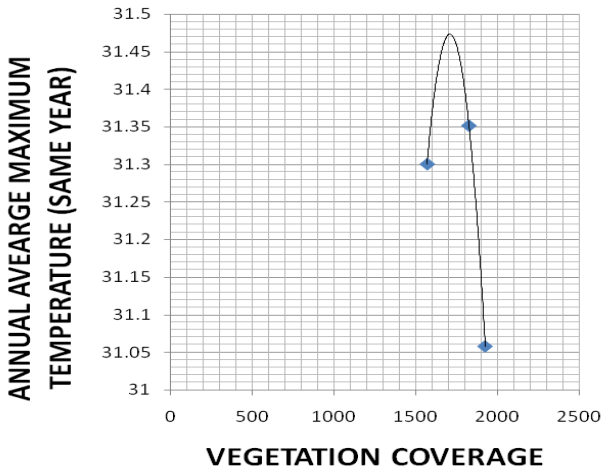


Figure 10 Impact of Vegetation Coverage (in Km^2) on Annual Average Maximum Temperature (in °C)

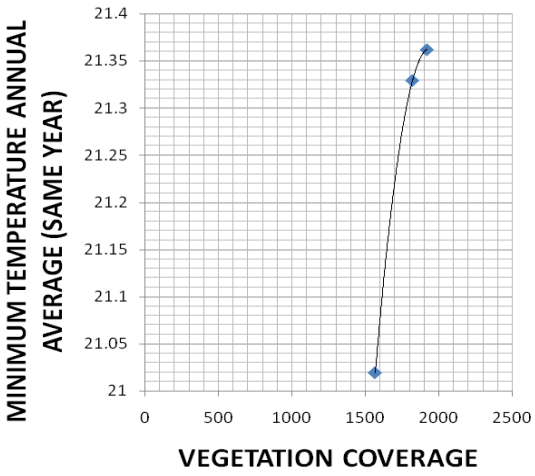


Figure 11 Impact of Vegetation Coverage (in Km^2) on Annual Average Minimum Temperature (in °C)

3. RESULTS AND DISCUSSIONS

Trend of decreasing vegetation (Figure: 2), increasing maximum temperature (Figure: 3), minimum temperature (Figure: 4) and decreasing rainfall (Figure: 5) indicates to the change in climatic scenario. Such change is becoming an alarming factor for the ecology of the Sundarbans. Disruption of ecological balance is becoming extremely prominent from the impact of rainfall (Figure: 6), maximum and minimum temperature (Figure: 7 and 8 respectively). Decreasing vegetation coverage in turn affects the region rainfall pattern in a direct correlation, (Figure: 9) and the temperature pattern following inverse correlation (Figure: 10 and 11 respectively) also. Henceforth, in either ways the situation is of concern for the most vibrant ecology including The Mangroves and the Royal Bengal Tiger.

From the economical perspective also it's a very serious cause of concern. Vegetation or the forestry of ISD which provides livelihood for many a population out there is facing a problem and heading towards an unsafe future which in turn is indicating towards weakening of the economic condition of the region. With the decrease in vegetation, the deltaic zone is becoming more and more susceptible to the natural disasters, which in turn is also posing a great challenge to the safety of the human settlement of the region. At the same time being very close to the metropolitan city of Kolkata, it also poses a possible threat to the climate of the city. In short the above mentioned changes have also nurtured the socio-economic condition of Indian Sundarbans Delta.

4. CONCLUSIONS

The ecology of ISD is being greatly impacted by the vegetation coverage of the region which in turn is also impacting the meteorological scenario of the concerned zone .Henceforth, proper management option with sustainability must be undertaken as soon as possible in order to save the "most vibrant ecology – The Indian Sundarban Delta "from a disaster which may become fatal for the human settlement of the entire State.

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