

IMPACT OF CLIMATE CHANGE IN INDIA: A REVIEW

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ABSTRACT

The studies on climate change are crucial for the survival of Mankind. The two most essential parameters to study the variation of climate variability and change are temperature and precipitation. In this study, a review on the Global Temperature and Rainfall along with the Indian sub Continent was done. Further, some important aspects of the impact of climate change in India were also reviewed and evaluated. It is evident from this study that climate variability is a continuous process but it is still immature to conclude with a particular climate trend for a particular region due to the lack of sufficient studies as compared to the vastness and complexity of the field. Rather, we can all conclude that there is some kind of climate variability taking place in different pockets of the earth with different trends and natures and the common effort of all mankind should be to realize the impact of climate change and find practical solutions for humans to survive.

Keywords: Agriculture; Climate Change; Climate Variability; Impact; Precipitation; Temperature;

Introduction

Climate change is emerging as one of the most crucial challenges for mankind in history. The reasons for climate change and its impact on environment is not completely understood. Studies in climatology indicate that climate continuously changes with time. The ice covering a significant portion of the earth in the glacial period had either melted or retreated to the poles due to an increase in the surface temperature of the earth. Climate change is caused by factors such as biotic processes, variation in solar radiation, plate tectonics and volcanic eruptions and human factors. However, the earth could absorb most of the effect of climate change into its own system and has survived throughout the ages. Now, the scenario has changed. It is now established that global challenges such as water scarcity, ozone depletion, food security, environmental hazards, extreme weather, flood and drought are all related with climate change. In other words, there are certain factors that are beyond our control for causing climate change but studies have predicted that man made activities are also related with climate change. The factors leading to climate change is beyond the scope of this paper and we will concentrate on a review of climate change with special reference to India and the impacts of climate change in the Indian sub continent.

METHODOLOGY

The Literatures on climate change and variability were collected and the search was narrowed to peer-reviewed and grey literature published in English. The selected literatures were classified into three broad areas namely the relevant literatures in the global context; the Indian context and the impact of climate change in India. Initially, some questions regarding climate change were formulated, reviewed and analyzed. The literatures were reviewed chronologically in the most possible form and were studied and evaluated in the Indian context. .

THE GLOBAL SCENARIO

Nature has been very kind to mankind. There were climate changes on earth that have been absorbed by its own natural systems. There was extreme hotness along the deserts while the polar region experienced a very cold temperature but humans were strong enough to survive the climate change by adapting to the climatic changes across the ages. Studies have shown that the changes in temperature variability play a vital role in predicting the future temperature distributions [1]. Therefore, a systematic study of climate change will help the scientist to predict the future climatic challenges. The two main occurrence of warming took place in the year ranging from 1910 to 1945 and the other warming from 1976 onwards [2] and there was an increase of 0.19°C per decade during the year 1979 to 1998 [3]. The average temperature of the earth's surface increased by $(0.74 \pm 0.18)^{\circ}\text{C}$ in the last 100 years for the interval 1906 to 2005 [4]. It is predicted that there may be an increase of around 1.8°C to 4.0°C at the end of this century [5] and the climate change will reduce the melt water availability from glaciers [6]. On the other hand, there was no concrete conclusion of increase in temperature in the recent past from some studies conducted for temperature variation in England [7].The conflicting results obtained by different researchers may happen

due to the different statistical approaches used by different scientist. The changes in variability could also depend on the nature of season and the local condition of the place [8].

The study conducted by Trenberth shows that there is some large scale patterns of systematic changes where there were decrease in precipitation at the subtropics and tropics outside of the monsoon trough and increases in land precipitation at higher altitudes regions of North America, Eurasia, and Argentina [9]. There was an increase in precipitation on land during the 20th century for the high latitude areas ranging from 55° N to 88°N, while the low latitude areas ranging from 10 ° S to 30 ° N reported a decrease in precipitation [10]. It is now assumed that precipitation is one of the key climate variables for predicting the climate trends on a regional scale [11]. Thus, it is now clear that the two climatic parameters namely, temperature and precipitation are very important to determine the climate variability of a place. The climate change effects the global precipitation with the change in surface temperature of the earth. Studies in climate modeling have shown that the earth may experience an increase in rainfall in the 21st century [5]. Gutowski Jr et al. [12] documented global and tropical rainfall changes using the Global Precipitation Climatology Project (GPCP) and found near zero global changes, but with large variability and changes over land that are largely compensated for by the opposite change over the oceans. The extreme variations in climate variability will have an immense impact on eco system of the earth and the socio-economic life of humans. This is due to the fact that the healthy survival of many organisms is largely dependent on the existence of various virus and bacteria that can co-exist only under certain temperature and climate. Easterling et al. [13] predicted that climatic extremes will become more frequent at the current projection of climate change. The drought occurrence may increase in many regions [14] and flood frequency may enhance [15] under the current climate projection.

THE INDIAN SCENARIO

The studies done by Arora et al. [16], Goswami et al. [17], Kothawale et al. [18] and others show a change in precipitation and temperature. The climate trend in the Indian sub-continent is in agreement with the global trend over the last century [19- 21]. There is an estimated increase in temperature in India [16; 21] and warming is more pronounced in tropical areas like India [22]. It is predicted that the maximum and minimum temperature may increase [23] in many parts of India. The northern part of India is found to have an abrupt increase in maximum and minimum temperature as compared to the southern part of India [21]. Changes in diurnal temperature for Kashmir were observed in some studies [24].

A good number of studies have been done in the past to evaluate the precipitation trend at the national and regional level in India. Pocket of significant long term rainfall changes was identified [25] and there is a change in monsoon pattern with drought in North East India and flood in Maharashtra, Gujarat and Rajasthan. There is an increase in heavy rainfall events while a significant decrease in low and medium rainfall [17] with an increasing trend in temperature during the last 112 years in India [26]. However, some studies showed that there is no significant trend in average annual rainfall over the country [27].

IMPACT OF CLIMATE CHANGE IN INDIA

India is one of the largest and most populous countries in the world. The topography of the country is diverse in nature. The country has high mountains, huge valleys and a massive plain that is very near to the seas. The cultures and economic conditions of the people vary from region to region and therefore a simple scientific trend rule cannot explain the varied climate changes that are occurring in this huge country. However, the striking common features of the country are that majority of the people are farmers and the Indian farmers hugely depend on the monsoon rainfall. The monsoon rainfall in India is largely affected by the change in temperature and the agricultural production will be effected due to increase in surface temperature and rainfall variability of the earth [28-29]. Studies have shown that the productivity have decreased due to the variation in climate [30]. The stable food for a large number of Indians is rice. However, the change in the rainfall trend for certain places could make it climatically not viable for the production of rice [31] and also for other crops like wheat [32], sunflowers [33] and sorghum [34]. The economic status of around 1.2 million daily wage earners is dependent on the tea Industry in Assam [35]. Studies have shown that climate variation is related with the quality of the tea produced [36-37]. It is found that the production of tea may decrease with the shift in monsoon season and an increase in rainfall [38].

The surface and ground water resources will be affected due to climate change [39] and there is more chance of flood due to erratic heavy rain [40]. Natural calamities like drought, hurricanes, ice storms, wind storms etc. is related with the change in climatic conditions [41]. Certain organism may extinct due to climate variability [42] and there are high chances for a permanent impact on natural environment with the current trend in the climatic conditions [43]. The economic and environmental impact due to drought may aggravate due to climate change [44]. There were around 166,304 suicide committed by farmers in India between 1995 to 2006 [45]. A study conducted on the suicide of farmers found that the farmers in the

Vidarbha region of Maharashtra committed suicide due to problems like debt, environmental problem and price issue [46]. Thus, the impact of climate change will influence agricultural and non - agricultural sectors creating an enormous shift in social, economic, political and individual life. It will decrease production in agriculture [47] and degrade the natural resources [48]. There is a sharp decrease in the income of Indian farmers due to climatic variability [49].

India is projected to be warmer and wetter with intense summer monsoon [50] with an increased rate of evapotranspiration due to the higher temperatures which will again drive higher precipitation leading to negative impact on soil moisture [51]. On the other hand, some climate models predict a decrease in summer monsoon rainfall due to sulfate aerosol forcing [52]. The distribution, structure and ecology of a forest are determined by the nature of the climate [53]. Thus, climate can produce new configuration of forest ecosystem [54]. The studies conducted by Immerzeel et al. (2010) and others found that there is a chance of reduction in water flow along the Brahmaputra and Indus basin under the projected climate change affecting agriculture and socio-economic activity of the region [55].

DISCUSSION AND RESULT

A large number of studies have been done to study the climate variability and change in India. It is predicted from many of the studies that climate variability and change vary from region to region. There have been studies that relate the global trend with regional variability but a more in depth study is required to suggest practical solutions to the impact of climate change.

There are various factors related with climate change but temperature and precipitation plays a very important role in climate variability and change. Studies have shown that it is very important to evaluate the present climatic parameters in order to predict the future climate trends. The climatic trend studied by different researchers shows some large scale patterns of systematic changes scale which sometimes conflicts with the studies done by others. This may be due to the different statistical approaches used by different scientist along with the accuracy of the data that they have processed.

The impact of climate change will be more intense in a country like India due to the low level of awareness among the people. The global warming may lead to more productivity in certain irrigated crops but may decrease for most of the other crops. Studies shows that the air temperature in India may increase highly effecting agriculture and humans due to climate change. We need to identify bio physical, socio economic and technological factors that influence agricultural production. Scientific diagnosis and assessment of the impact of climate change on the agricultural and allied sector is relevant for future studies. A phase-by-phase counterstrategies to prevent against climate change through the diagnosis of climate change phenomena and in-depth analysis of climate change impacts on the agricultural sector is essential for a large country like India. The counter measures for the agricultural sector against climate change should also focus on greenhouse gas mitigation. Fresh water will become scarcer with the projected climate change due to unpredictable monsoon rainfall leading to more frequent drought. Studies done in change of vulnerability are found to be very less in India and therefore special efforts should be there in this particular field to have a practical approach to the impact of climate change in India. We also find that the productivity of agriculture in India is heavily dependent on the intensity, periodicity, the nature and timing of the monsoon rain.

CONCLUSION

The earth has experienced climate variability and change in different ways and forms that have made an unpredictable impact on the environment which has caused immense hardship and turmoil to mankind but the earth could absorb most of the changes into its own system and humans could somehow adjust and adapt to the changing climate. Now, the change is becoming highly extreme and unpredictable that the destiny of humans on earth has become very uncertain and that the climate change is closely related to the social, economic and political system in India where majority of the people are farmers and rely mostly in monsoon rain for its agricultural production and are still unaware of the actual impacts of climate change in India. Yet, we don't have enough evidence to show the actual global trend of climate change due to the vastness and complexity of the subject. Rather, we can just conclude that there is definitely an impact of climate change and we ought to find practical solutions to the impacts of climate change depending on the geographical condition of the region. The research on the impact of climate change in India should be done in a more explicit and exhaustive form so as to create a Standard National Database on Climate Change which could be used by future policy makers and researchers.

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