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Effect of Climate Change on Aquatic Life with Special Reference to North-East Region of India

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Abstract Today global warming has now emerged as burning issue, threatening the continuation of life on earth. Changing climate is of vital importance because of major impacts by effecting water resources and agricultural economy. Climate change stresses will have complex pressure on fisheries resources and threatened the fish production in North-east India. A sign of increasing annual mean maximum and minimum temperature was observed by 3.7°C and 0.7°C between 1980 and 2010 in and around Guwahati. Possible changes in the hydro-climatic regime of the river valleys of the region is likely to cause higher siltation, erosion, flash flood in wetlands, lakes and reservoirs thereby affecting fisheries. Water temperature change may alter fish metabolism and physiology thereby affecting fish growth fecundity, feeding behavior, distribution, migration and abundance.

Keywords Climate change, Brahmaputra river, Temperature, Rainfall.

Introduction

The Earth is the only planet in our solar system that supports life. The evolution of life on Earth was possible only because of the presence of a unique set of environmental conditions viz. water, an oxygen-rich atmosphere, and a suitable surface temperature. The chemical composition of the atmosphere is also responsible for nurturing life on our planet. Most of it is nitrogen (78%); about 21% is oxygen, which all animals need to survive; and only a small percentage (0.036%) is made up of carbon dioxide which plants require for photosynthesis.

During the day, energy from the sun (largely in the visible part of the spectrum) is absorbed by the earth's surface for example the average visible solar radiation received at the earth surface in our area (26° North latitude) is estimated 149.88 cal.cm²/d. If all this energy were to be absorbed completely, the earth would gradually become hotter. But in reality, the earth both absorbs and simultaneously releases it in the form of infra-red waves. All this rising heat is not lost to space, but is partly absorbed by some gases present in very small (or trace) quantities in the atmosphere, called GHGs (greenhouse gases). Greenhouse gases (for e.g., carbon dioxide, methane, nitrous oxide, water vapour, ozone) re-emit some of this heat to the earth's surface. If they did not perform this useful function, most of the energy would escape, leaving the earth cold (about -18°C) and unfit to support life.

However, ever since the Industries Revolution began 250 years ago, man-made activities have added

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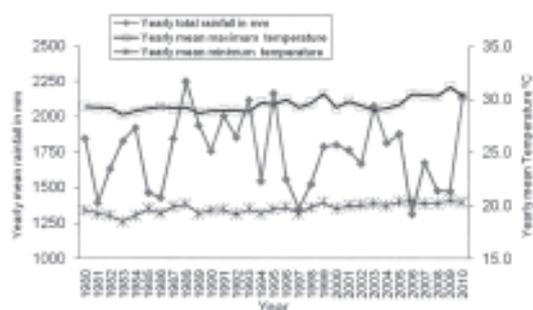


Fig. 1. Annual mean rainfall, mean maximum and minimum temperature fluctuation pattern in and around Guwahati, Assam over the last 30 years (1980–2010). (Source: IMD, Pune).

significant quantities of GHGs to the atmosphere. The atmospheric concentrations of carbon dioxide, methane and nitrous oxide have grown by about 31%, 151% and 17%, respectively, between 1750 and 2000 (1).

The rise in temperature due to the blanketing effect of the increased level of GHGs is called global warming or climate change. Another major contributing factor for global climate change in the post industrial revolution era has been the release of CFC and the resultant ozone layer depletion in the earth's atmosphere. The gradual depletion of the ozone layer in the atmosphere has been a major cause for concerned for continuation of life on earth because this layer protects the earth from harmful ultraviolet rays of sun light.

Effect of climate change on global ecology

The change in climate will affect ecosystems and human systems like agricultural, transportation and health infrastructure severely. An increase in global temperatures may bring broader changes, including glacial retreat, arctic shrinkage, and worldwide sea level rise. Changes in the amount and pattern of precipitation may result in flooding and drought. Other effects may include changes in agricultural yields, addition of new trade routes, reduced summer stream flows, species extinctions, and increases in the range of disease vectors (2). River ecosystems around the world are mostly threatened by climate change phe-

nomena. Most models on global climate change indicate that snow pack is likely to decline on many mountain ranges in the west, which would bring adverse impact on fish populations, hydropower, water recreation and water availability for agricultural, industrial and residential use.

Impact of climate change in North-east India

The vulnerability of the Indian subcontinent to the impact of changing climate is of vital importance because the major impact of climate change in this continent would be on the hydrology, affecting water resources and agricultural economy. In North-east India's more than one million people, about 68% are directly or indirectly dependent on agriculture even today. Despite rapid technological interventions, about two thirds of India's agriculture remains rainfed and vulnerable to present day climate variability. The implications of climate change is yet not clear, although scholars agree that global climate change will lead to greater unpredictability of weather conditions at local levels. This warrant serious deliberations on implication of change for agriculture in general and rural livelihoods in particular. The major river systems of the North East Indian subcontinent, namely Brahmsputra originated in the Himalayas, are expected to be vulnerable to climate change because of substantial contribution from snow and glaciers into these river system. Water supply in India is getting affected badly with Himalayan glaciers melting at the rate of 10–15 mt per year.

The rainfall and temperature data of past thirty years in and around Guwahati (Assam) shows considerable increasing trend depicting the evidence of climate change variability (Fig. 1). The annual mean maximum temperature fluctuated from 28.5°C (1983) to 31.2°C (2009) during the period from 1980 to 2010 showing a variability of 3.7°C on the whole annual mean maximum temperature in and around Guwahati over a 30 years period. Similarly annual mean minimum temperature increase from 19.6°C in 1980 to 20.3°C in 2010 thereby showing an increase in 0.7°C over the same period. On the other hand yearly mean rainfall showed considerable year to year fluctuation during the period showing ten peak and troughs. The amount of rainfall experience by the region during the study

period ranged from 1314.8 mm in 2008 to 2250.2 mm in 1988 showing wide variation of 947.4 mm. No definite trend of variation were observed in the rainfall pattern in the region apparently because rainfall is influenced by a complex set meteorological parameters/factors like atmospheric temperature, atmospheric and oceanographic events (including south west monsoon cycle).

Impacts of climate change on fisheries and aquaculture

The effects of climate change on fresh waters are already evident in different regions of the world. IPCC third assessment report identify an average increase in global temperature of 0.4~0.8°C in past century. Over same period preliminary results show this temperature increase to be between 0.7–0.8°C in regions like the Northeast India. The ecological systems which support fisheries are already known to be sensitive to climate variability. Most fish of small rivers, especially those cold-adapted will be particularly affected by rising temperatures. Glacial recession may cause an increase in the discharge of Himalayan rivers due to enhanced melting, initially leading to a higher incidence of flooding and landslides. Of late significant changes have been observed in the hydro-climatic regime of the Brahmaputra valley resulting in changed nature of water induced hazards in the river basins like the siltation, erosion, flash flood. It has been observed that the monsoon rainfall is trendless and is mainly random in nature in the last decade while floods are now more intense and frequent in this part of the country.

Raising temperature impacts directly on inland aquatic ecosystems by affecting water chemistry to indirect effects of alterations of species composition in the food chain of native ecosystem. Water temperature is one of the key influencing factors of most water chemistry parameters like dissolve oxygen, pH, nutrient concentration and toxicity of nature and anthropogenic pollutants which are critical aspect of water chemistry in the fisheries perspective.

Relatively little water temperature changes can alter fish metabolism and physiology, with consequences for growth, fecundity, feeding behavior, distribution, migration and abundance (3). The general

effects of increased temperature on parasites include, rapid growth and maturation, earlier onset of spring maturation, increased parasite mortality, increased number of generations per year, increased rates of parasitism and disease, earlier and prolonged transmission, the possibility of continuous, year-round transmission. Major changes will be likely to occur in the species composition, seasonality and production of planktonic communities and their food web interactions resulting in changes in higher trophic niches. It has been observed that the captures of the IMCs from the upper reaches of the Brahmaputra River has depleted down drastically in the last decade and are now available in the lower basin of the river only. While once abundant major carps of the Brahmaputra basin is replenish by minor carps and economically low valued trace fishes.

It is well known that temperature is an important factor which strongly influence the reproductive cycle in fishes. Temperature, along with rainfall and photoperiod, stimulate the endocrine glands of fishes which help in the maturation of the gonads. In India, the inland aquaculture is centered on the Indian major carps, *Catla catla*, *Lebeo rohita* and *Cirrhinus marigala* and their spawning occurs during the monsoon (June—July) and extends till September. In recent years the phenomenon of IMC maturing and spawning as early as March is observed from this agro climatic condition of northeastern region, making it possible to breed them till the end of August of a year. Thus, there is an extended breeding activity as compared to a couple of decades ago (4), which appears to be a positive impact of the climate change regime with a suspicion of its effect on the native ecosystem complex. Warming of water column also can enhance the bacterial growth thus poses danger for fishes from bacterial infection and disease.

Conclusion

Water temperature comes first in the list of most determinant factors of aquatic ecosystem since it is essential for the reproduction of fish species and the formation of an ideal living environment. Climate change in the North eastern region leading to high erosion of the river bank and heavy siltation has led to habitat shrinkage of aquatic fauna in the river and

the adjoining wetlands thus capture fisheries statistics has shown a sharp decline and wiped out of some commercially prized fish species from the region in the near future. Since the breaking of the food chain in nature once will lead to incredible results, the extinction of some species will directly affect the other species. Climate change is almost unavoidable therefore we need to step up our efforts and investment to fill critical knowledge gaps to make fisheries and aquaculture resilient and productive despite climate change.

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