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Impact of Climate Change on Fisheries and Aquaculture

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Abstract

Pollution is, undoubtedly, the most alarming issue of concern among all environmental hazards. The rate and degree of pollution is gradually increasing with the explosion in population of the world. Due to some anthropogenic activities and malpractices of some scientific methodologist gradual changes in climate turned the global situation into a critical position affecting different aspects of agriculture, fisheries and others. Impact of climate change is conspicuously observing in the field of aquaculture posing adverse impact on its productivity and variety. Objective of the study was to prepare a review concerning about the impact of climate changes on fisheries and aquaculture sector. This review can be useful to find out a possible way for relieving the constrain through constructing some solution through various scientific activities. In present generation, the altered climatic condition shows a great impact on Ocean temperature, variation in water level, impact of sea level rise. For this climate change, there is a great impact on inland water. It is altering distribution and productivity of marine and freshwater species, and changing food webs. This making the concerns for viable of aquatic ecosystems for fisheries and aquaculture. Besides, it can also hamper our future scenarios. If these harmful effects are randomly proceeds, the future generation will also undergo a dangerous condition. Global warming is the main fact of these climate changes. Therefore, at first the main point is to reduce global emission of GHGs, which is the main anthropogenic factor. Fisheries and aquaculture require specific adaptation and mitigation actions for responding to the chances for and threats to food and livelihood security due to climate change. The current generation need to decide, how should we get relief from these major problem of climate change and reduce the chances of future harm

Keywords: Global Warming; Pollution; Climate Change; Fisheries and Aquaculture.

Introduction

In twenty first century, climate change has recognized as a great problem for the entire environment around the globe. It has been forecasted that thefallout of climatic changesleads to an adversative and irreparable impacts on ecosystem. In the middle of the nineteenth century, earth's average temperature has been found to be increased at a rate of more than 0.8°C per hundred years globally but recent studies confirm that the rate of increasing temperature is now more than 0.1°C every ten years (Hansen et al., 2010). The raise of averageatmospheric temperature has concluded to cause noticeable changes like glacial retreat, shrinkage of arctic zone, sea level rise, melting of permafrost etc. Therefore, these reasons have been proven to show a great impact on fisheries and aquaculture in various aspects.

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Increase in global temperature leads to the melting of the ices present in high-altitude regions and high-latitude regions which in turn leading to the retreat and melting of glaciers, with great ramification for downstream water resources (IPCC, 2014). It has been reported that the liquefied condition of the Arctic sea has serious potential to disintegrate the global ocean tides or conveyor belt in marine ecosystem (Liu et al., 2017). The probable consequences will lead to abrupt changes in the

diversity of marine ecosystem.

Great rivers of the whole worlds have already affected by dam construction, water abstraction and regulations that are laborious to be incontestable. Besides the anthropogenic damages, it has been predicted that the melting of glaciers will surely increase the input into the river confluences in coming days (Jha et al., 2006; Siderius et al., 2013; Pervez and Henebry, 2015). This will pose some serious alteration to the productivity and diversity of cold water fisheries globally. The changing pattern of rainfall have substantially altered ecological aspects of many rivers and wetland, which causes a great influence on the diversity of aquatic environment.

Some natural processes both internal or external such as volcanic eruptions, infection of solar cycles, anthropogenic contributions to the composition of the atmosphere (viz., Green House Gases) etc have been proven to be the key behind altered climatic condition. The term "climate change" has been used and has also been described by UNFCCC (United Nations Framework Convention on Climate Change) for anthropogenic changes and 'climate variability' for other changes. According to a report by IPCC (2007) the average global atmospheric temperature has been reportedto be increased at the rate of 0.74±0.18°C (i.e., 1.33± 0.32°F).

Gradually, the occurrence of these climate changes have threatened the physical as well as biological nature of any aquatic environment. Climatic changes have imposed serious deleterious impacts on several aquatic species including aquatic plants, corals, echinoderms, shell and finfishesand aquatic mammals also (Delgado et al., 2003). The 93% additional heat caused by anthropogenic climate change has absorbed by global ocean. The melting of icecaps and snow have caused due to absorption of only three to four percent heat. The heat buffering system of oceanis thus extreme. Any little difference in the correspondence of heat between ocean and surface atmosphere have tremendous impacts on increase of average global air temperature (Reid, 2016).

Being an important source of animal protein for the human and many aquatic organisms, fishes can be collected from wild origin or can be farmed exclusively. Developing countries like India, China have incorporated their vast interest in dominating the global fish production and utilization pattern for last 25-year period (Delgado et al., 2003). Thus, fisheries and aquaculture sector is also proven to be a promising income domain for many countries. Climate change is directly exerting dreadful impact on fisheries sector and its environment. According to a report of IPCC (2007), human race is highly influenced by climate change in various aspects including food security.Among all primary food production sectors, fish production is expected to be greatly influenced by varying degrees of climate change and the manifestations can be conventionally present in varying forms in different parts of the world up to varying extent. The objective of the review work is to comprehend the potential role of global climate change on fisheries and aquaculture domain.

Review Methodology

It was a mammoth work in compile the available data on the research topic "Impact of Climate Change on Fisheries and aquaculture". In order to make an utmost consolidate manuscript on the topic extensive searching has been done using some key words. Data have been collected from different Science Journal of repute, published data sources or reports from various international agencies. Articles includingabstruse working methodologies have let off fastidiously. During data screening, importance have been paid exclusively to the reproducible articles, that are indexed in Science Journal database. Keywords have been meticulously scrutinized and searched based on standard scientific methodologies. Keywords, for searching; were as follows: Global warming, pollution, climate change, Fisheries and aquaculture. Data related to the research topic have chosen in such a way that a comprehensive manuscript can be provided to the future researches.

Result and Discussion

The principal aim of the review article is to consolidate the evidence on the impact of climate change on the domain of fisheries and aquaculturein the published literature. The objective of the article is also to evaluate the superiority of the scientific objectivity and quality of the evidence on the topic. Fisheries and aquaculture have acquired only little awareness in the principle analysis of climate change persuadedeffects on shell and fin fish production. It is vital to remember that significant attention to climate change issues on fisheries and aquaculture domain have been constructed almost a decade ago (Wood and McDonald, 1997).

Allowance of fisheries and aquaculture to food sector

Fisheries and aquaculture is noticeably a fast

growing sector related to food security and continue to emerge more speedily than other animal food-producing sector. From capture fisheries (both freshwater and marine) and aquaculture, fish products contribute about 1/10th of total agricultural exports of the world. The amount of global fish trade beat the total amount of international trade in all other animal food sources (World Bank, 2011). Normally, fish production and trading is responsible for about 0.5%-2.5% of total GDP of the world but these contribution is more than 10% for countries like Mauritania and Vietnam (Allison, 2011). In some small island states ofPacific Ocean, fisheries sector contributes about 25% of total GDP due to their geographical position (Gillett, 2009).

Presently, millions of people directly or indirectly depends on fisheries and aquaculture for their livelihoods around the globe. Fish products can afford 15% or more of the total intake of protein dominate for about 3 billion people of the world. It also supports economy and livelihoods of about 520 million people around the world, interestingly most of them are women (FAO 2009).

Global change in climate is now recognized as highly influencer of a wide range of environmental variables like rain fall, average temperature, volume of river water, ocean nutrients, severity and frequency of oceanic storm, harmful algal bloom and acidification of oceans (Fleming et al., 2006; Feely et al., 2009). These unusual changes of climate directly or indirectly affect the fish ecology and production of fisheries and aquaculture posing severe threat to the economy ofdependent communities like fishers, food-processor, retailer etc also to the wider economy (Cochrane et al., 2009; Merino et al., 2012).

The literature indicates the growing importance of fisheries and aquaculture is continuously contributing to fill the gap between demand and supply of fish (Merino et al., 2012). The growth also ensures the improvement of fisheries and aquaculture sectorlessening of rural poverty and safeguardingfood security.

Impact of climatic changes on environment related to fisheries and aquaculture

Impact on Ocean temperature

In 1960s, it has observed that many anthropogenic forces built a considerable contribution to raise up the temperature of the ocean surface (above 700 m) (Cheung et al., 2016). It has also found that there is an increase in the temperature of the surface waters by an average of 0.7°C per hundred years globally during a time span of 116 years (from 1900 to 2016) (Huang et al., 2015). Due to the variation in Oceanic current, various changes in fisheries and aquaculture may happen through changes in water temperature, primary productivity, food availability increasing rate of disease transmissions andgrowing toxic algal blooms (Handisyde et al., 2008).

Variation in Water Level

Global changes in average temperature of the world lead to melting of arctic ice caps and high altitude ice which finally result in rise in sea level and altering oceanic current. Mean sea level rise is a long term consequence which would happen over a long time period scale. It has been presumed that rise in sea level may affect distribution and migration patternof fish (Bakshi and Panigrahi, 2015).

Because of climatic and non-climatic factors, recorded mean sea level rise was about 3.1 mm/ year in recent years (Dangendorf et al., 2017). The projected global mean sea level rise will extend approximately(90% probability) between0.3m to 0.8m under RCP2.6, 0.4 m to 0.9 m under RCP4.5, and 0.5m and 1.2m under RCP8.5 in 21st century(Kopp et al., 2014).

Impact of sea level rise

The consequence of sea level rise is continuously posing severe threat to the halotolerant mangroves in Sundarbans and other mangrove forests. The unique ecosystem is very much vulnerable to the increase of sea water. Increased sea level will ensure the increased penetration of salt water into the land confirming decrease of habitat space for fresh water fishes. This could also ensure the increase of brackish water area along with its diversity (De Silva and Soto, 2009). From the report of 2000 to 2008, it has been found that there is arise in the level of sea of Sundarbans. The amount of sea level rise from the Sagar island observatory has observed at the rate of about 12 mm/year. Within the period of 2001-2009 the rate of coastal erosion in the Indian Sundarbans for the sea level rise has found to be about 5.50 km 2/year (Bakshi and Panigrahi, 2015), in the year 2001 a total land area of 6402.09 sq. km of Sundarbans has reduced to 6358.05 sq. km in 2009.

Turbidity of the aquatic ecosystem also changes due to the effect of climate change. Due to changing turbidity of riverine water there is decreasing in the production of the estuarine ecosystem. Therefore, these altered turbidity pattern is responsible for the effect of erosion of coastal region (Bakshi and

Panigrahi, 2015). The growth of phytoplankton has inhibited due to less penetration of sunlight and affecting the productivity of the whole ecosystem.

Impact on inland water

According to Ficke et al., (2007), the rate of increasing temperature of the atmosphere is certainly bringing about some changes in aquaculture that could affect the fisheries activities in both lentic and lotic waters. Even the temperature of any pond water has depended upon by atmospheric temperature,velocity ofwind, solar radiation, turbidity of water,humidity and pond geo-morphometry. The raise of the atmospheric temperature will surely cause an expansion in evaporation and cover ofcloud (IPCC, 2007).

The inland aquaculture in India is mostly depended upon Indian major carps or IMCs (i.e., Labeorohita or Rohu, Catlacatlaor Catla fish, andCirrhinusmrigalaor Mrigale). The spawning of IMCstake place during the time of monsoon (June-July) and extends until September. Now a peculiar phenomenon of Indian major carp maturation and spawning havealso observed in March enhancing the chance of breeding to twice a year. So, the breeding activity has noticeably found to differ in comparison with the last few decades(Dey et al., 2007).

Impact on net primary productivity

The productivity of any water body is determined by net primary production of the system. A good valuation of net primary productivity (NPP) in respect to the consequences of climate change may alter the future trend of marine as well as fresh water production. Change in temperature may affect the natural phenomenon of thermal stratification of any aquatic system; these also may put some distress the amount of respiratory gases exchange andalso the amount of bio-nutrients at the water surface altering the primary productivity. Therefore, the consequences may lead to alteration in food chain and food web resulting ultimate change in the species accumulation pattern (Dangendorf et al., 2017; Behrenfeldet al., 2018)

The base volume of marine food web is determined by the productivity of phytoplankton. It could regulate the energy flow and availability of food to the higher trophic levels even in fishes. According to Earth system model, primary production of marine ecosystem, as a result of climate change, is indeterminate. The model is alsosticking out both surges (Taucher and Oschiles., 2011) and declination of marine primary productivity up to about 20% by the year 2100 (Bopp et al., 2013). In some Arctic and boreal lakes, primary production has detected to increase (Michelutti et al., 2005) though exception has been detected in Lake Tanganyika in the tropics with a declinein primary productivity level (O'Reilly et al., 2003).

Climate Change Scenario in Twenty-first century

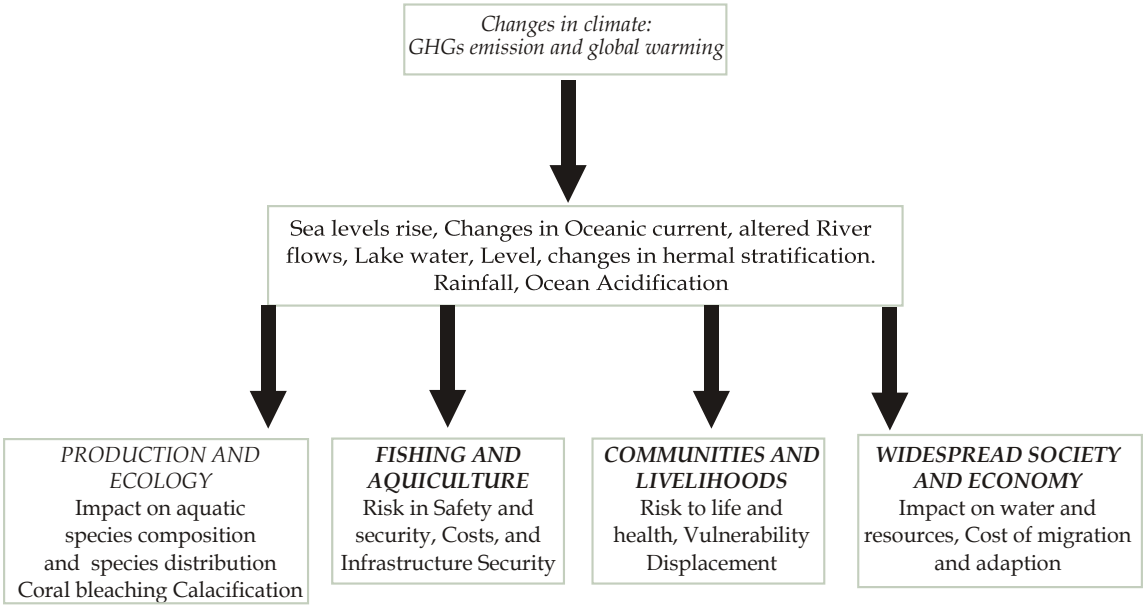

Fig. 1: Consequences of climate change on the fisheries and aquaculture

Therefore, we can summarize the total situation in the following way: increase of GHG and other harmful gases is the main reason behind the climate change which results in melting of polar ice, sea level rise, alteration in river flows, oceanic currents etc. These factors put direct impact on fisheries and its dependants (Fig 1).

Combustion of fossil fuel and other anthropogenic activities are directly related to the increase of greenhouse gases in the atmosphere which in turn responsible for increase of water temperature, decrease in oxygen content of water bodies, acidification of ocean water confirming the large-scale change in marine species diversity (Portner et al., 2014).These variations particularly ensure the alteration in marine primary productivity (Bopp et al., 2013) as well as marine biodiversity (Jones and Cheung, 2015). Human race is highly depended on fisheries sector for the source of protein thus these changes may surely hamper the promises of food security in the later part of 21stcentury (Lam et al., 2016; Cheung et al., 2016; Golden et al., 2016).

Conclusion

Fisheries and aquaculture has effectivelyrecognized as a major food sector over last two to three decades. It also providesa major portion of total animal protein requirements across most of thehuman communities of the world. Like other food producing sectors, fisheries and aquaculture have faced major challenge due to climate change. A number of climatic changes are natural and inevitable which also responsible for the change in aquatic flora and fauna diversity. Human race is heavily dependent up on the products of aquatic origin for food security in coming decade which is unfortunately under the threat of climate changes.

The predicted pattern of increases in water temperatures are often well understooddue to its natural occurrence. The temperature remains within a definite range particularly in the tropics and subtropics enhancing the chances of survival of cultured species. Thus it can be understood that warming of marine water would actually improve growth of cultured stocks in tropic and sub tropic regions increasing the fish production. The pattern of sea level rise is highly associated with the change in water temperature of ocean. Salt-water intrusion is also associated with the rise of water temperature confirming the constriction of natural habitat of fresh water fishes. The impression of climate change on fish populations is directly related to the growth of fisheries and aquaculture. Seasonal availability of the fish population altered with the pattern of climatic alteration affecting capture fisheries production very much.Naturalaccessibility of the raw materials and availability of suitable environmental condition for production of dry fishmeal and fish oil are also facing serious trouble therefore it can be said that unpredicted climatic changes are the reason behind peculiar constrains on fisheries. Coral bleaching due to changes in aquatic environment is putting serious threat to towards the loss of marine diversity which in turn affecting the capture fisheries sector indirectly. Global warming is proven to be the main cause of climate change. Therefore, the key solution is to reduce the emission of GHGs into the environment. Domain of fisheries and aquaculture must require exclusive adaptation and vindication actions like refining the management strategies of the sector to mitigate the problem of global warming as well as GHG emission. These improvements arevery much needed as threats to food security and livelihood is continuously increasing due to change in climatic condition.

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