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BRIEF COMMENTARY ON THE IMPACT OF GLOBAL CLIMATE CHANGE ON FISHERIES AND AQUACULTURE WITH SPECIAL REFERENCE TO INDIA

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Climate Change is a global phenomenon and is one of the burning glitches and emerging environmental issues in present time. The impact of climate change is manifold and having indelible impact on all aspects of earth life and biodiversity. Fisheries and Aquaculture have been considered as an important branch of Indian subcontinent economy associated with agriculture and allied sectors. Millions of stakeholders are dependent directly or indirectly on aquaculture and fisheriessector for their livelihood belonging mostly to the bottom of economic pyramid with lower incomes, unorganized jobs, greater socio-economic vulnerability. Often they are under privileged andmostly affected by the vagaries of climate change. Erratic temperature and rainfall patterns, storm-water surges, salinity invasion, increasing sea-surface temperature, oceanic acidification, salinization of freshwater resources associated with tropical cyclones such as Aila, Fani, Bulbul to the very recent Amphan and Nisarga has created a havoc loss in fisheries and aquaculture sector in both east and west coast of India as well as along Bangladesh coast. Frequent natural disasters associated with global climate change have been a common global phenomenon since last decade. Therefore, it is pertinent to understand the crucial interplay between multifarious impacts of global climate change on fisheries as well as aquaculture sector. Innovation and proper incubation of entrepreneurial opportunities in fisheries and aquaculture sector might provide the necessary oxygen for growth and proliferation. This can also help other developing economies relying on fish and aquaculture resources to develop a holistic approach on similar lines. This scientific communication throws light on these aspects through a brief commentary.

INTRODUCTION:

Ecosystems across the world are facing unanticipated changes due to fluctuations of global climate since the last century (Guldberg and Bruno, 2010; Pachauri, 2007)). The comprehensive understanding of how anthropogenic

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climate change is impacting marine and freshwater ecosystems around the world is poorly developed in scientific literature (Guldberg and Bruno, 2010).

Exponential increase in greenhouse gas concentration in hydrosphere is causing unprecedented changes in marine biodiversity across the blue planet, Earth. Nearly 50% of CO_2 concentrations released as a result of anthropogenic emissions between 1800 and 1994 is stored in the oceans (Sabine, *et al.*, 2004), and about 30 percent of modern CO_2 emissions are taken up by oceans today (Sabine, *et al.*, 2004). Continued uptake of atmospheric CO_2 has decreased the pH of surface seawater by 0.1 units in the last two hundred years. Rise in sea surface temperature, melting of polar ice, increase in sea levels, effects of El-Nino and La-Nina, changes in seasonal distribution, changes in ocean currents and wind circulation patterns associated with global climate change has wreaked havoc on marine biota. Sea water intrusion in low lying and tidal areas, salinization of coastal areas, intermixing of saline and fresh water, intrusion of invasive species in the intertidal zones have caused major ecological changes leading to direct and indirect impacts on fishery and aquaculture sector. Fisheries and Aquaculture forms a critical arm of ecosystem services rendered by marine ecosystems. However, researches and studies related to impact of climate change on these sectors are limited. Fisheries find only one mention in the Synthesis Report of the IPCC (2007), which suggests that in relation to the Atlantic Meridional Overturning Circulation (AMOC) global fisheries sector is heavily impacted. The Atlantic Meridional Overturning Circulation (AMOC) is an intricate humongous system of ocean currents that circulates warm, salty water from the South Atlantic and tropics via the Gulf Stream to the colder North Atlantic. There, warm salty waters cool, release heat, and eventually sink to the deep ocean and move south. The AMOC plays a key role in the Earth's climate and is a major component of the Global Conveyor Belt. AMOC slowdown as a result of greenhouse gas concentration in ocean systems and rising sea-level temperatures might result in significant changes in global fisheries and aquaculture sector. The direct impacts of climate change influence the physiology, patterns and rates of development, reproductive cycles, behavioral pattern as well as survival of individual species of fishes and other allied aquaculture products. The implications of global climate change on management of fisheries are further discussed by (Ficke, *et al.*, 2007; Allison, *et al.*, 2009). The study by (Allison, *et al.*, 2009) further indicates that four tropical Asian countries such as Bangladesh, Yemen, Cambodia and Pakistan are most vulnerable when cumulative impacts of anthropogenic climate change on fisheries and aquaculture are considered. Fishes contribute to 27% to dietary protein in least economically developed countries. Therefore, any negative impact of climate change on fisheries can take a serious toll on food security of these nations. The combined effects of vulnerability was due to global warming of ocean waters, the relative importance of fisheries to national economies and diets, and restricted societal capabilities to adapt to potential impacts and opportunities. There has been a growing body of case studies on the observed effects of climate change on the distribution and production of individual fisheries (e. g. Lehodey, *et al.*, 2006; Drinkwater, 2005; Kell, *et al.* 2005;

Brander, 2007), it is difficult to estimate or predict the broader or aggregate effects of climate change at national and regional scales (Brander, 2007).

The indirect effects of global climate change on fisheries and aquaculture are far reaching and act at ecosystem levels leading to alteration in food production, sudden abundance or absence of competitors and predators, alterations in prey-predator relationships or sudden outbreak of pathogenic diseases among both bony and cartilaginous fish communities. The projected studies related to global climate change poses multiple additional risks to fishery dependent communities especially in developing economies such as India, Bangladesh, Pakistan, Sri Lanka, Bhutan, Myanmar and some island nations along the Indian Ocean. The adaptation strategies with respect to global climate change is both contextual and location specific. The comprehensive strategy must address both short-term (e.g. vulnerabilities of fisher folk communities residing in Sundarbans during Amphan and post-Amphan period) as well as long-term (e.g. reduced productivity of aquatic ecosystems in the wake of climate change) approaches. Adaptation strategies must be inclusive (community, national and regional) and would further attain sustainability through capacity building, stakeholder awareness, livelihood promotion activities and women centered livelihood generation approaches. Adaptive and precautionary management of freshwater as well as marine resources would increase resilience and adaptability in the face of global climate change and its' consequences. Ecosystem Approaches to Fisheries (EAF) as well as to Aquaculture (EAA) is to be adopted to increase the resilience of aquatic resources ecosystems, fisheries and aquaculture production systems, and aquatic resource dependent communities (Barange and Perry, 2009). Aquaculture systems with lesser dependency on fishmeal and fish oil inputs (e.g. bivalves and macro-algae) have promising future scopes for expansion when compared with production systems dependent on capture fisheries commodities. Diversification of livelihood options and promotion of aquaculture crop insurance is a viable adaptation strategy to be practiced by fisher-folk communities across the Indian subcontinent. Frequent severe weather events such as Aila, Amphan, Nisarga exposes the vulnerability quotient of these fish farming communities. Therefore, technology based accurate forecasting systems, proper networking, improved insurance cover, family safety and social security schemes need to be introduced. Information services as well as adaptation strategies to cover disaster risk management, including disaster preparedness, and integrated coastal area management. SAARC meetings that include dialogue between the countries of Indian subcontinent must address these need-based issues for proper planning and management. Adaptations by allied sectors will have impacts on fisheries, in particular inland fisheries and aquaculture (e.g. irrigation infrastructure, dams,

fertilizer use runoff), and will require carefully considered trade-offs or compromises. Interactions between food production systems could compound the effects of climate change on fisheries production systems but also offer opportunities. Aquaculture based livelihoods could for example be promoted in the case of salination of deltaic areas leading to loss of agricultural land. It is imperative to note that problems may vary according to varying geographies and economies. However, the underlying problem and emerging issues remain the same. The emerging environmental and socio-economic issues require proper strategy and sustainable solutions. (De Silva and Soto, 2009) addresses the potential impacts, adaptation and mitigation correlating climate change and aquaculture.

Every aspect of socio-economic, cultural, environmental aspects needs proper consideration while understanding the impact of climate change on fisheries and aquaculture. A schematic diagram illustrating current and/or projected impacts of climate changes on major components of marine and coastal ecosystems is discussed in (Fig. 1). Climate change increase concentration of carbon-dioxide and temperature globally with significant rise in sea-surface temperature, erratic rainfall pattern, wind circulation and ocean currents. This may lead to significant decline in fish production and extinction of several fish species around the globe. For example, *Hilsa ilisha* is predominantly found in the regions of intermixing of saline and freshwater especially along the mouth of Bhagirathi-Hugli along West Bengal and Bangladesh. Changes in climate pattern and intrusion of saline waters in freshwater streams have resulted in significant decline in the production of the species during the last few years resulting in heavy loss in fishery industries of India and Bangladesh. Similarly, low lying countries such as Maldives and Tuvali are facing climate crisis and are supposed to become one of the first climate refugees globally. Fishing

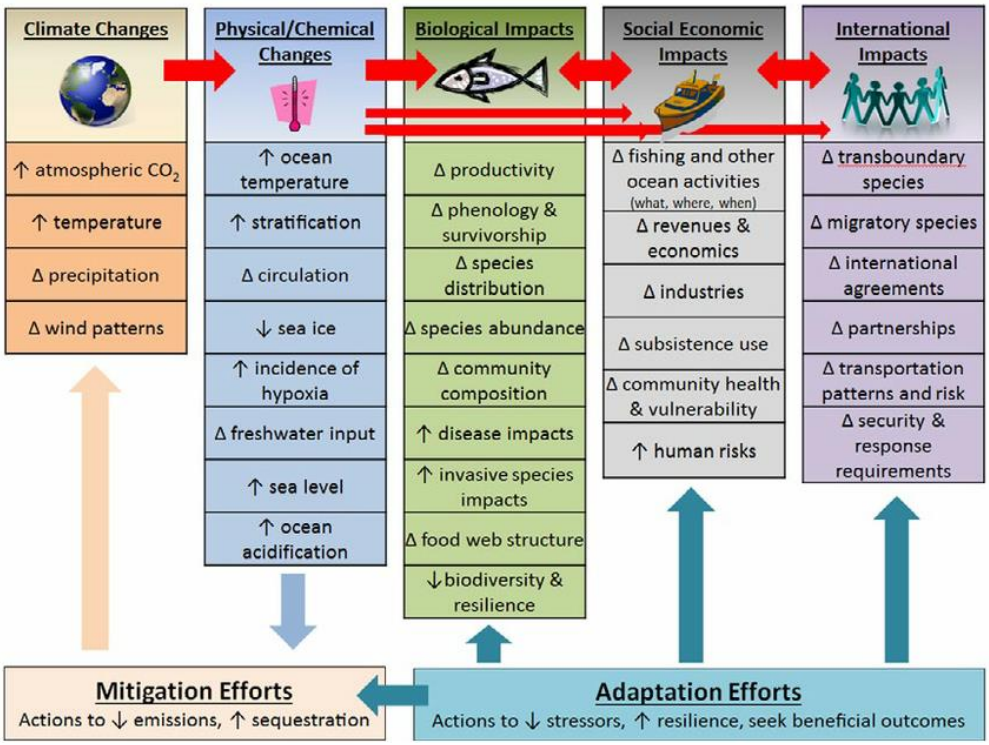

Fig. 1: Schematic diagram illustrating current and/or projected impacts of climate changes on major components of marine and coastal ecosystems (Link, *et al.*, 2015)

communities in India and Bangladesh are not only subjected to frequent natural disasters with loss in life and property but also their livelihoods are in question. One million tons of Basa fish is annually produced from Mekong River- one of the principal river systems of South-East Asia. Significant drop in fish production due to saltwater intrusion has led to havoc loss in the fisheries sector along the river in recent years (Halls, 2009). Fisheries and aquaculture contribute significantly to food security and livelihoods. Fish provides essential nutrition for 3 billion people and at least 50% of animal protein and minerals to 400 million people from the poorest countries, predominantly located in the Indian subcontinent (World Fish, 2008). A loss in production of fisheries and aquaculture therefore not only harms the economy and ecology directly but also human health. The food security of millions of people living in this densely populated region of the world is questioned. Therefore, the multidimensional impacts of global climate change on fisheries and aquaculture sector needs to be addressed from a multipronged perspective. The poorest are to be worst affected by the vagaries of climate change. It is imperative to note that we are living in a world made of glass-walls and the times ahead demand us to be scrupulous.

Minimal negligence or unwanted harm done on our part would result in cascading impacts on other sectors ultimately increasing our vulnerability manifold. Realizing the Sustainable Development Goals (SDGs) and achieving them in true word and spirit is therefore the only option we are left with in days ahead.

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