CERD FOUNDATION (Aspiring Better Future)
Issue I | Volume I | 2020
Homepage: www.cerdfoundation.com
CERD Green Chronicles

BRIEF COMMENTARY ON IMPACT OF GLOBAL CLIMATE CHANGE ON FISHERIES AND AQUACULTURE

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Ecosystems across the world are facing unanticipated changes due to fluctuations in global climate patterns since the last century. The unprecedented changes in ecosystems is having irreversible repercussions on its' flora and fauna leading to holistic degradation and mass scale loss of species. Freshwater and marine ecosystems have borne the brunt of global climate change to the maximum level due to the geographical expansion and increased vulnerabilities. The services offered by these ecosystems have likewise faced unpredicted alterations as a result. Fisheries being a pivotal arm of the ecosystem services rendered by aquatic ecosystems (both freshwater and marine) is facing high alert as a result of multitude of factors that govern global climate cycles which includes both physical and chemical factors such as temperature, wind circulation pattern, vertical mixing, ocean currents, salinity, dissolved oxygen and carbon-dioxide concentration, pH etc. The direct and indirect effects of these factors on global fish production are manifold and humongous. The direct effects of climate change influence the physiology, patterns and rates of development, reproductive cycles, behavioral pattern as well as survival of individual species. The indirect effects are more far reaching and act at ecosystem levels leading to alteration in food production, sudden abundance or absence of competitors and predators, prey-predator relationships or sudden outbreak of pathogenic diseases among both bony and cartilaginous fish communities.

A briefing from University of Cambridge based on IPCC AR5 (Fifth Assessment Report) lists down some key findings which indicate the global impact of climate change on fisheries and aquaculture. These are comprehensive but open ended with various scopes for consistent moderation and addition with rapidly changing global scenario. 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.

1. Climate change and acidification of freshwater ecosystems are interrelated. With increasing concentration of carbon-dioxide, the pH of the aquatic medium is changing indicating to high acidic levels which are detrimental to fish communities and other marine and freshwater based flora and fauna.
2. Projected impacts on fisheries and aquaculture are negative on the wake of global temperature changes, pH alterations, O2 and CO2 concentrations. This may wreak havoc in global fish markets leading to irreplaceable damages.
3. Anthropogenic impacts on fisheries are a monumental issue worldwide. These include overexploitation such as overfishing, oil spills, habitat loss, marine pollution etc.
4. Coral reefs across the global map are rapidly declining as a result of coral bleaching, natural disasters such as tsunamis, volcanic eruptions, earthquakes, water pollution etc. This might prove detrimental to coastal fisheries.
5. Adaptation of fishes to climate stressors is not uncommon but the scope is limited. Thus, reducing non-climate stressors is mandatory such as reducing overexploitation of fishes through overfishing, pollution, oil spills etc. A holistic environment management strategy is the need of the hour. Apart from the points discussed above, several other cross-cutting issues need immediate discussion with individual scientific evidences.

Climate change affects communities and livelihoods in fisheries and aquaculture, and efforts to adapt to and mitigate climate change must therefore be anthropocentric. Therefore, every aspects of socio-economic, cultural, environmental aspects need 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).

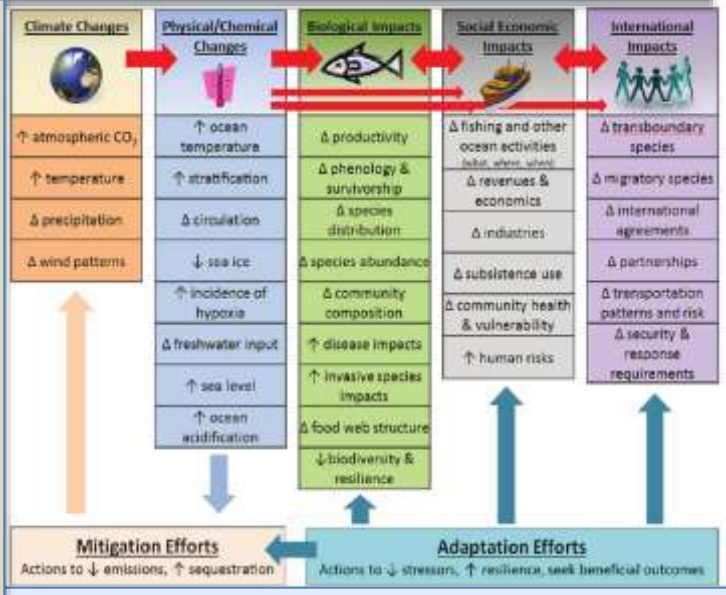

Fig. 1: Schematic diagram illustrating current and/or projected impacts of climate changes on major components of marine and coastal ecosystems (Link, et al., 2015).

A technical report published in 2015 by National Marine Fisheries Service (NOAA) highlights the current and projected impacts of global climate change on major components of marine and coastal ecosystems. The impacts of both climate variability and change on the physical, chemical, biological, and even social components of marine, coastal, and freshwater ecosystems are well documented (e.g., Doney, et al., 2012; Griffis and Howard, 2013; Intergovernmental Panel on Climate Change, 2013; Melillo, et al., 2014). Some of the major observed and expected changes to the physical and chemical characteristics of marine and coastal environments are illustrated in (Fig. 1) and include the following (Doney, et al., 2012; Intergovernmental Panel on Climate Change, 2013; Melillo et al., 2014);

• Warmer ocean temperature
• Reduced sea-ice thickness and extent
• Altered storm tracks and intensity
• Precipitation changes
• Altered freshwater input
• Sea level rise
• Reduced ocean pH (i.e., acidification)
• Reduced dissolved oxygen.

Climate-related changes in ocean and coastal ecosystems are impacting the nation's living marine resources (LMRs), pivotal services they provide, and the many people, businesses, communities and economies that depend on them. These changes increase the information and actions necessary to fulfill the National Marine Fisheries Service (NMFS NOAA Fisheries) mission to sustain LMRs and their ecosystems for the benefit of the nation. To fulfill this mission, NOAA Fisheries needs more information on the impacts of climate changes on LMRs, and science-based approaches for sustaining LMRs and resource-dependent communities in a changing climate.

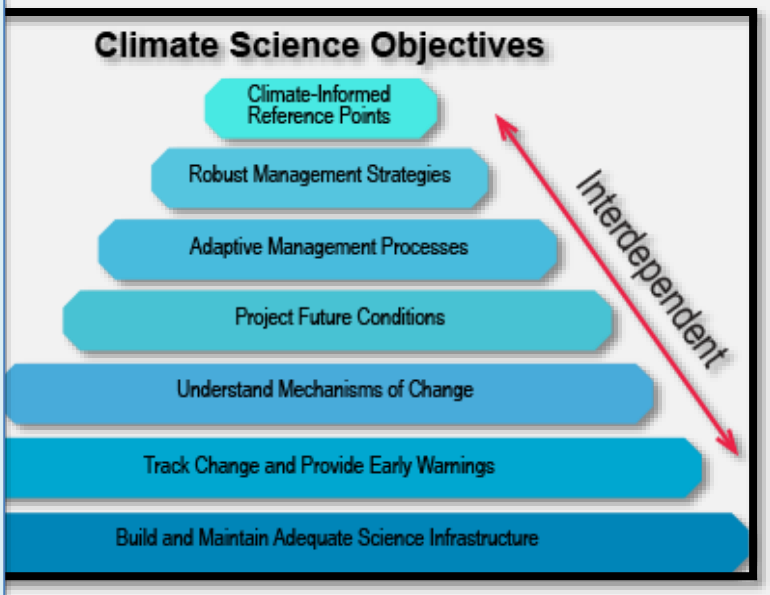

Fig. 2: NMFS Climate Science Strategy proposed by (Link, et al., 2015)

The goal of the NOAA Fisheries Climate Science Strategy ('Strategy') is to increase the production, delivery, and use of the climate-related information required to fulfill NOAA Fisheries mandates. Although the information needed to understand, prepare for, and respond to climate change impacts on LMRs is diverse, this Strategy identifies seven common objectives to meet the science information requirements needed to fulfill NOAA Fisheries stewardship mandates in a changing climate.

These are:

Objective 1: Identify appropriate, climate-informed reference points for managing LMRs.
Objective 2: Identify robust strategies for managing LMRs under changing climate conditions.
Objective 3: Design adaptive decision processes that can incorporate and respond to changing climate conditions.
Objective 4: Identify future states of marine, coastal, and freshwater ecosystems, LMRs, and LMR-dependent human communities in a changing climate.
Objective 5: Identify the mechanisms of climate impacts on ecosystems, LMRs, and LMR-dependent human communities.
Objective 6: Track trends in ecosystems, LMRs, and LMR-dependent human communities and provide early warning of change.
Objective 7: Build and maintain the science infrastructure needed to fulfill NOAA Fisheries mandates under changing climate conditions.

This 'Strategy' opens up a blue-print to guide efforts by NOAA Fisheries and partners that address the seven science objectives. NOAA Fisheries consistently work with regional partners for developing Regional Action Plans (RAPs) to identify strengths, weaknesses, priorities, and actions to implement the Strategy in each region across the globe.

The efforts of NOAA are laudable. To meet these seven priority objectives, NOAA Fisheries needs to identify and fill information gaps; bolster ongoing efforts that are climate-relevant; explore novel ways to produce and deliver salient information; and develop climate-smart management approaches.

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