Impacts and Adaptation Tactics of Global Climate Change on Coastal and Marine Ecosystem, Fish and Fisheries

Prof. Dr. Md. Aminur Rahman

Abstract— Climate change reflect in significant environmental changes such as warming, sea level rise, shifts in salinity, oxygen, and other ocean conditions, which is expected to impact marine organisms and associated fisheries (Fig. 1). These changes directly or indirectly impact on the ecology and physiology of marine fishes (Fig. 2). This paper summarises some of the ways in which climate change is impacting global coastal and marine ecosystems. It identifies how various ecosystem features are influenced by climate change and spotlights potential areas of concern. It also highlights areas where marine life may be more impacted by climate change compared with other areas. The spatial and temporal study give the exact explanations on how fish shift from one place to another or extinct from the sea by the small changes of temperature, salinity and ocean acidity. Little alterations of temperature and salinity can cause physiological and ecological changes on the reproductive output, larval survival, juvenile growth and adult performances of aquatic organisms. On the other hand, a recent analysis provides a holistic assessment of the detrimental effects of climate change and ocean acidification on marine organisms including coral, shellfish, echinoderm, and other calcifying species (Fig. 3). Projection of future aspects indicate further impact on the distribution, migration, biodiversity and abundance of fishes, resulting in the changing of the fish habitat. Besides, the coastal economies and disease incidence happened several times and dimensions due to the increase of global warming and sea level rise. The elucidations of evidence include many uncertainties about the future of affected marine and coastal fish species and their fishing communities, who exploit these stocks for their sustainable livelihood and social existence. There is subsistence, commercial and recreation fisheries that may be impacted negatively or positively by change in fish stocks due to the climate change. It is therefore, urgently needed to carry out more extensive research on biology, physiology, ecology and diversity of marine and estuarine fish species in the tropic, sub-tropic and temperate regions where a little research has been conducted in these aspects so far.

By accumulating the border and deeper information from the above research findings, the scientists will be able to make appropriate precisions, take proper action and forage relevant solutions. It is also found that various types of adaptation tactics such as practice change, and capacity building and that there is a lack of joint adaptation planning. Here, I discuss the challenge in identifying suitable adaptation and mitigation options (Fig. 4) to promote resilient and sustainable fisheries and to avoid losing their associated values. This work also suggests and supports the recent integration of climate change as a key consideration in the Marine Strategy Framework Directive (MSFD), which will be done by presenting a spatial description of the vulnerabilities of marine areas to climate change.

Dr. Md. Aminur Rahman, Professor, Department of Fisheries and Marine Bioscience, Faculty of Biological Science and Technology, Jashore University of Science and Technology (JUST), Jashore-7408, Bangladesh

https://doi.org/10.17758/EARES18.EAP1124233

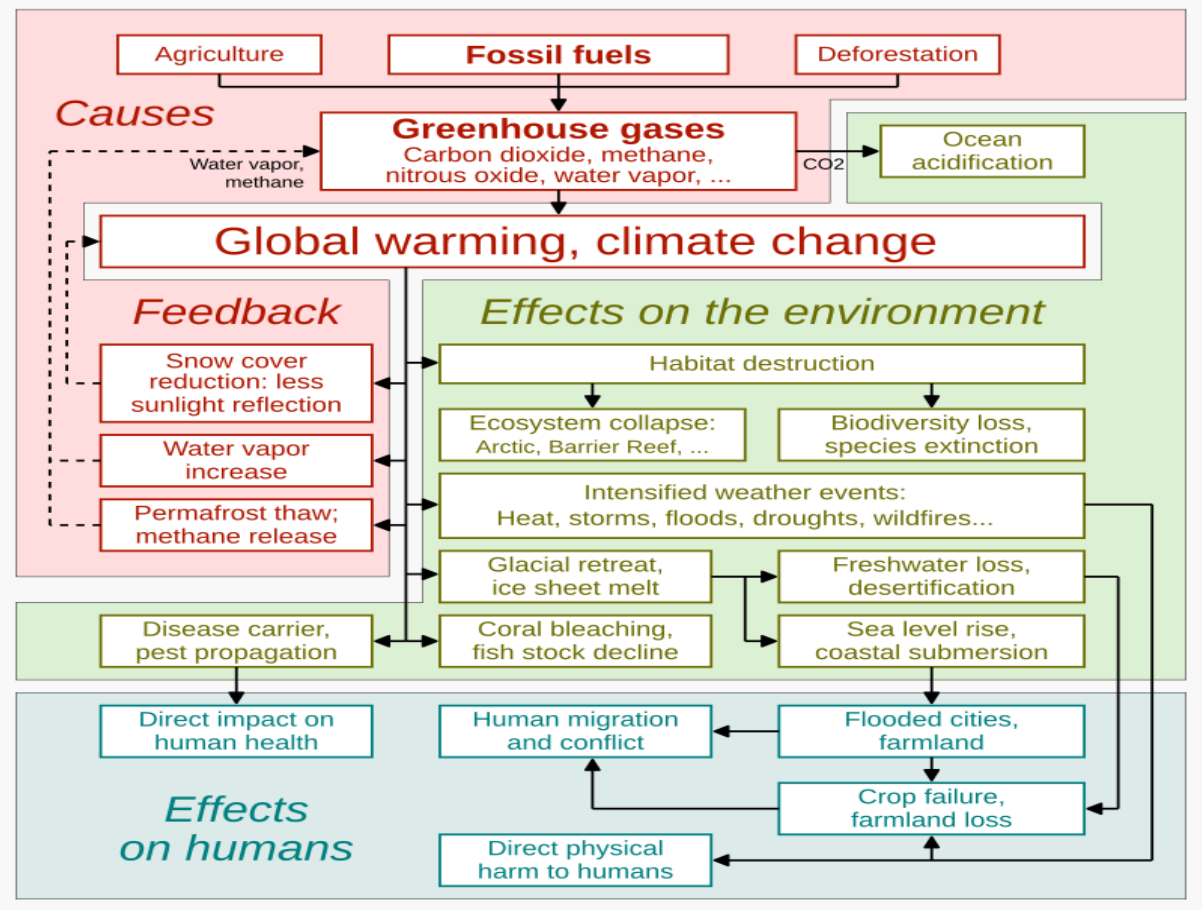

Fig. 1. The primary causes [1] and the wide-ranging impacts of climate impacts [2, 3, 4]. Some effects act as positive feedbacks that amplify climate change [5].

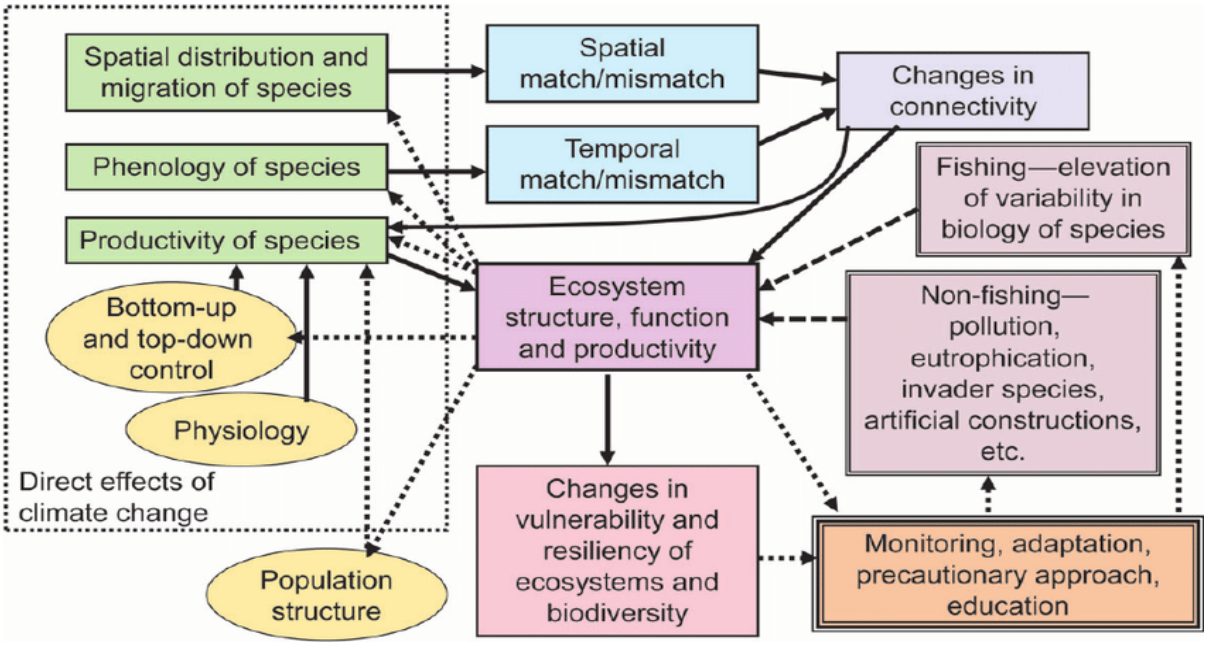

Fig. 2. Direct and indirect effects of climate change and other anthropogenic factors on marine ecosystems, with their implications to adaptation and management. Solid arrows indicate consequences of climate change, while dotted arrows indicate feedback routes [6].

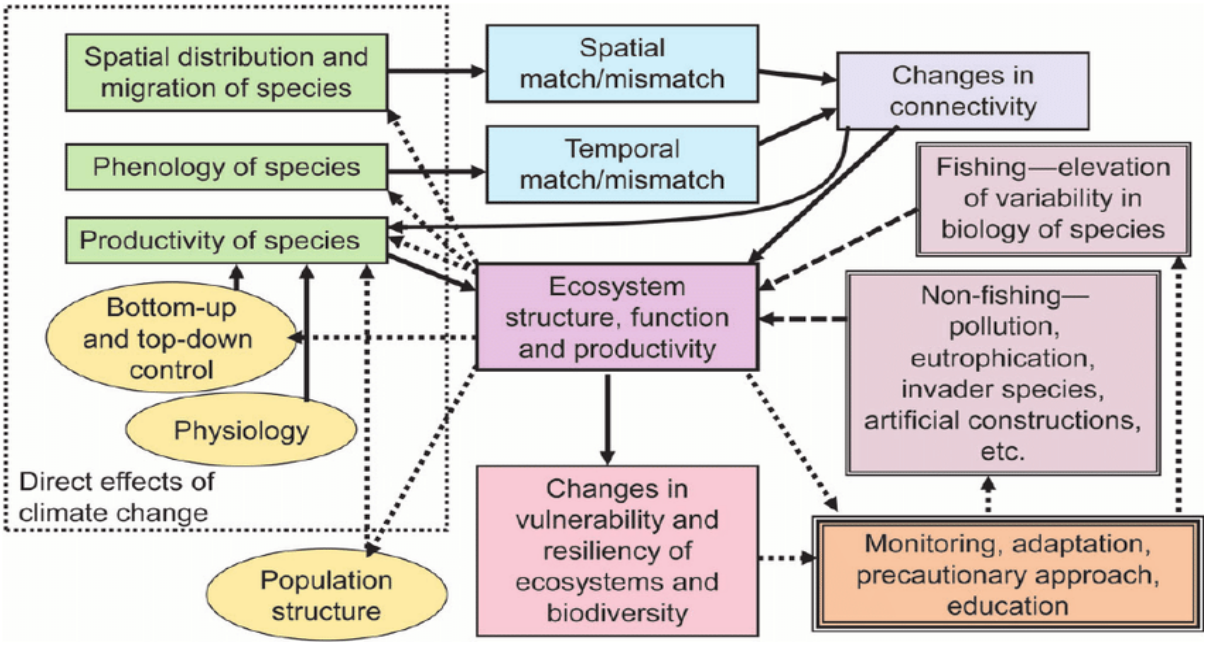

Fig. 3. Direct and indirect effects of climate change and other anthropogenic factors on marine ecosystems, with their implications to adaptation and management. Solid arrows indicate consequences of climate change, while dotted arrows indicate feedback routes [6].

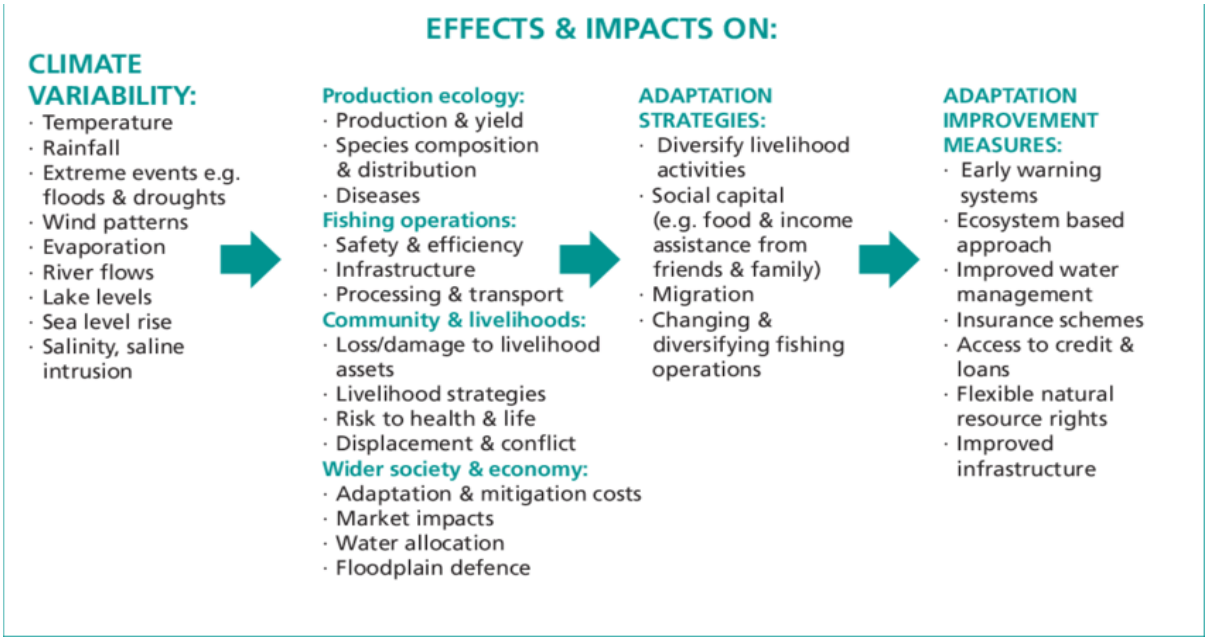

Fig. 4. Climate change impacts on capture fisheries, adaptation strategies (reactive/ autonomous actions) and adaptation improvement (planned/longer-term) measures [8].

Keywords— Environment, Ocean Conditions, Fish Species, Biology, Physiology, Ecology and Diversity of Marine

REFERENCES

[1] The Causes of Climate Change. 2019. climate.nasa.gov. NASA. Archived from the original on 21 December 2019.

[2] Climate Science Special Report. 2019. Fourth National Climate Assessment (NCA4), Volume I. science2017.globalchange.gov. U.S. Global Change Research Program. Archived from the original on 14 December 2019.

[3] Extreme Weather and Climate Change. 2023. NASA.gov. National Aeronautics and Space Administration (NASA). September 2023. Archived from the original on 26 October 2023.

[4] Intergovernmental Panel on Climate Change (IPCC), ed. 2022. Summary for Policymakers, The Ocean and Cryosphere in a Changing Climate: Special Report of the Intergovernmental Panel on Climate Change, Cambridge: Cambridge University Press, pp. 3–36. doi:10.1017/9781009157964.001, ISBN 978-1-009-15796-4 https://doi.org/10.1017/9781009157964.001

[5] The Study of Earth as an Integrated System. 2016. NASA.gov. NASA. Archived from the original on 2 November 2016.

[6] Hollowed, A.B., Barange, M., Beamish, R.J., Brander, K. et al. 2013. Projected impacts of climate change on marine fish and fisheries. ICES Journal of Marine Science, 70(5): 1023–1037 doi:10.1093/icesjms/fst081 https://doi.org/10.1093/icesjms/fst081

[7] Kroeker, K.J., Kordas, R.L., Crim, R., Hendriks, I.E., Ramajo, L., Singh, G.S., Duarte, C.M. and Gattuso, J.P. 2013. Impacts of ocean acidification on marine organisms: quantifying sensitivities and interaction with warming. Global Change Biology, 19(6): 1884–1896. https://doi.org/10.1111/gcb.12179

[8] Harrod, C., Ramírez. A., Valbo-Jørgensen, J. and Funge-Smith S. 2018. How climate change impacts inland fisheries. Chapter 18, pp 375–392. In: Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. and Poulain, F. (Eds.), Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO. 628 pp

Biography

Professor Dr. Md. Aminur Rahman

I have a doctoral degree in Marine and Environmental Sciences from University of the Ryukyus, Okinawa, Japan in 2001, where I also did two years JSPS postdoctoral research (2003-2005) on “marine biology, reproduction, fertilization, hybridization, speciation and aquaculture in the Indo-Pacific sea urchins”. I also worked in the Smithsonian Tropical Research Institute, Panama, and USA for two years (2007-2009) in the same field with Atlantic Sea urchins as the Smithsonian postdoctoral researcher. In addition, I was affiliated as a Chief Researcher in the Ocean Critters Ranch, Inc., Crowley, Texas, USA on “breeding and propagation of various marine ornamental fishes and corals”. I also worked as a Senior Research Fellow (Senior Associate Professor position) and was involved in teaching/supervising undergraduate and postgraduate students in various fields of marine sciences, fisheries and aquaculture as well as conducted research on “Biology, ecology, diversity, breeding, seed production, culture and biochemical composition of sea urchins, sea cucumbers, shrimps and fishes” in Universiti Putra Malaysia (UPM) during January 2010–August 2017. I was also involved in teaching and supervising postgraduate students in fisheries stock assessment, fisheries resource management, principles of inland fisheries, climate change impacts on fisheries, aquaculture and biodiversity conservation as a Professor in the FAO World Fisheries University (WFU), Pukyong National University (PKNU), South Korea, from 1 September 2017 to 28 February 2019 as well as an Advisory Professor in the same university of South Korea from 1 October 2019 to 31 December 2021. I also hold Visiting Professor positions in the Dalian Fisheries University (China), King Abdulaziz University (Saudi Arabia) and Halu Oleo University (Indonesia).

Moreover, I worked as a senior scientist in Bangladesh Fisheries Research Institute during 1988 to 2007 in various fields of Breeding Biology, Nursing, Seed Production, Aquaculture and Fisheries, and was also actively engaged in transferring and disseminating fish breeding, seed production, aquaculture and conservation technologies of commercially important native and endangered fish species of Bangladesh to the farmers, farm managers, private entrepreneurs, NGOs and GOs through on-farm training, demonstration, rally, meeting and mass media in collaboration with ICLARM (now the WorldFish Centre), FAO, DFID etc. In addition, I do have also experiences of teaching undergraduate and graduate students at the Department of Marine and Environmental Sciences, University of the Ryukyus, Japan etc. I supervised more than 45 undergraduate and postgraduate students, and around 36 national and international research projects in the above fields of my expertise. I have also examined around 30 postgraduate (PhD and MS) theses as well as 22 postgraduate research proposals from the international and national university students. Moreover, I have mentored and conducted 12 training courses on different aspects of spawning, breeding, nursing, seed production and culture of various species of commercially important and endangered fish species, and marine invertebrates (sea urchins, sea cucumbers, corals, etc.

Currently, I am involving in teaching and supervising undergraduate and postgraduate students in biological oceanography (marine biology), chemical oceanography, fish population dynamics, fisheries stock assessment and resource management, marine pollution, fisheries impact assessment and planning, aquaculture, fisheries management and conservation, climate change impacts on fisheries, limnology and aquatic ecology etc. as a **Professor** in the Department of Fisheries and Marine Bioscience, Jashore University of Science and Technology, Jashore-7408, Bangladesh, since 2 March 2019 to date. Meanwhile, I am involved in some international collaborative research work on marine biology, marine biotechnology, fisheries and aquaculture with scientists of different institutes, including Smithsonian Institution (USA), Australian Nuclear Science and Technology Organization (Australia), King Abdulaziz University (Saudi Arabia), Universiti Putra Malaysia, Australian Institute of Marine Science, Meio and Kindai University (Japan), Halu Oleo University (Indonesia) etc., while others are under the process of establishment.

My expertise areas broadly lie in Marine and Freshwater Biology, Limnology, Aquatic Ecology and Environmental Sciences, Reproductive Biology and Fertilization kinetics, Population dynamics, Stock Assessment, Breeding and Seed Production, Aquaculture and Conservation, blue economy development, Fish diseases, Climate Change and Food Security, and Taxonomy and Evolution. Through my research works, I have published 189 scientific papers in international

and nationally reputed high impact journals, 2 books, 17 book chapters, 42 referred proceedings as well as 53 abstracts in international conferences, symposia and seminars, with a total Google Scholar Citations of 2898, h-index of 29 and i10-index of 79. I have not only been serving as Editor-in-Chiefs, Editors and Editorial Board Members of more than 72 reputed international journals and proceedings but also presenting keynote, public and invited lectures in 64 reputed international conferences, symposia and seminars. Until now, I have served as session chairs of 38 international conferences and symposia as well as chairpersons of the 36 such international conference organizing committees. Moreover, I have received 23 International and national trainings on various aspects of fisheries and aquaculture as well as attended/presented papers at 185 international and national conferences, symposia, workshops and seminars. I have also been acting as potential reviewers for more than 73 high-impact peer-reviewed and online journals having profound international and national merits. Due to my outstanding contributions in the above fields of specialization, I have already received 43 professional awards from the reputed international and national organizations/institutes. I am also an open water SCUBA diver and have been extensively involved in marine research, and for this until now, I have successfully performed around 60 sampling expeditions in the World’s Oceans, especially for the “Exploration, Utilization, Conservation and Sustainable Management of the High-valued marine Bioresources Throughout the Pacific, Atlantic and Indian Ocean Ecosystems.