



Climate Change and Fisheries: A Global Perspective

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Abstract

Climate change presents a significant challenge to global fisheries and aquaculture systems, with a drastic impact on the fishing industry. Approximately protein need of 17% world's population fulfilled by aquatic foods. Climate change disrupts fish stocks and fisheries through alterations in water conditions, such as warming, oxygen depletion, acidification and sea-level rise, resulting in altered patterns of species distribution and ecosystem functions. Although climate change is recognized as a pressing environmental issue, its connection to specific weather events remains debated. Natural processes and human activities, notably greenhouse gas emissions from fossil fuels and deforestation, significantly contribute to climate change, exacerbating its impacts. Addressing these challenges is crucial for mitigating the adverse over fisheries and aquaculture induced by climate change, safeguarding global food security and to maintain the ecosystem integrity.

Keywords: Climate Change; Fisheries

Introduction

Fishing in Pakistan constitutes less than one percent of the GDP, yet it plays a pivotal role in the nation's economy by providing employment opportunities, especially in areas of Baluchistan and Sindh [1]. In 21st century, for guaranteeing global food security and nutrition, the role of fisheries and aquaculture sector is evident as about 17% of the world's population directly relies for protein on aquatic food source [2]. It is predicted that by 2030, there will be a clear rise in consumption of aquatic foods, may be reached to 21.4kg per capita [3]. The production contribution from aquaculture sector of fish production has been steadily rising, reached to 82.1 million tons which is 46% of 179 million tons of global production, with expectations for further growth to 53% by 2030 [4].

Climate change can pose direct and indirect impacts on aquaculture production systems. Basically, the direct effects encompass alterations in the physical and physiological

aspects of both fish and shellfish populations, while that of indirect impacts may disrupt ecosystems and affect productivity, input supplies and product prices [5,6]. Additionally, the changes in temperature regimes could increase susceptibility to diseases and may cause the occurrence of exotic diseases in cultured species [7]. It emerges as a significant disruptor to global fisheries systems and their governance frameworks, posing a pressing management challenge. Pakistan stands as one of the most vulnerable national economies to the forthcoming impacts of climate change on fisheries and aquaculture sector [8,9].

Climate change is indeed a severe global environmental issue, and its effects are expected to continue in the coming decades. Aquaculture and fisheries is a foundational industry that directly impacts the wellbeing of surrounding communities and plays a significant role in economic development, providing a baseline for secondary and tertiary industries. Climate change's impact on the fisheries and aquaculture sector has been historically underestimated

due to the devaluation of its importance. However, coastal and riparian communities are now experiencing tangible effects that are increasingly difficult to overlook [10]. The unpredictable consequences on both inland and aquaculture production vary, with current and future global impacts including temperature increases, shifts in precipitation patterns, and more frequent extreme weather events [11]. Capture fisheries, in particular, face mounting pressure from climate change effects, compounded by overfishing, habitat degradation [12], pollution, and the introduction of new species. The objective of this summary is to highlight the adverse climatic change impacts on fish stocks and fisheries driven by alterations in water conditions.

Pakistan Vulnerability to Climate Change

Pakistan, with its extensive freshwater resources running through the country, is particularly vulnerable to climate change impacts. Despite contributing minimally to global greenhouse gas emissions, Pakistan experiences a wide range of human-induced climate change consequences. The country's conservation efforts, despite the green revolution era, have been insufficient. While government policies exist, their practical implementation falls short of effectively conserving the aquatic environment. The Indus delta has witnessed a significant rise in mean annual air temperature and a decrease in precipitation, with projections indicating further temperature increases and alterations in precipitation patterns [13]. Such changes pose significant threats to fish populations, particularly cold-water species and intertidal shellfish induced by thermal stress [14,15]. The aquaculture system is particularly vulnerable to climate change due to its direct link with water availability and the effects of melting ice caps. For the sustainability of the aquaculture sector, it is crucial to consider the impacts of climate change to develop mitigation strategies and to be prepared for unavoidable challenges.

Over the course of the twenty-first century, the ocean is anticipated to undergo exceptional changes, with increasing temperatures, oxygen decline and acidification because of ongoing anthropogenic driven climate change [16]. Associated effects i.e. aquatic environments warming, have been linked to an upsurge of disease outbreaks across wild fish and the aquaculture settings. Temperature alterations influence the fish immune response, potentially leading towards immunological disorders and an upsurge in infections susceptibility [17,18]. Furthermore, climate change adversely affects water quality parameters, including dissolved oxygen levels, contributing to large-scale deoxygenation and severe hypoxic events. These conditions impose critical challenges on fish performance, behavior and survival [19-21].

Human Influence and Environmental Impact

Human-induced climate change, driven by carbon dioxide emissions, exerts significant alterations on water conditions, including warming, oxygen loss, acidification and sea-level rise. These changes lead to shifts in marine species distribution, biological events and ecosystem functions, negatively impacting fisheries yield [22,23].

Furthermore, climate change is recognized as the primary environmental concern of the twenty-first century, with expected adverse and irreversible impacts on the earth and its ecosystems. These impacts, including glacial retreat, arctic shrinkage and worldwide sea-level rise, are exacerbated due to human activities, particularly greenhouse gas emissions.

Natural Processes and Greenhouse Gases

Natural processes, such as variations in solar output and atmospheric greenhouse gas concentrations, contribute to climate change. Volcanic eruptions emit gases like sulfur dioxide, leading to sulfate aerosol formation. However, human-made greenhouse gases, such as carbon dioxide emission from fossil fuel burning and through deforestation, is the primary contributors to enhanced climate change [24]. Increases in carbon dioxide, particularly from fossil fuel burning, are the largest factor in climate change. Current atmospheric CO₂ concentrations are the highest in millennia, with projections indicating substantial increases by the end of the 21st century [24]. Although Pakistan's greenhouse gas emissions constitute less than 1% of the global total, the country's vulnerability to climate change-induced crises is around 8% [25,26]. We are undoubtedly living in a world prone to catastrophic events, with countries contributing minimally to greenhouse gas emissions often being the most vulnerable to these events [27]. This paradox underscores the global nature of the climate crisis and the need for coordinated international action to address its impacts on fisheries, aquaculture, and the communities that depend on them.

This wave of climate change is primarily driven by anthropogenic actions and is directly linked to greenhouse gas emissions [28]. The main threats - heavy precipitation, droughts, flooding, and heat waves are all directly connected to climate change [29]. The impacts of these disasters are often unmanageable, resulting in economic and social imbalances within communities.

Impact of Changing Rainfall Patterns on Aquaculture

Changes in rainfall patterns, including flooding and drought events, significantly impact aquaculture sustainability [30].

Increased rainfall poses risks such as pond damage, loss of fish and invasion by unwanted species, thereby threatening environmental sustainability and economic gains in aquaculture [31,32]. Conversely, drought events heighten risks, particularly at 2°C global warming levels, affecting the overall stability of aquaculture production [30]. The severity of climate change impacts on Pakistan was starkly illustrated in 2022 when the country faced approximately \$30 billion in losses due to flooding. This disaster affected 33 million people, resulted in 1,400 reported deaths, and led to economic disruption and increased crime rates. Rainfall during this period was 190% higher than the average over the past 30 years.

Ocean Acidification and Its Implications

Ocean acidification, attributed to increased CO₂ uptake by oceans, poses a significant threat to aquatic species by affecting growth, development, calcification and abundance [30]. Rising ocean acidity levels endanger shell-forming organisms, potentially jeopardizing marine aquaculture production [33]. Moreover, ocean acidification contributes to alterations in hydrology and hydrography, leading to red tide occurrences [34].

Conclusion

Climate change emerges as a significant disruptor to global fisheries systems, posing management challenges and threatening the sustainability of aquatic ecosystems. Pakistan stands as one of the most vulnerable economies to these impacts, with projections indicating further temperature increases and alterations in precipitation patterns, particularly in the Indus delta region. Climate change exacerbates risks associated with changing rainfall patterns, ocean acidification and other environmental stressors, posing significant threats to aquaculture sustainability. In essence, addressing the adverse climatic change impacts over fish stocks, fisheries and aquaculture requires concerted efforts both at global and local levels. Implementing mitigation measures to cut greenhouse gas emissions and adaptations regarding the environmental conditions is imperative for safeguarding the future of fishing and aquaculture industries worldwide.

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