Impacts of El-Nino on Marine Environment

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ABSTRACT

Marine fisheries exhibit a critical role in global food security by providing essential protein for billions, particularly in developing nations. Sustainability of marine ecosystem is threatened by variety of factors such as overfishing, habitat degradation, pollution, climate change, etc. El Nino, a recurring climatic event characterized by ocean-atmosphere interactions in the Pacific, significantly impacts marine ecosystems. This phenomenon alters sea surface temperatures, ocean currents, and upwelling processes, disrupting food availability and habitats for marine species. It leads to reduced rainfall, altered ocean circulation, and impacts on marine biodiversity and fisheries, such as declines in fish catches. With climate change expected to increase the frequency and severity of El Nino events, adaptive management strategies are essential to mitigate its effects on marine ecosystems, fisheries, and biodiversity.

INTRODUCTION

Marine capture fisheries continue to be the primary source of aquatic animal production worldwide, accounting for 43% of total production (FAO, 2024). Stocks recover as a result of good fisheries management, and swift action is required to duplicate effective practices and buck deteriorating sustainability trends. Marine fisheries are essential to community livelihoods, economic stability, and global food security. They give billions of the people access to vital animal protein, especially in underdeveloped countries where fish makes up a sizable amount of the diet. In order to

combat issues like overfishing and habitat damage and provide long-term benefits for ecosystems and human groups, marine fisheries management must be sustainable. According to the National Oceanic and Atmospheric Administration, El Nino is defined as the three-month average positive sea surface temperature anomalies above the 0.5 °C threshold based on the running means of several 30-year base periods in the Nino 3.4 region (5°N-5°S, 120°-170°W). The warm phase of El Nino Southern Oscillation (ENSO) cause changes in atmospheric and ocean conditions, which is a term used to describe the inter-annual climatic variability (Lu *et al*., 1998). It causes intense rainfall resulting in drought in the equatorial Western Pacific (EWP) region including Australia, Indonesia, and Philippines, and floods in the equatorial Central Pacific (ECP) and equatorial Eastern Pacific (EEP) regions (Rasmusson & Wallace, 1983). Under typical circumstances, the EWP has a low atmospheric pressure while the EEP has a high. From EEP and ECP, the warm surface water is pushed towards the EWP by the easterly tradewinds, which is driven westward by the atmospheric gradient. Because the water remains restricted, the EWP experiences a deeper thermocline and a higher water level than the ECP and EEP. In addition, the EWP experiences regular tropical rainstorms due to the low air pressure.

Impacts on Environment

El Nino events cause monthly rainfall to decrease; strong events decrease typhoon strength whereas weak to moderate events cause them to move toward the northeast. El Nino occurrences have an impact on the North Equatorial Current (NEC) bifurcation. During El Nino, NEC bifurcation shifts towards north, strengthening the Mindanao current to the south and weakening the Kuroshio current to the north. Both currents have an impact on the Philippines' and its bordering regions' ocean circulation and transport systems, which in turn has an impact on some marine life. Additionally, El Nino impacts climatic variability not just in the tropics but also in the sub-tropics and certain mid-latitude regions due to teleconnections that disperse tropical climatic patterns towards the pole. El Nino impacts corals, fish, marine mammals, and phytoplankton community especially in marine ecosystems. ENSO occurrences vary the upwelling and sea surface temperature thereby impacting fish and other marine species' access to food and their suitable habitats. Decreases in fish catches from a number of fisheries, including those in the East China Sea and the North Pacific, as well as those of highly migratory species and Peruvian anchoveta in the Eastern Pacific, have been connected to El Nino episodes. In 11 of the 19 maritime FAO Major Fishing Areas, marine fisheries were impacted by strong to exceptional Eastern Pacific El Nino occurrences, according to FAO's retrospective analysis 1950–2023 (FAO, 2024).

Effects vary by target species, geographic location, and kind of fishing or aquaculture, and they can be both negative and positive. The catches of Peruvian anchoveta decreased while yellowfin tuna and skipjack tuna catches increased. Global warming is predicted to increase the frequency of extreme ENSO episodes in climate models. Implementing adaptive fisheries management strategies, such as dynamically adjusting the fishing season and restricting access to fishing grounds based on near real-time monitoring, is therefore essential. Delos Reys & David (2006) observed that previous El Nino occurrences decreased the rainfall rate by up to 50%, causing drought, depending on their intensity. Furthermore, tropical cyclones were avoided by intense El Nino, although the weather was affected for a longer period of time by weak to moderate events. According to Delos Reys and David (2006), weak to moderate El Nino episodes only take one to four months and

have milder but longer-lasting harm, whereas strong El Nino events take five to eight months to cover the nation with drought and have strong but short effects.

Impacts on marine fishes

Marine fishes are adversely affected by El Nino events; the biology and migration of marine fishes is hampered by rise in temperature. The preferred thermal niche or temperature of skipjack tunas are mostly in EWP due to their preference of warm waters. The global distribution of pelagic is influenced by fluctuating temperature. El Nino events caused devastation of Peruvian anchovy, tunas, *Scylla serrata*, etc. which caused reduction of nutrients in marine waters. There are some positive impacts on sardine fishery in Zamboanga Peninsula during El Nino events of 2003 and 2007 due to enhanced upwelling which us beneficial to pelagic planktivores fish species such as sardines (Villanoy *et al*., 2011). However, increased primary productivity cause eutrophication and algal blooms for some species, causing adverse effects to shellfishes and also fish kills due to oxygen depletion.

Impacts on Coral Reefs

Corals need certain temperature limits to survive as they have very narrow temperature range tolerance, making them the first to get adversely affected by fluctuating temperature of water. Being the most crucial part of reef ecosystem by protecting and supporting all the organisms that reside in reefs. They take part in primary productivity, nutrient recycling and reef growth. They are the most diverse marine ecosystem comprising of coral reefs, fishes, organisms, etc. Disturbance or devastation of the corals disrupts the entire food chain interconnected with each other. El Nino is a warm current causing influx of water with high temperature resulting in coral bleaching. Moderate El Nino events can cause decrease in survival rate of corals while extreme events can cause the corals mortality. Coral bleaching cause changes in biodiversity regimes as it causes reduced recruitment of reef-associated fishes.

Impacts on seaweeds

Seaweeds distribution is subjected to temperature and salinity of marine waters. El Nino cause prolonged warm sea surface temperature with frequent rainfall resulting in negative impact on giant kelps growth. The shallow water cultured seaweeds on coastal areas can be most affected by extreme heat caused by El Nino. The chances of disease like suminori in porphyra and white-tips in gracilaria can happen due to exposure to high temperature. The increased temperature and lowering salinity of sea can significantly hamper the overall growth, survival and distribution of seaweeds.

CONCLUSION

The interplay between El Nino and marine fisheries underscores the importance of understanding and mitigating climate impacts on aquatic ecosystems. El Nino's disruptions to oceanographic conditions have far-reaching consequences, ranging from diminished fish stocks to altered marine biodiversity. While its impacts vary by region and species, the trend toward more frequent extreme El Nino events due to global warming highlights the urgency of sustainable fisheries management. Strategies such as dynamic adjustment of fishing seasons and near real-time monitoring of fisheries can help adapt to these climatic changes. The socio-economic implications of El Nino demand comprehensive approaches that combine scientific research, policy adjustments, and community engagement. Addressing El Nino's impacts is critical not only for maintaining marine biodiversity but also for ensuring the long-term viability of

fisheries and the livelihoods of those who depend on them.

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