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IMPACTS OF CLIMATE CHANGE ON OCEANS AND COASTS, BASIC PHYSICAL AND CHEMICAL PHENOMENA INFLUENCE ON BIOLOGICAL PROCESSES AND FISH STOCKS WHILE CONSIDERING THE CHALLENGES AND PROSPECTS FOR THE MARITIME INDUSTRY

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ABSTRACT

Mankind's reliance on the ocean for numerous activities and services means any change occurring in the ocean will have profound influence on our lives. Coasts and oceans are steadily being affected by the change in our climate. Periodic flooding and steady sea-level rise impact coastal areas and inundate fresh water supplies. Elevated storm severity imperils small communities, in addition to big towns. Marine resources allocation, weather patterns, ocean circulation and currents are affected by melting Arctic ice. Coral reefs and other calcium carbonates are made weak by ocean acidification. Food security, lifestyle and economic conditions of numerous countries depending on oceans are at danger. The most direct possible impacts of climate change on fisheries will result from alterations in the places of the fish stock and productivity. Climate change may as well impact the maritime ecosystem that corroborates those populations by changing primary productivity as well as total productivity, composition and structure of the marine ecosystems on which fish rely. Alterations in environmental conditions, ocean temperature and ocean acidification all powerfully impact the locative distribution of fish.

Climate change represents a vital threat to maritime transport, particularly ports. While the rising sea level will definitely raise serious complications to ports, there are other main interests about the raised intensity of extreme events and the combined impact of local environmental situations. Changes in the intensity of waves will as well cause a need to increase dredging of channels and ports in turn raising costs. In addition to direct effects of climate change, there can be indirect impacts, involving possible changes in trade flows as a result of climate change and following changes to transportation infrastructure.

It is for these reasons that governments, organizations, and agencies have begun to act in accordance. The Maritime Sector, while contributing to the increase of GHG emissions noticeably less than other transportation sectors, is taking considerable action to mitigate and adapt to the threats and opportunities inherent within climate change.

KEYWORDS: Climate Change, Physical Phenomena, Chemical Phenomena, Maritime Industry, Fish Stock, Polar Region and Greenhouse Gases (GHG)

INTRODUCTION

Climate change has frequently been qualified to be one of the widely imperative ecological difficult and stimulating tasks. Our social welfare, our wellness, our economies and our way of life are all influenced by climate.

Climate change has the possibility to affect all countries of the world and substantially every economic sector (Lemmen & Warren, 2004).

Changes in climate are impacting ocean chemical, physical and biological systems, in addition to people usages of these systems. Ascending levels of atmospheric $CO_2$are one of widely critical issues since its impacts are internationally unchangeable and penetrating on ecological time scales. The two prime frontal results of raising atmospheric CO_2 in marine ecosystems are raising ocean acidity and temperatures. Rising temperatures generate a diversity of other ocean changes involving declining size of sea glass, growing ocean stratification, rising sea floor and varied patterns of precipitation, fresh water input, storms and ocean circulation. These and other changes in ocean chemical and physical states like nutrient attainability and oxygen concentrations, are affecting strongly a diversity of ocean biological attributes involving species interactions, species allocation, community structure, phenology and primary production, thus affecting crucial ocean services (Griffis, Howard, Helmuth, Cornell & Babij, 2012).

The oceans are progressively warming as a frontal outcome of increasing atmospheric CO_2 and other Greenhouse Gases (GHG). This warming has diverse results, involving salinity, alterations in ocean circulation, raised stratification of the water column, change in global climate patterns and the rise of sea level. In addition to warming the ocean, CO2 is being involved in giving rise to a succession of chemical reactions that lead to a reduction in ocean pH (Griffis, Howard, Helmuth, Cornell & Babij, 2012).

Ocean warming enlarges the obtainable energy used to produce ephemeral storms; a warming ocean will probably cause enlarged storm intensity. Asthe ocean surface warms, stratification will takeplace, causing the warmer water toremainat the surface instead of blending with the cooler water beneath. The chemical and physical changes taking place in the oceans regulate the phase for following impacts on marine organisms (Griffis, Howard, Helmuth, Cornell & Babij, 2012).

Climate change will compel changes to both habitat and landforms statuses in a scope of coastal environments. There is the possibility for saline inundation of wetlands, change of tidal systems, beach destruction and shoreline erosion (Climate change risks to Australia’s coast, 2009).

The maritime industry is not separated from climate changes; the size, type and range of effects change in accordance with local situations. Direct effects are probably in regard to maritime transport infrastructure, maintenance and operation. Maritime transport services can as well be influenced indirectly by climate change impacts on energy exploration, forests, agricultural production, demographics, investment decisions, fishing activity and trade (UNCTAD, 2009).

THE COMPLEXITY IN THE IMPACTS OF CLIMATE CHANGE

Nowadays, the ocean is challenging, influential and unfamiliar impendences, due to climate change, which boost present potentials from increasing human activity in the ocean. These changes will negatively impact the ocean’s capability to uphold the ecosystems, cultures and human populations (Herr & Galland, 2009).

Climate change will have considerable impacts on all sectors connected to human uses of the ocean, containing but not restricted to tourism, maritime governance, human wellbeing, security, transportation, energy and fisheries (Griffis, Howard, Helmuth, Cornell & Babij, 2012). “Global average surface temperatures rose by 0.6^{o} C +/- 0.2^{o} C and sea levels rose by 0.12 to 0.22 meters during the 20 century. Other observed changes in Earth systems that are consistent with anthropogenic climate change include: Earth isn't warming uniformly. Notably, climate change is expected to affect the Polar Regions more severely. Melting snow and ice expose the darker land and ocean surfaces to the sun, and retreating sea ice increases the release of solar heat from the oceans to the atmosphere in winter. Many natural ecosystems are vulnerable to climate change impacts, especially systems that grow and adapt slowly. For instance, coral reefs are under serious stress from Rapid Ocean warming" ("The Habitable Planet", n.d.).

Climate change is seeming to change weather patterns and hydrologic cycles in many ways, causing further extreme weather events such as droughts and storms, decreasing or expanding rainfall from place to another and changing storm track. While precipitation tendencies alter excessively over an area and time, "total precipitation increased during the 20^{th} century over land in high-latitude regions of the northern hemisphere and decreased in tropical and subtropical regions" ("The Habitable Planet", n.d.).

Altering hydrological cycles and rising temperatures are probably to have numerous impacts;several regions will turn intothe dryer and others become wetter. Change in Storm tracks can happen, resulting ordinary change in weather patterns. Natural ecosystems may be disturbed by these changes, possibly resulting in casualties to species ("The Habitable Planet", n.d.).

Melting of polar ice glaciers and caps is already dominant. Continuous sea level rise, growing storm surge levels and flooding in coastal regions are results from the continued melting of sea ice. Tropicalregions surface temperatures are already raising the intensity of hurricanes, and this tendency can quicken as far as there is a rise in ocean temperatures ("The Habitable Planet", n.d.).

Ocean chemistry is changing in reaction to the taking in of CO_2 from the atmosphere. Ocean acidification relate to the fall in the pH of the ocean connected to the CO2 and following chemical reactions. Ocean acidification is linked to, but distinguished, climate change. Acidification is not a climate course of action, however instead a lead impact of increasing CO_2 taking in on ocean chemistry ("The Habitable Planet", n.d.).

Acidification can as well be intensified by alterations in ocean's circulation. Deep waters which are welled up are comparatively acidic, that can cause a negative effect on marine organisms. One of the well exceptional impacts of the ocean's speedy altering of pH is the effect on low-frequency sound intake. Sound is generated as a result of numerous anthropogenic actions like gas and oil exploration and shipping, etc. besides normal sources of noise in the ocean such as earthquakes, mammals, Wind, etc. ("The Habitable Planet", n.d.).

Changes in strength and frequency of intense precipitation events, in addition to seasonal changes, are probable to have consequential economic and social effects on productivity, production, mortality and sustenance involving management of natural and human systems infrastructure (Tamiotti, Teh, Kulaçoğlu, Olhoff, Simmons & Abaza, 2009).

Possible biophysical effects of climate change on the coast are: loss of coastal habitation, higher sea surface temperatures, higher storm-surge flooding, increased sea ice cover, salt water intrusion into fresh water aquifers and coastal erosion (Lemmen& Warren, 2004).

Prospective socioeconomic effects of climate change in coasts are; loss of cultural resources (e.g., fisheries), increased flood hazards and possible loss of life, raised risk of disease, raised property loss, and change to coastal infrastructure, involving that used for recreation and transportation (Lemmen& Warren, 2004).

The main physical effect of the quickened sea level rise should be an increasing of the rates of shoreline change which is already taking place inthe coasts. Processes like migration toward the solid ground, cliff erosion and beach draw back and erosion would persist, though more widely and quickly (Lemmen& Warren, 2004).

The decrease of water levels due to climate change would in an important manner affect activity, infrastructure and coastal communities. While some impacts can be advantageous such as less flooding, wider beaches, many will be disadvantageous. For example, lower levels would impact water supplies of shoreline municipalities, obligate enlarged dredging of ports and reduce shipping chances (Lemmen& Warren, 2004).

Sea level rise as well participate to a growing risk linked with extreme cases. Risks like extreme short-lived inundation events may raise a peril to infrastructure and natural social systems and transfer huge amounts of sediments, which affects coastal settlement (Climate Change Risks to Australia's coast, 2009).

Coastal waters will persist to be impacted by extreme tides, storm tides and storm surges, which can become more and more serious in numerous places because of climate change. These causes will act reciprocally with sediments in coastal systems. The integrated impact of changes in extremes and sea level rise will cause much immense hazards in the coasts as compared to any single cause (Climate change risks to Australia's coast, 2009).

THE INFLUENCE OF PHYSICAL AND CHEMICAL PHENOMENA

In connection with biological and physical effects, climate change is reallocating species. In a general manner, warm-water species are being moved from usual localestoward the poles and are experiencingalterations in the productivity and the size of their habitats. In warmed regions, ecosystem productivity is seeming to be decreased in most subtropical and tropical oceans, lakes and seas and raised in higher latitudes. Elevated temperatures will as well impact fish physiological processes causing both unfavourable and favourable impacts on fisheries, according to and region (Cochrane, Young, Soto &Bahri, 2009).

Differences in warming among oceans and land and among tropical and Polar Regions will impact seasonality, strength and number of occurrences of extreme weather events and climate patterns (e.g. El Nino). The integrated impact of salinity and temperature changes as a result of climate warming is anticipated to alter surface mixing, decrease the density of the surface ocean and amplify vertical stratification (Cochrane, Young, Soto & Bahri, 2009).

Water column stability and higher vertical stratification in the oceans is probably to decrease nutrient accessibility to the euphotic zone and there for primary and secondary production in warm regions. In higher latitudes the residence time of particles in the euphotic zone will raise, stretching the growing season and therefore enlarging primary production (Cochrane, Young, Soto & Bahri, 2009). The effects of ocean acidification will be particularly serious for cold water corals, shell-borne organisms and tropical coral reefs.

Multiple long-term alterations in physical for cesinvolving seasonal patterns, hydrological cycles, stratification, ocean currents, variability and intensity patterns and circulation have been spotted as a consequence of climate change. (Cochrane, Young, Soto & Bahri, 2009).

The effects of these forces on biological processes, providing support for fish and fisheries production in marine ecosystems have previously been remarked. Climate impacts on communities and species' anthropogenic global climate change have intense implications for the productivity and survival of ecosystems, marine populations and communities.

Changes in ocean chemistry may be more significant than changes in temperature for the survival and the performance of numerous organisms having calcium carbonate structures (Hobday, Okey, Poloczanska, Kunz & Crick, 2005). Some possible effects include changed ecosystem functions, largervulnerable to parasites and/or disease, raised contest from a foreign species, improved or decreased growth and changes in species distributions. These alterations could remove species from part or all of their current habitat and could impact, sustainable harvests of fish (Lemmen & Warren, 2004).

Fisheries can be affected in an enormous range of forms as a cause of climate change. These involve biophysical effects on the production or distribution of fish stock through processes like to interrupt precipitation, alterations in oceanography, habitat deterioration and ocean acidification. Fisheries will as well be vulnerable to a varied range of indirect and direct climate effects; effects on infrastructure and coastal communities owing to sea level rise; the frequency or distribution of tropical storms. These current socioeconomic trends and the indirect impacts of climate change may react with, diminish or magnify biophysical effects on fish ecology. The diversity of various impact techniques, sophisticated interactions among economic, social and ecological systems and the probability of unexpected and abrupt changes make future impacts of climate change on fisheries hard to announce in advance (Cochrane, Young, Soto & Bahri, 2009).

Climate change can offer some challenges as well as opportunities and impendences for the fisheries. Increased opportunities may exist if tropical species move toward the poles in reaction to a warming ocean. The scientist's findings confirm that fisheries will be affected differently according to the physical changes in the localized environment (Climate change risks to Australia's coast, 2009).

The abundance and distribution of many fish and their migration will be directly impacted by alterations on ocean currents. Numerous species' distribution is connected to the fronts among water masses. The location of these fronts and therefore the migration and distribution of species would be changed, if any, alteration in ocean currents takes place (Robinson, Learmonth, Hutson, Macleod, Sparks, Leech, Pierce, Rehfisch & Crick, 2005).

Changes in salinity, such as with alterations in melting ice and river run-off will affect the abundance and the distribution of trophy through impacts on circulation and stratification and perhaps as well because of restricted salinity tolerance (Robinson, Learmonth, Hutson, Macleod, Sparks, Leech, Pierce, Rehfisch & Crick, 2005).

"There may be effects of elevated CO_2 partial pressures on acid-base regulation, calcification and growth, respiration, energy turnover and mode of metabolism. Acid-base parameters, such as pH, bicarbonate and CO_2 levels are likely to affect metabolic function and therefore growth and reproduction"(Robinson, Learmonth, Hutson, Macleod, Sparks, Leech, Pierce, Rehfisch & Crick, 2005). Changes in ocean chemistry caused by greater CO_2 levels can have an unfavourable influence on coral reef involvement and wellness, which could have a damaging impact on the collaborated alterations in weather patterns (Robinson, Learmonth, Hutson, Macleod, Sparks, Leech, Pierce, Rehfisch & Crick, 2005).

Intensified run-off will be caused by more extreme precipitation events. Rises in water temperatures, integrated with multiplied nutrient input into coastal waters would result in a rise in toxic algal blooms and eutrophication. Eutrophication can act a significant function in community activities and phytoplankton seasonal that in line will impact fish (Robinson, Learmonth, Hutson, Macleod, Sparks, Leech, Pierce, Rehfisch & Crick, 2005).

Extensive patterns of climate changeability, like the El Niño-Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO), give an explanation for main changes in weather and climate around the globe and have been proven to influence species and fish stocks through both indirect and direct pathways. “El Niño events have been linked directly and indirectly to massive die-offs of plankton and fishes. Warm events associated with the El Niño-Southern Oscillation is predicted to increase in frequency, which would result in a decline in plankton biomass and fish larvae abundance, adversely impacting fish recruitment patterns and spatial distribution of fish stock” (Robinson, Learmonth, Hutson, Macleod, Sparks, Leech, Pierce, Rehfisch & Crick, 2005).

THE CHALLENGES AND OPPORTUNITIES FOR THE MARITIME INDUSTRY

Climate change will seemingly influence transportation. For example, the warming of the Arctic is forcing regions of the ocean to be more fordable by ships as compared to the past. With sea ice retreating due to warming temperatures, international shipping patterns have been altered and will go on altering significantly in the future (Griffis, Howard, Helmuth, Cornell & Babij, 2012).

The maritime industry affects much of the present global trade. Therefore, expanded maritime transport in the Arctic will extremely influence the export and import of cargo throughout the world economy. Additionally, global seaborne trade is growing, thus emphasizing the relationship between trade, economic growth and demand for maritime transport services. Presumed this is what is going on, climate change impacts on marine users and resources will probably include indirect and direct opportunities and challenges to the maritime transportation sector (Griffis, Howard, Helmuth, Cornell & Babij, 2012).

With fuel costs and canal fees (Suez Canal and Panama Canal) and other pertinent factors which set freight rates into consideration, new navigation lanes should be compelled to lower the cost. These possible shorter routes should encourage large contest with present routes, through a lowering in transport costs, perhaps encouraging global economic and trade integration. A passable North is probably as well to assist resource exploration activities in the region. World shipbuilders can hence be anticipated to get more requests for ice-class vessels (UNCTAD, 2009).

Higher temperatures are seeming to impact maritime transport infrastructure, equipment and means. Extreme temperatures and enormous changes, add to more repeated freeze and melt cycles, should, for instance, cause a damage of ports’ paved areas. Heat should as well result in damage to gear (e.g. Cranes) (UNCTAD, 2009).

Inundations, flood and rising sea levels cause massive consequences for transport infrastructure and can include deterioration of cargo, containers, warehouses, storage yards, intermodal facilities and ports. Enlarged sediment movability and alterations in sedimentation and erosion patterns surrounding ports and approach channels would as well make difficult operations and increase costs through the necessity for dredging. Behind direct costs, losses induced by sea level rise, inundations and floods would contribute to delays, suspension of service, port shutdowns and additional economic damages (UNCTAD, 2009).

Extreme weather events should interrupt terminal services, as well as create challenging sailing conditions and possibly raise risks to the environment, crew, cargo, vessel and navigation. This can cause further implications for GHG emissions, fuel consumption and infrastructure investments, more over reduce efficiency and cause trade stagnation (UNCTAD, 2009).

MITIGATION EFFORTS WITHIN THE MARITIME SECTOR

As it stands maritime transport is the most energy efficient means of mass transport and a marginal contributor to global CO2 emissions (3-5 %) as compared to road transport which accounts for approximately 70% of total CO2 emissions produced from transportation (IPCC, 2014: Climate Change 2014: Impacts, Adaptation, and Vulnerability). None the less, improvements in energy efficiency and emission reduction within the maritime sector are actively being sought by Governments, working through the International Maritime Organization (IMO), the shipping industry and numerous environmentalist groups.

IMO's focus in dealing with emissions from international maritime transport is aimed to provide more effective, less GHG emitting fuels and to encourage the use of newer, better technologies mitigate GHG emissions within the maritime industry. The maritime sector, through the IMO, became the first international industry sector to adopt mandatory measures to reduce GHG emissions (IMO, 2011).

IMO has formulated an Energy Efficiency Design Index (EEDI) which is to be phased in between 2013 and 2025. The new EEDI aims to improve the energy efficiency of certain types of new ships and sets technical standards to allow for the reduction of GHG emissions (IMO, 2011). However, the EEDI may not meet the target if ships demand increases faster than fuel, carbon and energy intensities improve (2014: Transport. In: Climate Change 2014: Mitigation of Climate Change). Thus, the voluntary Ship Energy Efficiency Management Plan (SEEMP) was carried out in 2013. It offers a minimal energy efficiency level for different ship types and sizes. As much as 70 % reduction of emissions from new ships is anticipated with the objective to accomplish roughly 25 – 30 % reductions overall by 2030 compared with business-as-usual. It is estimated that, in combination, EEDI requirements and SEEMP will cut CO2 emissions from transportation by 13 % by 2020 and 23 % by 2030 compared to a 'no policy' baseline (2014: Transport. In: Climate Change 2014: Mitigation of Climate Change).

CONCLUSIONS

Mankind's reliance on the ocean for numerous cargo and services means which ocean changes influences us. Periodical flooding and fixed sea-level rise impact coastal land and inundate fresh water supplies. Expanding storm harshness imperils small communities, in addition to big towns. Marine resources allocation, weather patterns, ocean circulation and currents are affected by melting Arctic ice. Coral reefs and other calcium carbonate are made weak by ocean acidification. The food security, lifestyle and economic situations of numerous countries that depend on ocean are at danger (Herr & Galland, 2009).

The most direct possible impacts of climate change on fisheries will result from alterations in the places of the fish stock and productivity, which are the present and future targets of those fisheries. Mortality, producing capacity and growth rates of fish populations may be directly influenced by change in climate. Climate change may as well impact the maritime ecosystem that corroborates those populations, by changing primary productivity as well as the total productivity, composition and structure of the marine ecosystems on which fish rely on. Additionally, alterations in environmental situations, ocean temperatures rise and ocean acidification all powerfully impact the locative distribution of fish (Griffis, Howard, Helmuth, Cornell & Babij, 2012).

Climate change would have hostile impacts, especially for regions which were previously holding out more regular storms and higher precipitation changeability in addition to water scarcity. Climate change represents a vital threat to maritime transport, particularly ports. While the ocean level rise will definitely raise serious difficulties to ports, there were other main interests about the raised intensity of extreme consequences and the aggregated impact of local environmental situations, like the subsidence of port cities constructed on subsiding and low-lying coasts. Changes in waves would as well direct to increase dredging of channels and ports which in turn raise costs. In addition to direct effects of climate change, there would be indirect impacts, involving possible changes in trade flows because of climate change and following changes to transportation infrastructure (UNCTAD, 2009).

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