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CLIMATE CHANGE EFFECTS ON AQUATIC ECOSYSTEM: STRUCTURE AND DISEASE

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ABSTRACT

Climate change is projected to cause significant alterations to aquatic biogeochemical processes, (including carbon dynamics), aquatic food web structure, dynamics and biodiversity, primary and secondary production; and, affect the range, distribution and habitat quality/quantity of aquatic animals. Nutrient and carbon enrichment will enhance nutrient cycling and productivity, and alter the generation and consumption of carbon-based trace gases. Consequently, the status of aquatic ecosystems as carbon sinks or sources is very likely to change. The magnitude, extent, and duration of the impacts and responses will be system and location-dependent.

INTRODUCTION

Climate change is very likely to have both direct and indirect consequences on the biota and the structure and function of tropical freshwater ecosystems. Changes in key physical and chemical parameters at the landscape scale as described by Allison *et* al (2007) are very likely to affect aquatic community and ecosystem attributes such as species richness, biodiversity, range, and distribution, and consequently alter corresponding food web structures and primary and secondary production levels. The magnitude and extent of the ecological consequences of climate change in freshwater ecosystems will depend largely on the rate and magnitude of change in three primary environmental drivers: the timing, magnitude, and duration of the runoff regime; temperature; and alterations in water chemistry such as nutrient levels, DOC, and particulate organic matter loadings (Barange, 2009).

The key threats to natural resources including aquatic resources and fisheries have been categorized as over-exploitation, invasive species, habitat change and pollution (Loh, 2008). Freshwater ecosystems and organisms are believed to be susceptible to climate variability and change. Fluctuations in precipitation are manifested in quantity of rainfall, floods and drought. Flood events can increase productivity as nutrients are washed into aquatic systems but may also enhance siltation, displace communities and destroy infrastructure. Climate change will probably produce significant effects on the biodiversity of freshwater ecosystems throughout the tropical and possibly initiate varying adaptive responses. The magnitude, extent, and duration of the impacts and responses will be system- and location-dependent, and difficult to separate from other environmental stressors. Biodiversity is related to, or affected by, factors including: the variability and availability of local resources; disturbance regimes in the area; the local species and their dispersal opportunities or barriers and biotic interactions with flexibility in reproductive and life-history strategies for certain aquatic organisms (Brucet, 2009). There is growing evidence, however, that climate change will contribute to accelerated species losses at regional and global levels and that the effects of alterations in the biodiversity of ecosystem structure and function are likely to be more dependent on given levels of functional diversity than on the total number of species (Dembski, 2009). Moreover, both the number and type of functional units present in a community largely affect ecosystem resilience and vulnerability to change (Brucet, 2009).

A second major effect of climate change will probably be alterations in the geographic range of species, thereby affecting local and regional biodiversity. As climate change effects become more pronounced (e.g., degree-day boundaries or mean temperature isotherms shift northward), the more ecologically vagile species are likely to extend their geographic ranges (Hecky, 2006). In North America, for example, the distribution of yellow perch (*Perca flavescens*) is projected to expand northward beyond its current, primarily subarctic distribution.

Impacts on Aquatic Productivity Processes

Change in fish community structure resulted by physic-chemical alteration leading to increased proportions of smaller-bodied individuals (Jepssen *et al.,* 2010 and Murisa Ndebere *et al* 2011) associated with climate warming is expected to impact other lake processes, such as nutrient dynamics and mobilization. Aquatic productivity processes are affected through changes in phytoplankton composition and primary production, invertebrate composition and production, and food-webs.

Impacts on composition, distribution, abundance, fishery yield and life history of fishes

Climate factors modify biological cycles of fish which are adapted to certain hydrological conditions especially seasonal patterns such as in riverine species. Climate change will modify distribution of freshwater species through shifts in distribution of plankton, invertebrates and fishes. Changes in timing, intensity and duration of floods will affect migration especially of riverine fish species and will affect spawning and transport of spawning products.

Fishes are cold-blooded organisms and their metabolic rates are strongly affected by warming. Increasing temperature affected physiology of fishes because of limited oxygen transport to tissues at higher temperatures. Temperature mediated physiological stress and timing may affect recruitment success, abundance and populations and changes in abundance and can alter composition and growth rate.

Changes in timing of floods may trigger production at the wrong time from plankton to invertebrates and fish may be considered as consequence of climate change. Shifts in species phenology including spring advancements and delays of annually recurring life cycle events are amongst the most severe consequences of global warming (Durant *et al*., 2007). These shifts are often unequal amongst species and trophic levels, causing a mismatch between the phenology of organisms and their food.

Climate change may shift species dominance. It may provoke sudden and unpredictable responses as ecosystems shift from on state to another. Regime shifts in fish stocks have been observed to be mediated not only by over-fishing and pollution but also by climate change.

There is close relationship between life history parameters and temperature. Cool water species are more affected by slight temperature change than warm water fish (Parmesan, 2006). A cross-comparison of fish populations in temperate lakes has shown that lower-latitude fish species are often not only smaller, but also grow faster, mature earlier, have shorter life spans and allocate less energy to reproduction than populations at higher latitudes (Blanck & Lammouroux, 2007).

Impacts on parasites and disease incidences in fish

Temperature is one of the key driving forces behind many ecological processes that affect the life-cycle of parasites. Global increase in average temperatures is expected to affect productivity of capture fisheries and aquaculture systems by increasing the vulnerability of fish species to parasite attacks and diseases (Marcogliese, 2001). Climate change increases susceptibility of fish to disease as their immune function is compromised in the presence of stressors like high temperatures and crowding.

High temperatures and reduced oxygen concentrations are also expected to lead to proliferation of gill parasites, thus causing respiratory problems and even death of infected fish (Pojmanska *et al*., 1980). A climate change is also expected to indirectly affect parasites and their hosts in aquatic systems through alteration in water levels, eutrophication and ultra violet radiation (Marcogliese, 2001; Cochrane *et al*., 2009).

Conclusions and recommendations

Climate variability and change is a major environmental and socio-economic problem which poses a major challenge to natural resources such as fisheries and livelihoods. The international, regional and national governments and institutions are increasingly recognizing this challenge. There is need to understand the impacts of climate variability and change on different production sectors and on livelihoods. The capacity, knowledge, policies, regulations, awareness are all still weak and need to be built to maturity if the challenges posed by climate change are to be adequate addressed to reduce their effects on livelihoods. Policies to address climate change issues at international, regional and national levels have been developed and there are some international, regional and national legal instruments which can be applied to address climate issues but putting these in practice still remains a challenge.

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