BIODIVERSITAS
Volume 17, Number 1, April 2016
Pages: 322-331

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d170144

Review: Climate-induced hydrological changes and the ecology of tropical freshwater biota

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Manuscript received: 29 February 2016. Revision accepted: xxx April 2016.

Abstract. *Sunardi, Wiegleb G. 2016. Climate-induced hydrological changes and the ecology of tropical freshwater biota. Biodiversitas 17: 322-331.* Climate change is believed to pose adverse effects to biodiversity of aquatic systems, with no exception of those in tropical areas. However, next few decades species extinction is suggested as dark future as we lack researches uncovering how climate change threats the aquatic biota. Unluckily, the tropical freshwater systems are expected to suffer more severe impacts of climate change, from heavy floods or extended drought than do the boreal areas. A comprehensive understanding of biota' performance in face of climatic pressures, will guide the further necessary researches. This paper presents a review on the available researches addressing ecological effects of the most influential climatic parameter in tropic area, the hydrological regime, on freshwater biota. The research reveal that the extreme water fluctuations induced by climate change have negatively affected the performance of freshwater biota. In the next few decades, climate change seems to remain as one of the main threats for freshwater ecosystems, and is responsible for the lost of its biodiversity.

Keywords: Biota performance, climate change, drought, flood, tropical freshwater

INTRODUCTION

Global change has been shown and predicted to have major effects on biodiversity at global, regional, and local scales, although global change constitutes a number of different forms of anthropogenic impacts (Sala et al. 2000), including land use alterations, nitrogen deposition, and invasions of exotic species. In other words, changes in climate and climate variability would, somehow, significantly affect natural ecosystems, and may pose additional threats to the already-stressed ecosystems. Furthermore, the effect of future climate change on biodiversity has been predicted to be unprecedented as well, with 15-37% of terrestrial species possibly becoming extinct due to climate change alone in the next 50 years (Thomas et al. 2004), and a similarly dark future has been suggested for freshwater species in the next few decades (Xenopoulos et al. 2005).

Freshwater ecosystems are vulnerable to global change. Important global climate variables that are expected to change in the next decades with respect to freshwater habitat are air temperature and precipitation (Mitchell et al. 1990). Changes in these variables will affect water temperature, water quantity and water quality variables of freshwater environments which are the three primary linkages between climate and freshwater organisms (Regier and Meisner 1990).

Climate change pushes species out of their ecological synchrony and environmental landscape. This influences not only species distributions or community structure, but also the services they provide to ecosystems. Understanding how species' performances change along with the environmental gradients is worthwhile. This is particularly important in aquatic systems, where shifts in habitat quality associated with environmental perturbations threaten the integrity of aquatic biota (Strayer et al. 2004).

The magnitude of impacts and responses of aquatic ecosystems, however, differ between boreal and tropical area with regard to the global change. This is due to climatic variation between the two areas. In the tropics, the annual variation in air temperature is smaller, but there is a large and predictable annual variation in precipitation (Lowe-McConnell 1987). The seasonal precipitation cycle produces wide ranges in river flow rates and water levels, which directly alters the amount of freshwater habitat available for biota and indirectly alters many critical characteristics of that habitat (eg, O_2 levels, turbidity, food availability, etc.).

The increase in global temperature, nevertheless, will lead to a more vigorous hydrological cycle, with changes in precipitation and evapotranspiration rates regionally variable. Warming accelerates land-surface drying as heat goes into evaporation of moisture, and this increases the potential incidence and severity of droughts, which has been observed in many places worldwide (Dai et al. 2004). In tropical systems, evaporation and evapotranspiration often already exceed precipitation in the dry season (Irion and Junk 1997). In weather systems, convergence of