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Q1 Original Research Article

Evaluation of ecohydrological variables in relation to spatial and temporal variability of macroinvertebrate assemblages along the Zigi River – Tanzania

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ABSTRACT

The spatial and temporal variability of aquatic macroinvertebrates in relation to eco-hydrological variables was investigated along the Zigi River in Tanzania during the end of the dry (early March) and wet (May) seasons of 2012. We studied a number of ecohydrological variables, such as discharge, depth, velocity, Froude number, pH, temperature, substrate type and conductivity, together with macroinvertebrate sampling along a set of five river zones delineated based on slope, identified as mountain streams (MS), upper foothills (UF), lower foothills (LF), rejuvenated foothills (REJ) and mature lower river (MR) in the two seasons. The macroinvertebrate assemblages varied significantly along the Zigi river, the five river zones proving to be significantly different from each other in terms of number of taxa, total abundance, species richness and species diversity indices, while the sampling season (temporal variation) was not found to be significant. In relation to macroinvertebrate assemblages, conductivity, substrate type, discharge, temperature and pH were found to be important factors influencing their distribution. Analysis further showed that the life cycle of an macroinvertebrate (*Afronurus* sp.) may be important in determining its temporal variability. The ecohydrological approach, aimed at understanding the relationships between hydrological variables and the biotic component, lays the ground for prediction of macroinvertebrate indicative species based on physical parameters in Tanzania and East Africa, as well as proper watershed management to support sustainable ecosystems.

1. Introduction

Spatial and temporal variability in biological communities, in particular aquatic macroinvertebrates, is a widely studied characteristic of lotic ecosystems (Hawkins et al., 1997). Several studies have used aquatic macroinvertebrates as bioindicators for assessing water quality in surface waters; such studies have been conducted in Tanzania and East Africa (Masese et al., 2009, 2010; Ngupula and Kayanda, 2010). Macroinvertebrates have also been used as indicators in determining minimum flow requirements (environmental flow assessment) in rivers of eastern and southern Africa (GLOWS-FIU, 2012, 2014; King et al., 2000).

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There is strong evidence that aquatic macroinvertebrate distribution is influenced by eco-hydrological variables and processes including hydrological dynamics, hydraulics and in-channel processes and environmental changes that occur in the river (Kemp et al., 2000; Rossaro et al., 2006). Rossaro et al. (2006) presented different curves describing the preference of various macroinvertebrate species for velocity, depth, discharge, Froude number and substrate size, demonstrating that a range of species preferences do exist. Other physical factors like water temperature (Camur-Elipek et al., 2010), conductivity (Mesa, 2010), dissolved oxygen (Gabriels et al., 2007), substratum and channel geomorphology (Goncalves et al., 2004) have also been shown to influence the distribution of macroinvertebrate assemblages.

The relative importance of eco-hydrological processes on macroinvertebrate life varies inter- and intra-regionally (Park et al., 2007; Song et al., 2007). Hydrological, hydraulic and environmental conditions in a river have been identified by many authors as the best predictive variable of macroinvertebrate distribution (Barmuta, 1990; Kemp et al., 2000; Blettler et al., 2012). Although there is a close linkage between eco-hydrological factors and macroinvertebrate assemblages, the understanding of how and which variables of hydrology, hydraulics and environmental processes influence the macroinvertebrate assemblages is still less explored; moreover, this knowledge is particularly limited in Tanzania.

This research aimed to assess the spatial and temporal distribution of macroinvertebrate assemblages along the Zigi River and its relationship with eco-hydrological (hydrological, hydraulics and environmental) variables, knowledge which is essential for aquatic ecosystem conservation, protection and management (regulation).

2. Materials and methods

2.1. Study area

The Zigi River is a perennial water body located in the Tanga Region, north-eastern Tanzania (Fig. 1). The river catchment lies between latitudes 04°48′ S and 05°15′ S and longitudes 38°34′ E and 39°03′ E with a catchment area of about 1100 km^2. It rises in the Amani Nature Reserve on the eastern slopes of the East Usambara Mountains at an altitude of 1130 masl. The Zigi River has two main tributaries flowing from the north (Muzi stream) and south (Kihuhwi stream) and after their confluence, it drains eastwards out of the Usambara Mountains and north of the city of Tanga into the Indian Ocean via the Mabayani Dam, a source for the Tanga Municipal Water Supply. The Zigi river catchment is characterized by a bi-modal rainfall pattern,

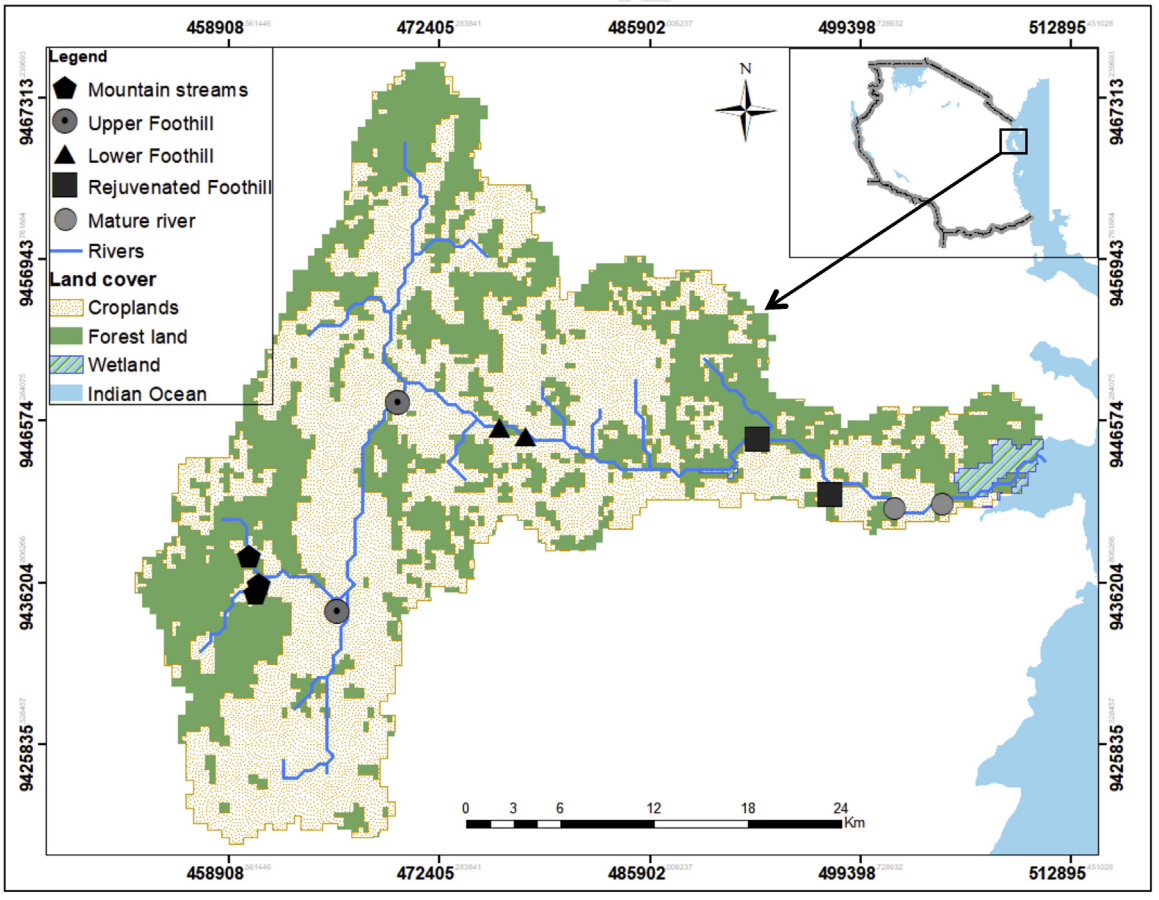

Fig. 1. Land cover map of Zigi River catchment showing sampling stations.

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