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Exploring spatio-temporal patterns of plankton diversity and community structure as correlates of water quality in a tropical stream

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ABSTRACT

Ecology of plankton in the downstream reaches of Kaduna River, Zungeru, Niger state, Nigeria was investigated between April and August 2015. Plankton and surface water samples were collected monthly from three stations for analysis of plankton diversity and physico-chemical parameters respectively. Station 1 is relatively unperturbed station located at the outskirts of Zungeru town, station 2 with moderate human activity located in Zungeru town while station 3 with minimal level of anthropogenic activities was located in Wushishi town about 7 km from station 2. The result revealed that the minimum and maximum values for pH water temperature, air temperature, conductivity, dissolved oxygen (DO) biochemical oxygen demand (BOD), phosphate, Nitrate, and secchi disc transparency were 5.38–6.79, 25–31 °C, 26–31 °C, 32–72 μs/cm, 3.50–8.20 mg/l, 1.00–5.00 mg/l, 0.06–1.13 mg/l 0.44–1.31 mg/l, 39.140 cm respectively. A total of 26 species of zooplankton and 24 species of phytoplankton were encountered in the study. The highest number of plankton (20 taxa) was recorded at station 2 while station 1 with 18 taxa and station 3 with 13 representative taxa. For zooplankton, the highest number of taxa was recorded at station 1 (20 taxa), followed by station 3 (14 taxa) and 10 taxa in station 2 were identified. Copepoda of the order cyclopidae dominated all the three stations while Bacillariophyta dominated the three stations for phytoplankton diversity. Canonical correspondence analysis (CCA) ordination was used to determine phytoplankton and zooplankton abundance in relation to the physico-chemical parameters. Nitrate, phosphate and dissolved oxygen had over riding influence on the distribution of the plankton in the water body which indicate that the river is still very productive in terms of providing starter food organisms for higher aquatic life. However, care should be taken to protect the river from further deterioration due to various degrees of human activities.

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1. Introduction

Rivers are important ecosystems providing a variety of resources to the communities that depend upon them thereby leading to socio-economic development and sustainability of the environment [1]. Rivers harbour a range of aquatic flora and fauna including plankton which are either directly or indirectly beneficial to man. Plankton (phytoplankton and zooplankton) are identified as important components of this ecosystem and serve as basis upon which the aquatic ecosystem is supported. The plankton community is a dynamic system that responds quickly to environmental changes; hence they act as indicators of water quality [2,3].

Plankton are of immense value as food and play an important role in the natural purification of waters. The relative abundance of chlorophyll is indicative of productive water [4]. Plankton have fast growth rates, thus they can provide meaningful and quantifiable indicators of ecological change over short time scales [2,5].

Phytoplankton are primary producers and regarded as the starting point in aquatic food chain. They are of great relevance to the zooplankton that solely depends on it for survival in the water body. They are highly sensitive to changes in nutrient levels, temperature, pollution, levels of light and increase in predation [6–8]. On the other hand, zooplankton assist in regulating algal and microbial productivity through grazing and in the transfer of primary productivity to fish and other consumers and by so doing they help in improving water quality [9,10].

Planktonic primal in fresh water are dominated by rotifers, cladocerans and copepods. The relative abundance of planktonic communities is influenced by the prevailing abiotic and biotic parameters and these determine their abundance, occurrence and seasonal variations [11]. Plankton is of utmost important in fresh water ecosystem as these are the main source of energy and having a very high nutritive value [12]. Plankton respond quickly to environmental changes because of their short life cycle, hence, their species composition are more likely to indicate the quality of the water which they are found [13].

This study, therefore, is a baseline study of the plankton community of lower Kaduna River, aiming to contribute to the pool of knowledge of plankton ecology in large water bodies and as an environmental impact

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assessment (EIA) for the proposed dam at Zungeru that had already commenced at the beginning of this study. The aim of this study is to determine plankton community composition and abundance at different sampling stations and also to ascertain the dynamics of the plankton communities of lower Kaduna River in relation to environmental variables as the study has not been previously carried out.

2. Materials and methods

2.1. Study area

Zungeru is the Capital of Wushishi local government area of Niger state, Nigeria. It lies within the longitude 6° 9' 21" E, and Latitude 9° 48' 46" N, with an estimated population of 24,447 people according to GeoName geographical database (July 2015). It is approximately 65 km away from Minna the capital of Niger state. Zungeru is surrounded by mountains, giving it a lower elevation than the surrounding topography. In addition to the Kaduna River, the smaller Nnamaye and Tosheta Rivers flow near the town. The area surrounding the Zungeru is a mixed wooded savanna; species of plants growing in the area include *Azalia africana*, *Isobertlinia* species, and *Burkea africana*. The town and surrounding country is one of the hottest and most humid parts of Nigeria.

The Kaduna River is a tributary of the Niger River which flows for 550 km through Nigeria. It got its name from the crocodiles that lived in the river and surrounding area. From its source along the western margin of the Jos Plateau, the river flows northwest across the Kaduna plains. Just before it reaches the city of Kaduna, it turns to the southwest, cutting several gorges through rugged terrain between Kaduna and

Zungeru. Drainage basin is moist savanna. Dense rain forests line at the lower course of the river, where moisture is more abundant. Annual rainfall averages about 1250 mm (50 in), occurring seasonally between May and September. Great seasonal fluctuations characterize the Kaduna's water flow; peak discharges occur between July and September.

The study site lies within the Savannah region in North Central Nigeria. It is characterized by two seasons (rainy and dry season). The rainy season is from April to October, while the dry season is from November to March. For the pursuit of this research, the study area was divided into three stations, namely:

2.1.1. Station 1

This station designated as site A on the map (Fig. 1) is located at the outskirts of Zungeru town. Water velocity at this station is swift flowing (mean value = 0.24 m/s). The vegetation cover is thick with a dense tunnel of trees and consists mainly of emergent macrophytes and few floating plants such as *Nymphaea lotus*. The marginal vegetation is composed mainly of *Cocos nucifera*, *Havea brasiliensis*, and *Raphia vinifera*. This station was located far from human settlement, therefore it can be classified here as unperturbed site.

2.1.2. Station 2

Station 2 (designated as site B on the map) is at the bridge in Zungeru town. The area has much less aquatic vegetation when compared to Station 1. Water velocity is fast and relatively higher than Station 1 (mean value = 0.49 m/s). The vegetation consists mainly of *Commelina* spp., *Nymphaea* spp., *Pistia stratiotes*, and *Panicum repens*. Artisan fishing, washing of clothes, and bathing are the major human

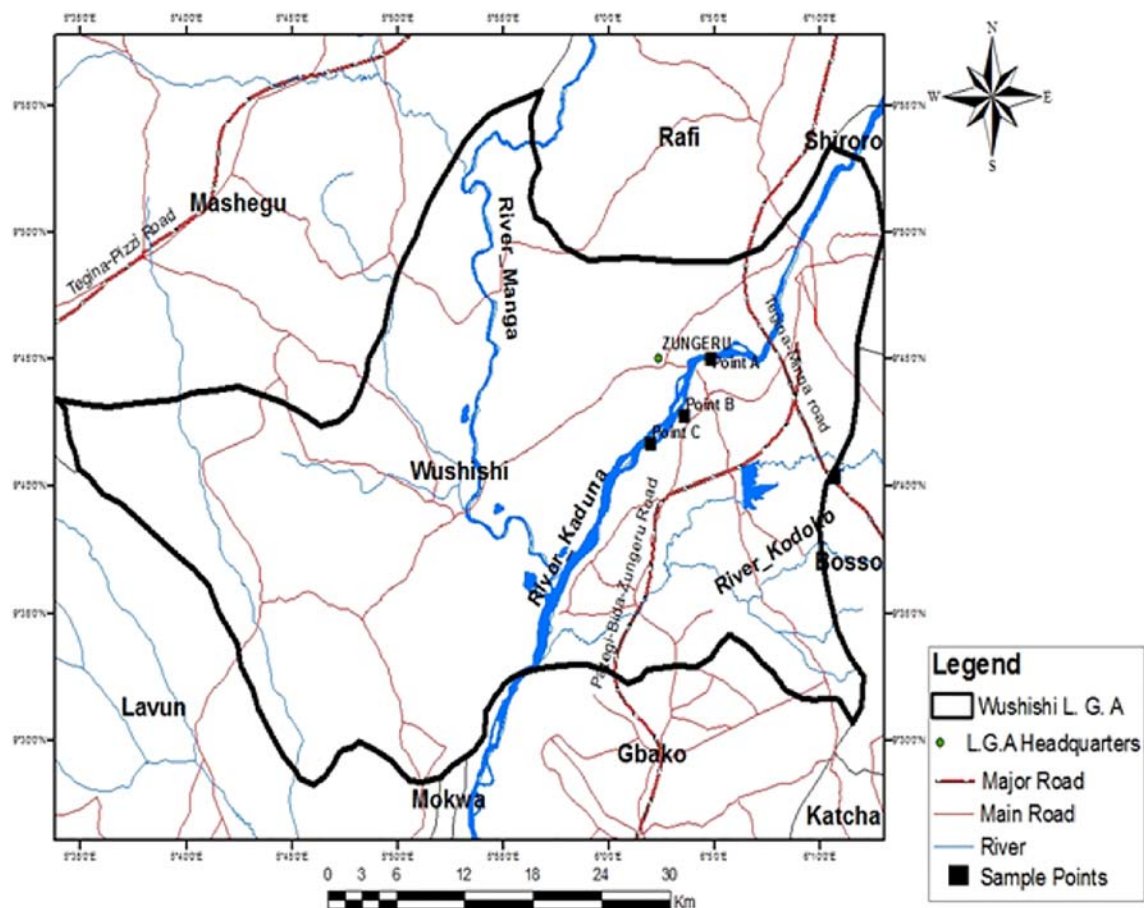


Fig. 1. Sample points distribution along River Kaduna in Wushishi LGA, Niger State, Nigeria. (source: Remote sensing/GIS Lab, Department of Geography, FUT MINNA 2015).

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