

CONTRIBUTIONS OF THE SEASONAL AND LONG TERM FLOOD PATTERNS OF RIVER NIGER TO THE DEVELOPMENT AND CONTROL OF WATER HYACINTH (*Eichhornia crassipes*) IN KAINJI LAKE, NIGERIA

I.G. MBAGWU, B.M.B. LADU and A.O. AMADI¹

*National Institute for Freshwater Fisheries Research (NIFFR)
P.M.B. 6006, New Bussa, Niger State, Nigeria*

¹*Hydrology Department, Jebba Hydro Power Generating Station,
National Electric Power Authority, Jebba. Niger State, Nigeria.*

ABSTRACT

This paper reviewed the seasonal flood regime of River Niger, which produces the two Annual floods – White and Black – which sustain the lake level. It further identified a low flow period of the river, which seems to last 30 years. The annual flood regime produces a draw-down which exposes a substantial area of the shoreline during the year. This abandons a lot of water hyacinth strands that usually get trapped within the rooted shoreline vegetation during the high water period. Thereafter, the stranded water hyacinth strands die and rot.

The long low flow period reduced the water residence time of the lake from 4 to 2 within the 32 years it has existed. The implication of this is that the water surface area became more stable. This reduced nutrient export and consequently offered pleustophytes such as water hyacinth time to extract nutrients and build up population. The envisaged end of the low flow period will reverse this situation and discourage the establishment of water hyacinth in the lake

INTRODUCTION

This paper reviews the flood regimes of the River Niger as measured in Nigeria, the manifestations of the flood regimes in Kainji Lake and the possible contributions of these flood regimes to the development and control of water hyacinth in Kainji Lake

The Flood Patterns of River Niger in Nigeria

The River Niger flow in Nigeria exhibits a seasonal flood regime, which is responsible for the annual flood characteristics of the river in Nigeria and a time trend, which hitherto has not been described.

The Seasonal Flood Regime

Nedeco & Balfour Beatty, (1961) described the seasonal hydrology of River Niger. During the months of May to October, rainfalls in the northern parts of Nigeria south of Niamey (Fig.1: inset) produce floods that quickly reach Kainji with a peak flow of 4,000 to 6,000 m³ s⁻¹ in September to October. This floodwater is laden with silt/clay sediments and is of high turbidity. Due to its colour, it is locally referred to as the "White Flood".

The second flood originates from the river's headwater region of high annual rainfall in the Fouta Djallon highlands in Guinea, and passes through the sub-arid region and deltaic swamps around Timbuctu. In these areas it loses much of its silt load and water to evaporation and infiltration. Very little water is added to the flow before it reaches Kainji in November with a peak flow of about 2,000 m³ s⁻¹. The water is

relatively clear due to its low silt load and is thus locally called the "Black Flood"

Two distinct floods were thus manifested at Kainji annually. (Fig. 2)

The Long Term Flood Cycle

In an analysis of the discharge data of River Niger from 1954 to 1977, Sagua and Fregene (1979), opined that River Niger flow has a time trend that was not taken into account in the design of Kainji Dam. However the precise time lag of this trend was not known.

This study investigated the annual discharge data of The Niger at Jideribode from 1954 to

2000 with a numerical technique for analysis of trends in a time series.

First WETNESS INDICES were derived for all the years as

$$I = (Q_x - Q_m) / Q_m$$

where Q_x = Annual run-off and Q_m = Average annual run-off for 1954 to 2000.

The wetness index is used to quantify the relative wetness or dryness of a particular year with respect to the total amount of water that entered the lake within a specific period.

Secondly the **Wetness Index** series was plotted against **Time** and 5-year Running Averages fitted on the series to search for trends in the data. This analysis revealed a low flood flow period for the river, which has lasted for about 30 years (Fig. 3).

Manifestations of the River Niger Flood Regimes in Kainji Lake

Annual Floods

The two annual floods – the White and Black floods, sustain the Kainji Lake level. However there is only one high lake level period during the dry months of the year as a result of the regulation of the river flow by Kainji dam. As water use for hydropower generation continues, the lake level is progressively drawn-down and a substantial area of the shoreline is exposed as the draw-down area (Fig. 1).

The Long Term Flood Cycle

The low flood flow cycle of River Niger resulted in increased residence time for water in Kainji Lake. With an Active Storage Capacity of 12.0 x 10⁹ m³, a replenishing rat

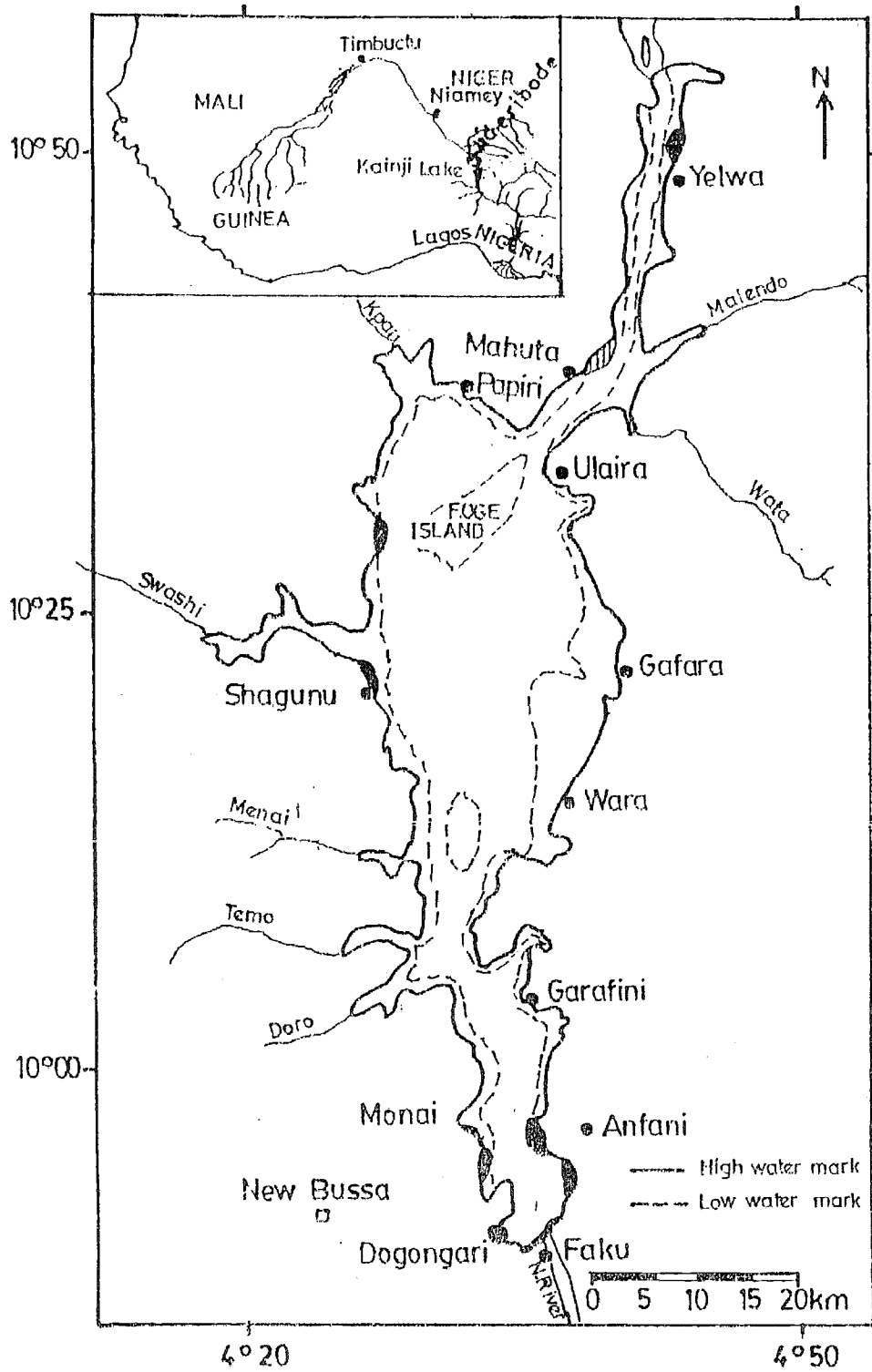


Fig. 1. Map of Kainji Lake. Inset shows the River Niger basin and its tributaries.

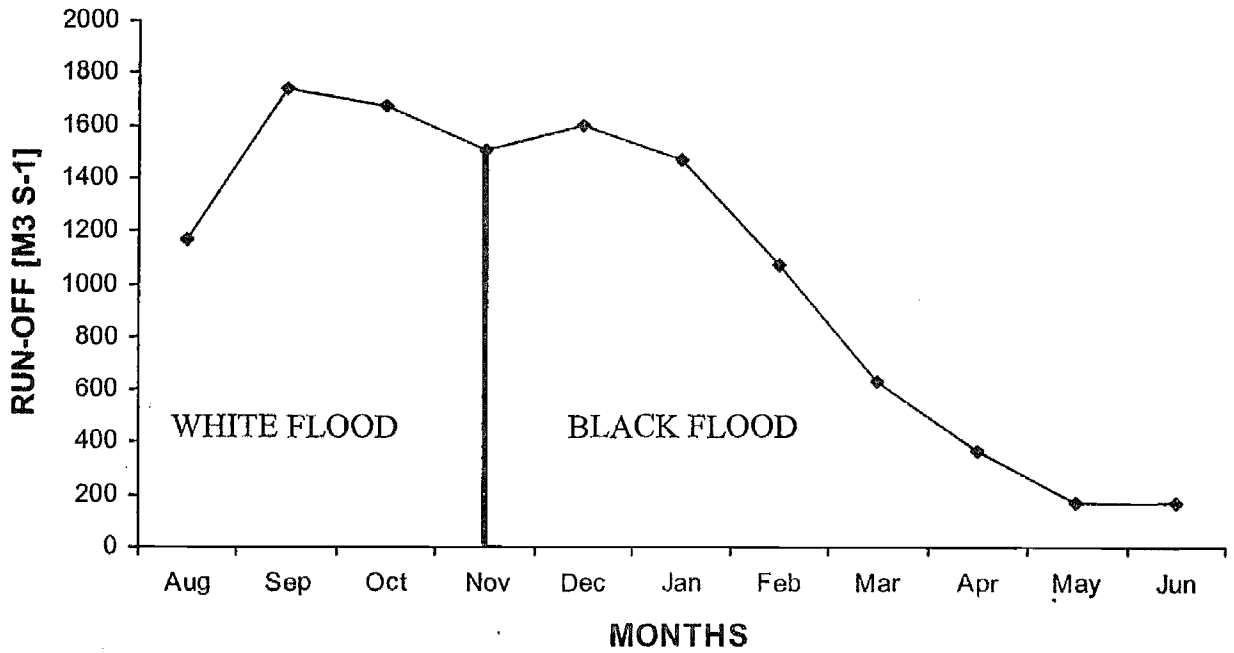


Fig. 2: Seasonal Flood Regimes of River Niger in Nigeria

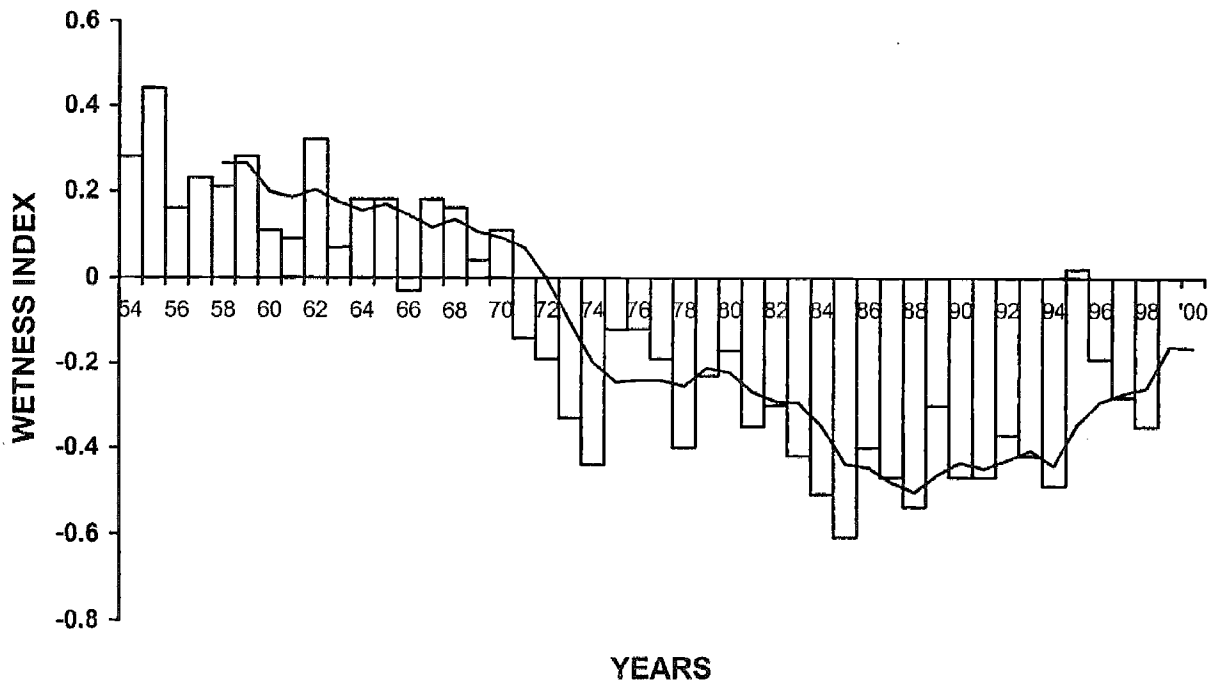


Fig. 3: Wetness Indices of River Niger Hydrological Years (1954-2000) with Trendline of 5-Year Moving Averages

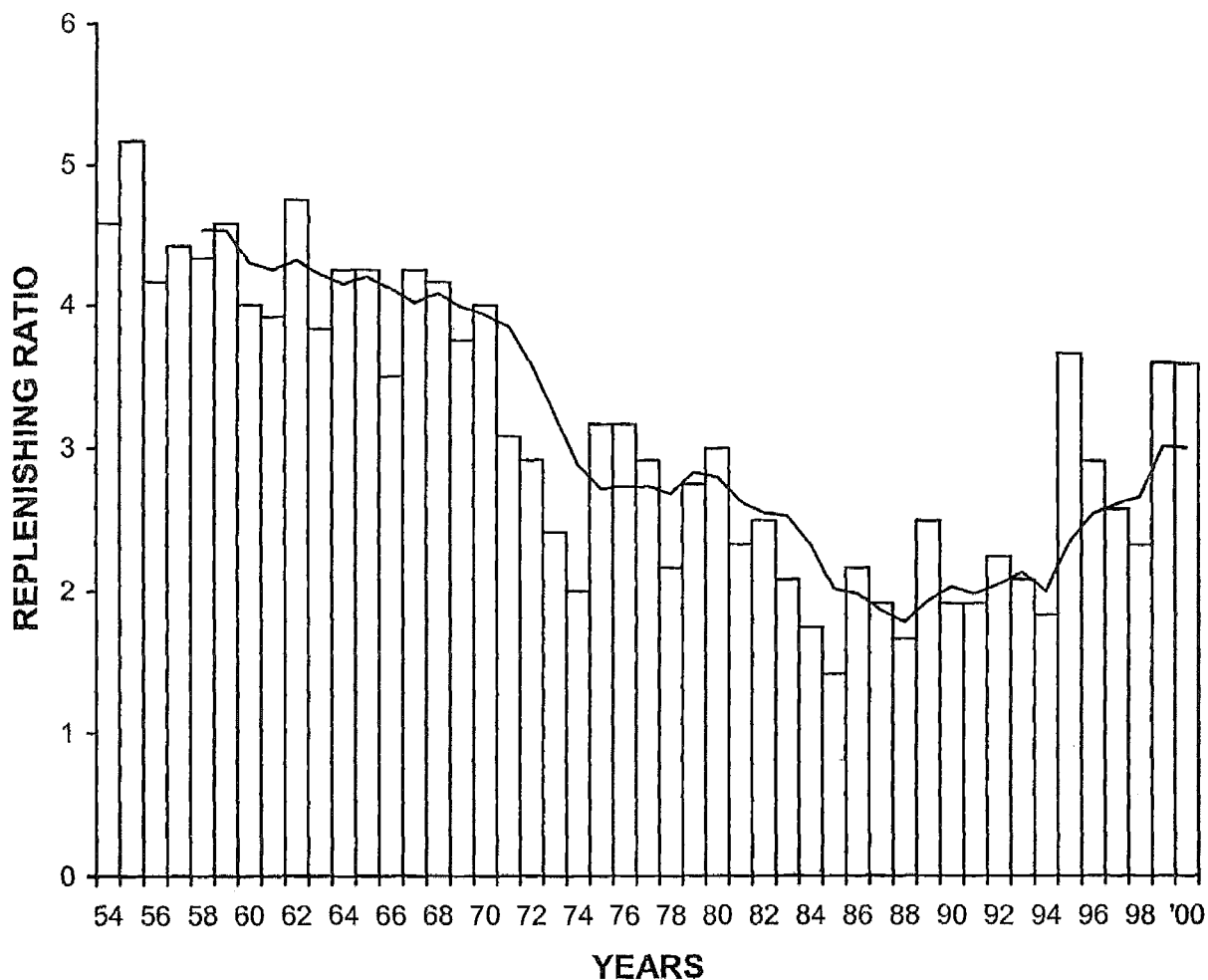


Fig. 4: Replenishing Ratio of Kainji Lake (1954 to 2000).

io of 4.0 was designed for the reservoir using observations in the flow of River Niger at Jideribode from 1954 to 1960 (Nedeco & Balfour Beatty, 1961). The flow of The Niger potentially maintained this ratio until the first 5- and further to 2.0 in the following years until 1995. Since then however, the replenishing ratio has been rising. The implication of this is that in the 32 years of the existence of the lake, its hydrological residence time gradually increased from 90 days at impoundment to as much as

180 days year period (1968-72) immediately following the closure of the dam (Fig. 4). Consequently, the replenishing ratio of lake fell to 3.0 in the first decade of the existence of the lake

Contributions of the River Niger Flood Patterns to the Development and Control of Water Hyacinth in Kainji Lake.

Contribution of the annual floods

The annual flood pattern has a profound influence on the annual development of water

hyacinth in Kainji Lake. Several reports (e.g. Fregene and Amadi, 1993) indicate that the plant recruits upstream within the inner basin of

River Niger. During the annual floods, the plants are flushed into Lake Kainji where most of them get trapped within stands of rooted aquatic macrophytes along the shorelines. Those that reach the damsite get trapped or spilled over to Jebba Lake. Eventually the annual draw-down destroys those trapped within the shoreline while those trapped at the damsite die and rot.

Contribution of the annual floods

Longer water retention in Kainji Lake implies more time for the mineralisation of particulate forms of Nitrogen and Phosphorus and a proportional reduction in the rate of nutrient export from the lake. Exogenous sources of nutrients into the lake has increased in later years from residues of fertilizer arising from intensification of agricultural activities around the lake since impoundment and phosphorus released annually by bush burning (Mbagwu & Adeniji, 1994). With increased autochthonous and allochthonous inputs of nutrients simultaneously in place alongside a lowered flushing rate, a more stable water column will result leading to improvement in ecological productivity.

Obot (1984; 1986) attributed the failure of floating macrophytes to develop in Kainji Lake to the rapid removal of nutrients from the lake ecosystem caused by the high replenishing ratio of 4.0. The current proliferation of water

hyacinth in the lake can be interpreted as arising from the prolongation of the residence time of water in the lake, which has enabled the plants to have more time to extract nutrients and build up population. In contrast, the seeming end of the low flow cycle of River Niger could reverse this scenario and return the Kainji Lake to a regime of high replenishing ratio that will discourage the establishment of water hyacinth in the lake.

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