Research Journal of
Botany

ISSN 1816-4919

Academic
Journals Inc.

www.academicjournals.com

Research Journal of Botany 2 (2): 108-112, 2007
ISSN 1816-4919

Occurrence and Distribution of Aquatic Macrophytes in Relation to the Nutrient Content in Sediments of Two Freshwater Lake Ecosystems in the Nigerian Savanna

Sunday P. Bako, Priscilla Daudu, Mohammed L. Balarabe and Mathias Chia
Department of Biological Sciences, Faculty of Science, Ahmadu Bello University, Zaria, Kaduna State, Nigeria

Abstract: Studies were conducted to evaluate the variation in the composition of the macrophyte communities in relation to the nutrient content in the sediments of Kubanni Lake and Makwaye Lake Zaria, located in the Northern Guinea Savanna eco-region of Nigeria. Nitrogen, Phosphorus and Calcium were higher in Makwaye Lake than in Kubanni. Potassium on the other hand, was higher in Kubanni than in Makwaye Lake. Magnesium was not detected in either of the two lakes. Emergent aquatic plant species dominated the vegetation of the two lakes during the period of sampling. Both the number of species present and the densities of such species were higher in Makwaye than in Kubanni lake. While 15 species were recorded in Kubanni lake, 18 were recorded in Makwaye lake. Similarly species densities (stands per square metre) ranged from 1-36, in Kubanni, while this ranged from 3-75 in Makwaye. Implications of these trends to the well being of the two ecosytems are highlighted.

Key words: Macrophyhtes, sediments, nutrient, dynamics, Makwaye lake, Kubanni lake

INTRODUCTION

Nigerian aquatic habitats are infested by several species of aquatic macrophytes, which constitute varying levels of nuisance to the intended uses of such water bodies (Bako and Oniye, 2004). There are some notorious cases, such as water hyacinth (*Eicchornia crassipes*), which has invaded the river and lake systems of the Niger, Benue and Kaduna (Ita, 1993).

Eutrophication is a special case of water pollution that often occurs as a result of organic pollution. Over the last few decades, many wetlands have undergone gradual eutrophication mainly through agricultural runoff and wastewater. The main sources of nutrients for plants in a lake are the sediment and the water. Nutrient inputs can directly modify or change biological communities. Fluctuation in hydrological conditions induces changes in nutrient input. The high dependence on hydrology is particularly important in semi arid and arid areas, where surface water levels fluctuate both seasonally and inter annually (Sanchez-Carrillo and Alvarez-Cobelas, 2001). These complex interactions, in turn make nutrient dynamics change with biotic and abiotic changes (Bako and Balarabe, 2005). Emergent macrophytes are particularly well adapted to hydrological fluctuations and hence are probably the best indicators of such dynamics (Sanchez-Carrillo and Alvarez-Cobelas, 2001). Macrophyte cover changes inter annually, so nutrient cycles in freshwater marsh ecosystems are particularly difficult to assess because of spatial heterogeneity and metabolic variability of emergent macrophytes (Sanchez-Carrillo and Alvarez-Cobelas, 2001).

Macrophyte biomass has usually been neglected in classical eutrophication models since these plants obtain their nutrient requirements from sediments and do not compete directly with phytoplankton for nutrients.

Corresponding Author: Sunday P. Bako, Department of Biological Sciences, Faculty of Science, Ahmadu Bello University, Zaria, Kaduna State, Nigeria Tel: +2348037037445

Sanchez-Carrillo and Alvarez-Cobelas (2001) stated that since emergent macrophytes are by far the highest biomass of all the biological communities, they might be controlled by nutrient dynamics and their response could explain eutrophication patterns better in this type of ecosystem. Such a hypothesis was suggested by the fact that macrophyte cover changed every year throughout the sampling period. These changes might not only be conditioned by the size of inundated area, but also by fluctuations in nutrient concentration. (Kolo and Oladimeji, 2004).

With recent spectacular invasions of a number of lakes by these plants, the weed problems that these macrophytes pose have become more apparent. In Nigeria, studies on nutrient dynamics and the response of aquatic macrophytes to such are rather limited. The objective of this study therefore, is to evaluate the distribution of aquatic macrophytes in Kubanni and Makwaye lakes in relation to the nutrient content of the lake sediments.

MATERIALS AND METHODS

Study Area

The study sites were Kubanni Lake (Ahmadu Bello University Dam) and Makwaye Lake (University Farm Dam) in Samaru, Zaria. Zaria is located on a plain at 11°3`N and 7°42`E. It is 686 m above sea level in the Northern Guinea Savanna eco-region of Nigeria. The soils of Samaru are generally ferruginous, with relatively high Cation Exchange Capacity (CEC).

Makwaye Lake is an unprotected natural lake ecosystem around the catchments of which, a lot of irrigation farming and animal grazing goes on. Kubanni Lake on the other hand was formed by the impoundment of the Kubanni stream that receives a significant level of municipal waste from the surrounding University campus and neighbouring Samaru village. Although in the past there have been limited irrigated farming and grazing activity around the catchments of this lake, it is now (over the past five years) relatively well protected from these activities.

Preliminary survey of the study area was conducted. Vegetation studies were conducted during which the composition of the macrophyte community was observed. Collections of the different species was made, put in well-labelled polythene bags and taken to the herbarium of the Department of Biological Sciences A.B.U Zaria, where the plant species were sorted and identified with reference to standard texts such as Cook *et al*. (1974) and Obot and Ayeni (1987)

Sampling

The study sites were mapped and each of the four cardinal points of the two lakes served as sampling sites.

Random sampling was assumed and sampling was done in five by five meter quadrats to obtain a good representation of the marshland vegetation. Plants falling in each quadrat and their dominance were recorded. After sampling, samples of the dominant plants at each of the sampling points as well as the sediment on which the plants grew were collected, put in labelled polythene bags and taken to the laboratory. Samples were collected in the dry season of 2005, shortly before the commencement of the rains.

RESULTS AND DISCUSSION

Table 1 shows that Nitrogen, Phosphorus and Calcium were higher in Makwaye Lake than in Kubanni. Potassium on the other hand, was higher in Kubanni than in Makwaye Lake. Magnesium was not detected in either of the two lakes.

Emergent aquatic plant species dominated the vegetation of the two lakes during the period of sampling. Both the number of species present and the densities of such species were higher in Makwaye (Table 3), than in Kubanni lake (Table 2). While 15 species were recorded in Kubanni lake, 18 were recorded in Makwaye Lake. Similarly species densities (stands per square metre) ranged from 1-36, in Kubanni, while this ranged from 3-75 in Makwaye.

Table 1: Concentration (ppm) of the major plant nutrients in sediments of Makwaye and Kubanni Lakes [F= *8.86 for Nutrients; * = Significant at p≥0.05]

	N	P	K	Ca	Mg
Makwaye	30.0	20.0	12800.0	0.0	0.0
	10.0	16.5	12400.0	8110.0	0.0
	10.0	22.3	17050.0	0.0	0.0
Kubanni	20.0	20.0	57900.0	0.0	0.0
	10.0	14.8	16600.0	0.0	0.0
	10.0	14.8	14400.0	0.0	0.0

Table 2: Densities of aquatic macrophytes in Kubanni Lake

Species	Family	No. of stands (m^{-2})	Growth form
Cyperus rotundus	Cyperaceae	20.0	Emergent
Fuirena ciliaris	Cyperaceae	20.0	Emergent
Fuirena umbellata	Cyperaceae	2.0	Emergent
Eclipta alba	Asteraceae	1.0	Marginal
Emilia coccinea	Asteraceae	1.0	Marginal
Axonopus compressus	Poaceae	20.0	Emergent
Leersia hexandra	Poaceae	5.0	Emergent
Hecklechoa sp.	Poaceae	1.0	Emergent
Polygonum lanigerum	Polygonaceae	36.7	Emergent
Hydrocotyl bonariensis	Apiaceae	1.0	Marginal
Ludwigia decurrens	Onagraceae	6.0	Emergent
Euphorbia thymifolia	Euphorbiaceae	1.0	Marginal
Molugo naudicaulis	Molugonaceae	1.0	Marginal
Ipomea aquatica	Convolvulaceae	2.0	Emergent
Typha australis	Typhaceae	10.0	Emergent

Table 3: Densities of aquatic macrophytes in Makwaye Lake

Species	Family	No. of stands (m^{-2})	Growth form
Mimosa pudica	Fabaceae	27.0	Marginal
Pycraeus lanceolatus	Cyperaceae	19.5	Emergent
Hydrolea paulustris	Hydrophylaceae	15.0	Marginal
Oplismenus sp.	Poaceae	70.0	Emergent
Salvinia nymphellula	Salviniaceae	70.0	Floating
Ipomoea aquatica	Convolvulaceae	2.5	Emergent
Polygonum senegalensis	Polygonaceae	35.0	Emergent
Polygonum lanigerum	Polygonaceae	4.5	Emergent
Ludwigia erecta	Onagraceae	32.5	Emergent
Ludwigia decurrens	Onagraceae	10.0	Emergent
Ludwigia repens	Onagraceae	3.0	Emergent
Ludwigia stolonifera	Onagraceae	75.0	Emergent
Ludwigia leptocarpa	Onagraceae	25.0	Emergent
Utricularia gibba	Lentibulariaceae	35.0	Submerged
Mariscus alternifolia	Cyperaceae	20.5	Emergent
Typha australis	Typhaceae	15.0	Emergent
Najas pectinata	Najadaceae	45.0	Submerged
Nymphaea lotus	Nymphaeaceae	10.0	Semi-emergent

Both the number of species present and the densities of such species were higher in Makwaye than in Kubanni Lake. This could be as a result of enhanced deposition of plant nutrients obtained from animal manure, and application of fertilizers (such as nitrates and phosphates) in the catchments, that are washed into the water. Precipitation and surface run off/drainage from the catchments are important contributors to the nitrogen and phosphorus budgets of Lake ecosystems and these have been known to alter their functioning (Majaliwa *et al*., 2005; Wlodzimierz, 2005; Sa'ad and Hemeda 2005). High levels of these plant nutrients are known to encourage vegetative growth of plants. Extensive human activities including cultivation/tillage, application of fertilizers and over grazing in the catchments could result in marked fluctuations in the physicochemical parameters of lentic ecosystems (Ezealor *et al*., 1999; Gbem *et al*., 1999). Nutrient availability is a crucial factor in aquatic macrophyte, phytoplankton and periphyton growth (Hough *et al*., 1989). The total pool of nutrients is less important than the amount of its exchangeable fraction. The amount of this fraction depends on ecosystem efficiency and to some extent on macrophytes occupying the water body as they both depend on and create a nutrient budget for their environment. The most common result of such a modification of the ecosystem is eutrophication. Eutrophication is a special case of water pollution that often occurs simultaneously with organic pollution. Human sewage, wastewater of intensive husbandry and run off from agricultural fields are the most common causes of eutrophication.

Most of the species of macrophytes encountered were emergent or terrestrial forms. This implies an encroachment of terrestrial vegetation into the lakes probably due to siltation processes, which have reduced the depths of the Lakes. Excessive vegetation accelerates silting, makes difficult the movement of fish and stops the water from warming. Macrophyte structure and abundance in lakes depend on different factors, which include trophic status, light penetration and water currents. Sedimentation and infestation by aquatic macrophytes over the years have been major problems that threaten many aquatic ecosystems in Nigeria because they seriously reduce the depths of lakes. Decrease in depth favours the occurrence of emergent species of macrophytes, which in turn displace floating types. Commonly a pattern of succession involving several seral stages is observed as these aquatic ecosystems transit into terrestrial ones (Bako and Oniye, 2004). Development of aquatic macrophyte communities in lentic habitats is a function of events that modify physical and chemical characteristics of the habitat such as water temperature, organic matter, soil depth, etc. those factors influence the occurrence, establishment, survival and reproduction of macrophytes (Gbem *et al*., 1999; Bako and Oniye 2004; Bako and Balarabe 2005; Bako *et al*., 2005). Uncontrolled development of aquatic plant communities in fish farming/fisheries systems has several undesirable implications (Balogun *et al*., 2000) These include further depletion of water volume through additional evapotranspiration from surface of plants (especially emergents), hindrance to navigation and fish cropping, clogging of machinery and turbines (where applicable) and depletion of oxygen from the water column) especially during decay processes. All these factors will reduce the well being, growth and reproduction of fish and consequently, lead to lowered production rates and poor returns from investment made on the fish farm/lakes (Bako and Oniye, 2004).

An understanding of the factors controlling the structure of macrophyte communities is critical if these lakes are to be protected, restored and managed (Vaithiyanathan and Richardson, 1999).

REFERENCES

Bako, S.P. and S.J. Oniye, 2004. Macrophyte community development and its implication for fisheries in Maigana fish farm, Kaduna state, Nigeria. J. Aquatic Sci., 19: 85-93.

Bako, S.P. and M.L. Balarabe, 2005. Occurrence of Aquatic Macrophytes in relation to biotic and abiotic factors in a medium sized tropical Lake in the Nigerian Savanna. Proceedings of the 11th World Lake Conference Held at Kenyatta International Conference Center, Nairobi, Kenya. 31st October-4th November 2005.

Bako, S.P., S.J. Oniye and I.L. Mordi, 2005. Infestation of Aquatic Macrophytes in Relation to Water Quality Status of a Small Fish Farm in the Nigerian Savanna. Proceedings of the 11th World Lake Conference Held at Kenyatta International Conference Center, Nairobi, Kenya. 31st October-4th November 2005.

Balogun, J.K., J. Auta, M.L. Balarabe and S.P. Bako, 2000. Fisheries management and development a case study of Zaria reservior. A paper presented at the fisheries society of Nigeria (FISON) 15th Annual Conference held at Hill Top Hotel, Jos 19th-25th March, pp: 9.

Cook, D.K.C., B.J. Gut, E.M. Rix, J. Schneller and M. Seitz, 1974. Water plants of the world: A manual for the identification of the genera of freshwater macrophytes. Dr. W. Junk. Bv. (publ.). The Hague, pp: 33.

Ezealor, A.U., T.T. Gbem, W.S. Kwande, J. Auta and S.P. Bako, 1999. Sedimentation: A threat to man-made reservoir in the Savanna (A case study of Kubanni Reservoir Zaria, Nigeria). A paper presented at the International Seminar on performance of large and small-scale irrigation schemes in Africa (15-19th November) Abuja, Nigeria, pp: 17.

Gbem, T.T., M.L. Balarabe, S.P. Bako, J. Auta and J.K. Balogun, 1999. A study of the changes in physical characteristics of a small man-made freshwater ecosystem in relation to aquatic vegetation (a case study of Bomo Lake, Zaria) (1987-1997). Proceedings of the International Seminar on Performance of Large and Small-scale Irrigation Schemes in Africa. ICID/NINCID Workshop, Abuja, Nigeria, 15th-19th November, 1999, pp: 307-315.

Hough, R.A., M.D. Fornwall, B.J. Negele, R.L. Thompson and D.A. Putt, 1989. Plant community dynamics in a chain of lakes: Principal factors in the decline of rooted macrophytes with eutrophication. Hydrobiologia, 173: 199-217.

Ita, E.O., 1993. Aquatic plants and wetland wildlife resources of Nigeria. CIFA Occasional Paper No. 21: FAO, Rome (1993).

Kolo, R.J. and A.A. Oladimeji, 2004. Water quality and some nutrient levels in Shiroro lake, Niger state; J. Aquatic Sci., 19: 99-106.

Majaliwa, J.G.M., O. Semalulu and J. Kitamirike, 2005. Non-point pollution into the Uganda catchment of Lake Victoria. Proceedings of the 11th World lake conference held at Kenyatta International Conference Center, Nairobi, Kenya. 31st October-4th November 2005.

Obot, K.A. and S.O.J. Ayeni, 1987. Handbook of Common Aquatic Plants of the Kainji lake Basin, Nigeria Kainji lake research institute. Saolog Printing Productions. Ilorin, pp: 51.

Sa'ad, M.A.H. and E.I. Hemeda, 2005. Impact of agricultural development on the levels of total Nitrogen and Phosphorus in Lake Qarun, Egypt. Proceedings of the 11th World lake conference held at Kenyatta International Conference Center, Nairobi, Kenya. 31st October-4th November 2005.

Sanchez- Carrillo, S. and Alvarez-Cobelas, 2001. Nutrient dynamics and Eutrophication patterns in a semi-arid wetland; the effect of fluctuating hydrology; Water, Air Soil Pollu., 131: 97-118.

Vaithiyanathan, P. and C.J. Richardson, 1999. Macrophyte species changes in the Everglades: Examination along a Eutrophication Gradient; J. Environ. Quality, 28: 1347-1358.

Wlodzimierz, M., 2005. Deposition of phosphorus and nitrogen coming from precipitation into the lakes of North Poland. Proceedings of the 11th World lake conference held at Kenyatta International Conference Center, Nairobi, Kenya. 31st October-4th November 2005.