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Original article

Effect of Selected Water Quality Properties on the Occurrence and Distribution of Aquatic Macrophytes in the Floodplains of River Benue at Makurdi

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Abstract

A study was carried out in River Benue and 10 sites constituting the floodplains of River Benue to determine the effects of selected water quality parameters on the incidence and infestations of aquatic macrophytes. All water quality properties were analyzed using Standard Procedures. Water pH was observed to be variable, ranging from 5.7 at River Benue at the point at which effluents from BBL are discharged to 7.8 at River Benue. Odour, turbidity, dissolved oxygen, (DO), total dissolved solids (TOD), biochemical oxygen demand (BOD) and chemical oxygen demand (COD), respectively also followed the same trend. No significant relationships existed between the occurrence and density of *Azolla pinnata*, *Cyperus difformis, Kyllinga pumila*, *Pycreus lanceolatus* (Poir.), *Ludwigia decurrens, Leptochloa caerulescens Steud., Cardiospermum heliocacabum, Myriophyllum aquaticum, Pistia stratoites, Mariscus longibracteatus, Heliotropium indicum Linn., Sphenoclea zeylonica Gaertn.and Melochia corchorifolia* and the water quality parameters at the study locations. However, positively significant relationships existed between the occurrence and density of *Cyperus erecta* and the pH of the water at River Benue and the amount of dissolved oxygen (DO) in water at the time of collection. There was a positive and highly significant relationship between *Polygonium lanigerum* R.Br., *Heliotropium indicum, Persicaria decipens* and Biochemical DO, BOD, COD and COD. Also, a positive and highly significant relationship existed between *Ludwigia hyssopifolia* and *Sacciolepis africana* with turbidity of water. The relationship to dissolved oxygen at time of water collection indicated the favorable disposition of these weeds to thrive and do well under conditions of relatively higher dissolved oxygen.

Keywords: Aquatic macrophytes, River Benue, Water properties, Occurrence, Distribution.

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INTRODUCTION

Jones et al. (2010) defined aquatic macrophytes as a group of large macroscopic photosynthetic organisms usually growing with their roots in soil or water. These plants are either adapted to continuous supplies of water or are at least tolerant to waterlogged soil conditions for substantial periods of time. Macrophytes include any plant observable by the naked eye and nearly always identifiable when observed (Holmes and Whitton, 1977) and are associated with open water or wetlands with shallow water (CEC, 2002).

Aquatic macrophytes are important components of freshwater ecosystems because they enhance the physical structure of habitats and biological complexity, which increases biodiversity within littoral zones (Estevez, 1998; Wetzel, 2001; Agostinho et al., 2007, Pelicice et al., 2008). They are an important part of the aquatic food web of water bodies as they play an important role in aquatic systems worldwide because they provide food and habitat to fish, wildlife and aquatic organisms (Gross, 2003).

Dumen et al. (2007) noted that aquatic macrophytes growing in the rivers are known to induce substantial changes to the water quality. Some of these effects are due to direct interactions such as uptake of nutrients, whereas others may be merely attributed to indirect effect of the water plants on hydrodynamics or sediment chemistry (Yaowakhan et al., 2005). Macrophytes have become increasingly valued as a means of indirectly monitoring water quality as for instance, eutrophication can produce a progressive change in species composition and a loss of species diversity.

Aquatic weed growths in any source of water create problems involved with practically all water uses (Joshi, 2012). In most subtropical and tropical rivers, the excessive growth of aquatic macrophytes provokes some negative effects (Bini et al., 2005).

Excessive proliferation of non-native species can displace diverse communities of native aquatic plants, affect trophic structure of fish assemblages, create over-populations of fish stunted in size, degrade water quality, and reduce the recreational and aesthetic enjoyment of a water body (Duke, 2001). Pieterse and Murphy, (1990) reported that despite the ecological importance of aquatic macrophytes, the excessive growth of some species may be considered a nuisance to some water uses such as recreation and electrical generation, and may become nuisance by hindering human uses of water and threaten the structure and function of diverse native aquatic ecosystems.

Dense canopies formed by non-indigenous species have been reported to reduce plant diversity and abundance (Madsen et al., 1996). The reduction of habitat complexity also results in reduced macro vertebrate diversity and abundance (Keast, 1984) and growth reduction in fishes (Little and Budd, 1992). When found in large populations, macrophytes can cause extensive socio-economic and environmental problems. They are considered one of the key pressures on world's biodiversity: altering ecosystem services and processes, reducing native species abundance and richness, and decreasing genetic diversity

of ecosystems (Rands et al., 2010, Villa et al. 2011, Hejda et al., 2009). They cause substantial economic losses estimated to a total of US$120 billion annually in the USA (Pimental et al. 2005, Kettunen et al. 2009). In South Africa, estimated economic costs due to invasive alien species are currently above US$ 700 million (R6.5 billion) per annum or 0.3 % of South Africa's GDP, and could rise to over 5 % of GDP if invasive plants are allowed to reach their full potential (Wilgen and Lange 2011).

This study was therefore carried out to identify some of the water quality properties influencing the occurrence or infestations of macrophytes in the study area.

Materials and Methods

Collection of water samples

Water samples were collected in thoroughly washed and sterile 75 cl bottles, below the surface of the water, determined by the depth of the water body. These bottles were then placed in sealed giant flask coolers to prevent alterations in temperature and water quality. All sample sites were selected on the basis of weed presence, density and diversity. The weeds which could not be identified on site were collected by hand and placed in a 250 μm mesh net and all sediments removed from the sample by washing in the water at the point where the samples were collected. Macrophyte samples were kept cold in a cooler box and taken to the laboratory where they were identified to species. Macrophytes were identified and classified to species according to their life forms. An identification of the macrophytes was carried out using *A Handbook of West African Weeds* by Akobundu and Agyakwa (1987), Western Weeds: *A Guide to the weeds of Western Australia by* Hussey et al., (2007), MCIAP, (2007) and National Pest Plant Accord, by http://www.biosecurity.govt.nz/nppa, (2008). The water quality parameters assessed in this study were all measured using standard procedures as outlined below.

Data Collection

Water quality data

Water parameters measured were; odour of water, water colour, temperature, turbidity, total dissolved solids (TDS), electrical conductivity (EC), hardness, Ammonia-Nitrogen, free carborn dioxide, phosphorus, pH, dissolved Oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total oxygen demand (TOD), Calcium, and Magnesium.

The water samples collected before and after herbicide application were analyzed in a standard laboratory of the Benue State Water Board for the following water quality parameters:

pH and temperature**.**

These measurements were taken on the spot using a hand held HANNAH microcomputer, model HI 9024, Romania.

Dissolved oxygen

Dissolved oxygen concentration of the sampling areas was determined using Winklers titrimetric method (Mackereth, 1963). Two milliter of manganous sulphate followed by 2 mL Potassium iodide (KI) solution were added to water samples in order to fix the oxygen. The bottle was carefully closed with a stopper to exclude air bubbles and mixed by thoroughly shaking the bottle. The formed precipitate was taken to the laboratory for analysis.

In the laboratory, 2 ml of H_2SO_4 was added and the bottle shaken thoroughly to dissolve the precipitate. About 10 ml of this solution was placed into conical flask and titrated against 0.0125 M $Na_2S_2O_3$ (sodium thiosulphate solution) using 2 drops of starch solution as indicator. Dissolved oxygen (mg/l) was calculated as follows:

$$\text{DO (mg/l)} = \frac{\text{Vol. of 0.0125 M } Na_2S_2O_3.5H\,O \text{ (ml) x101.6}}{\text{Volume titrated}}$$

Determination of free carbon dioxide

Water samples were collected using a 75 cl water bottle. It was completely filled to leave no air space. The samples were siphoned into a 100 ml graduated cylinder and five to ten drops of phenolphthalein indicator was added. Titration was carried out into the cylinder with standard alkali solution and stirred gently until pink colour persisted for 30 seconds. A colour comparison is provided by adding 5-10 drops of phenolphthalein indicator to 10 ml NaHCO solution in a similar graduated cylinder.

$$\text{Calculated as } CO_2 \text{ mg/l} = \frac{\text{V x M x 44,000}}{\text{ml of sample used}}$$

Where, V = ml of Na_2CO_3 used for the titration of the sample

M = Molarity of the standard alkali

Chemical oxygen demand (COD)

Titrimetric method was employed in the determination of COD. A 10 ml of 0.125 M $K_2Cr_2O_7$ was added to 20 ml of the water sample using a pipette in a refluxing flask. Glass beads or anti -bumping chips were added. Then 30 ml of concentrated H_2SO_4 was added slowly and with gentle swirling. The flask was connected to the condenser and refluxed for 2 h. After that, the flask was cooled and the condenser washed with distilled water into the flask and diluted to about 150 ml. The excess dichromate was titrated with 0.05 M ferrous ammonium sulphate (FAS) using 2 drops of ferroin as indicator. A

blank mixture was prepared and treated using the same procedure (Ademoroti, 1996). This was calculated as:

$$COD\ (mg/l) = \frac{Vb\text{-}Vs \times M \times 1600}{Ml\ sample}$$

Where: Vb = ml FAS used for blank, Vs = ml FAS used for sample, M = molarity of FAS.

Conductivity

Water sample conductivity was measured using HACH conductivity meter. This meter was standardized using distilled water and the probe inserted into the sample. The conductivity value was displayed on the meter and value recorded.

Turbidity

Turbidity was determined using Varian UV-Visible Spectrometer. The spectrometer was standardized with distilled water at a wavelength of 830 nm (infra-red). Turbidity was then determined by reading the value shown on the meter.

Ammonia-Nitrogen (NH-N)

Fifty milliliters of water sample were added into a flask, equivalent amount of Cl^- ion determined was added to the standard Ag_2S_4 solution to remove any Cl^- that may interfere as AgCl precipitate. A clear sample of the water was then evaporated to dryness over a hot water bath.

The residue was then rinsed with 1ml Phenol disulphonic acid reagent and was heated mildly to dissolve all solids. Ten milliliter of distilled de-ionised water was added, followed by 3 ml of concentrated ammonium hydroxide solution. The solution was then transferred to a 50 ml volumetric flask. Absorbance readings were taken at wavelength of 410 nm with SP-200 Spectrometer. Concentration of nitrate in water sample was deduced from the calibration curve.2

Total suspended solids (TSS)

About 100 ml of the filtered sample (using a pre-weighed filter paper) was transferred into a weighed evaporating dish. Evaporation to dryness was carried out on a steam bath. The dish was cooled and weighed. This was continuously done until a constant mass was obtained. The dissolved solids were calculated as mass of dissolved residue over volume of sample.

Total dissolved solids (TDS)

This is based on the weight of residues on evaporation after drying at the temperature of $105\text{-}110^0$ C. The loss on ignition is determined on the residue used for determining total dissolved solids by careful

ignition over a small flame or in a covered metal dish. In calculating the quantity of dissolved material, the figure for bicarbonate is divided by 2.03 to account for the conversion to carbonate on evaporation and the quantities of the other constituents as found by analysis are added to give the quantity of dissolved mineral matter.

Potassium

This was determined using the tetraphenyl borate method, using the Acid-Floride extraction (Engelbrecht and McCoy, 1956).

Biochemical oxygen demand (BOD)

Water samples were collected in 75 cl water bottles and incubated for 5 days by wrapping them in a black nylon bags and keeping in the cardboard. At the end of the 5 days, the oxygen concentration of the samples was determined in the same way as dissolved oxygen as outlined by APHA, (1993) using Alterberg-Azide method. The BOD values of the samples were then determined as the difference between the dissolved oxygen content of the fresh water samples and that of the incubated samples in the relationship:

$$\text{BOD (mg/l)} = \frac{\text{DO (before incubation)} - \text{DO (after incubation)}}{B}$$

Where B= fraction of the sample used

Water hardness

25 ml of the water samples were placed in different 250 ml conical flasks to which were added 2 drops of Erochrome Black T indicator and 3ml of ammonium chloride in concentrated ammonia buffer (NH_4Cl/conc.NH_3). This was then titrated against 0.01 M EDTA solution until there was a colour change to blue from violet.

$$\text{Hardness in mg/l } CaCO_3 \text{ was calculated as } \frac{V \times M \times 1000}{1M \text{ used sample}}$$

Where M= molarity of EDTA and

V= volume of EDTA used

Statistical analysis

All the laboratory data on water parameters were subjected to Analysis of Variance (ANOVA) using the Genstat statistical tool version 12 and where statistical differences were observed, the means were separated using Duncan Multiple Range Test (DMRT) at 5 % level of probability.

Results and discussion

Selected water quality parameters of the water bodies sampled are as shown in Table 1.

Table 1. Selected water quality parameters of the water bodies sampled

	pH	Odour	Turbidity	TDS	DO1 (mg/l)	DO2 (mg/l)	BOD (mg/l)	COD (mg/l)	TOD (mg/l)
BBL EF.DP	5.7	0	116.4	54.8	4.5	1.6	176	372	548
BBL 2	5.8	0	154.6	64.2	4.3	1.2	184	372	556
Abattoir	6.6	0	106.0	51.8	4.5	2.4	128	256	384
Adubu	6.5	1	450.8	77.4	4.6	3.4	71	144	215
A.Adubu	6.2	1	168.4	66.4	4.6	2.6	112	228	340
Tyumugh1	6.8	1	56.8	20.8	5	3.9	64	130	194
Tyumugh2	6.5	0	142.8	58.2	4.4	2.3	126	266	392
Berbesa 1	6.7	1	658.6	8.7	4.5	2.5	118	234	352
Berbesa 2	6.6	1	482.6	79.4	4.5	3.2	76	158	234
Agongul	6.4	1	23.2	14.2	5.4	4.4	58	118	176
R.Benue	7.8	1	24.1	19.7	6.1	4.8	78	156	234

0 = objectionable odour; 1 = unobjectionable odoura. TDS= total dissolved solids, BOD= biochemical oxygen demand, COD= chemical oxygen demand, TOD= total oxygen demand

Water pH was observed to be variable, ranging from 5.7 at River Benue at the point at which effluents from BBL are discharged to 7.8 at River Benue. Odour was also variable, ranging from objectionable at the point of effluent disposal at BBL, BBL 2, new bridge abattoir and Tyumugh 2 to unobjectionable odour at Adubu, Anam Adubu, Tyumugh 1, Berbesa 1 and 2, Aogongul and River Benue. Turbidity also followed a similar trend, varying from 23.2 NTU at Agongul to 658.6 NTU at Berbesa 1. Total Dissolved Solids was variable and varied from 8.7mg/l at Berbesa 1 to 79.4 NTU at Berbesa 2. Dissolved oxygen on the first day of water collection varied from 4.3 mg/l at BBL 2 to 6.1mg/l at River Benue while that after 5 days of water collection varied from 1.2 mg/l at BBL 2 to 4.8 mg/l at River Benue. The trend was similar in Biochemical Oxygen Demand (BOD) where BOD varied from 58 mg/l at Agongul to 184 mg/l at BBL 2. Chemical Oxygen Demand (COD) also varied from 118 mg/l at Agongul to 372 mg/l at the point of effluent disposal at BBL. Total Dissolved Oxygen varied from 176 mg/l at Agongul to 556 mg/l at BBL 2.

The Relationships between water quality properties, occurrence and population density of Identified Weeds is shown on Table 2. No significant relationships existed between the occurrence and density of *Azolla pinnata*, *Cyperus difformis*, *Kyllinga pumila*, *Pycreus lanceolatus* (Poir.), *Ludwigia decurrens*, *Leptochloa caerulescens* Steud., *Cardiospermum heliocacabum*, *Myriophyllum aquaticum*, *Pistia stratoites*, *Mariscus longibracteatus*, *Heliotropium indicum* Linn., *Sphenoclea zeylonica* Gaertn.and *Melochia corchorifolia* and the water quality parameters at the study locations. There was however a positively significant relationship (r=0.773) between the occurrence and density of *Cyperus erecta* and the pH of the water at River Benue which was alkaline (7.8). There was also a relationship

between this weed and the amount of dissolved oxygen (DO) in water (r=0.819) at the time of collection. No other relationship existed between this weed and the other water quality parameters.

Table 2. Relationships between water quality parameters and occurrence and population density of identified weeds

	pH	Odour	Turbidity	TDS	DO1	DO2	BOD	COD	TOD
E. crassipes	0.(a)	0.(a)	0.(a)	0.(a)	0.(a)	0.(a)	0.(a)	0.(a)	0.(a)
C. difformis	0.773**	0.239	-0.300	-0.345	0.819**	0.550	-0.231	-0.239	-0.236
C. erecta	0.444	0.102	-0.278	0.124	0.203	0.308	-0.331	-0.330	-0.331
K. pumilla	0.773**	0.239	-0.300	-0.345	0.819**	0.550	-0.231	-0.239	-0.236
P. lanigerum	0.773**	0.239	-0.300	-0.345	0.819**	0.550	-0.231	-0.239	-0.236
R. nasturtium	-0.593	-0.602	-0.221	0.208	-0.249	-0.625*	0.798**	0.802**	0.801**
L. abbysinica	0.773**	0.239	-0.300	-0.345	0.819**	0.550	-0.231	-0.239	-0.236
S. naumanniana	0.773**	0.239	-0.300	-0.345	0.819**	0.550	-0.231	-0.239	-0.236
E. calva	0.773**	0.239	-0.300	-0.345	0.819**	0.550	-0.231	-0.239	-0.236
L. flava	0.773**	0.239	-0.300	-0.345	0.819**	0.550	-0.231	-0.239	-0.236
P. lanceolatus	0.773**	0.239	-0.300	-0.345	0.819**	0.550	-0.231	-0.239	-0.236
C. haspan	0.397	0.463	-0.012	0.174	0.420	0.394	-0.319	-0.327	-0.324
L. decurrens	0.773**	0.239	-0.300	-0.345	0.819**	0.550	-0.231	-0.239	-0.236
S. nymphellula	0.539	0.344	0.449	-0.282	0.100	0.254	-0.317	-0.314	-0.316
A. cordifolia	0.773**	0.239	-0.300	-0.345	0.819**	0.550	-0.231	-0.239	-0.236
M. aquaticum	0.773**	0.239	-0.300	-0.345	0.819**	0.550	-0.231	-0.239	-0.236
L. caerulenscens	0.773**	0.239	-0.300	-0.345	0.819**	0.550	-0.231	-0.239	-0.236
L. hyssopifolia	0.125	0.356	0.815**	-0.036	-0.241	-0.034	-0.134	-0.143	-0.140
H. indicum	-0.541	-0.653*	0.125	0.043	-0.499	-0.767**	0.831**	0.838**	0.836**
A. pinnata	0.055	0.213	0.397	-0.182	-0.069	0.151	-0.288	-0.276	-0.280
C. helicacabum	0.005	0.352	0.158	0.086	0.110	0.338	-0.448	-0.433	-0.438
M. aquaticum	0.212	-0.054	0.293	-0.068	-0.312	-0.042	-0.158	-0.151	-0.153
P. esculentum	0.128	0.356	0.831**	-0.093	-0.240	-0.047	-0.114	-0.125	-0.122
P. decipens	-0.677*	-0.624*	-0.188	0.240	-0.333	-0.677*	0.815**	0.822**	0.820**
P. stratiotes	0.082	-0.131	0.430	-0.257	-0.286	-0.236	0.156	0.156	0.156
M.longibracteatus	-0.065	0.239	-0.301	-0.415	0.390	0.432	-0.383	-0.378	-0.380
H. indica	-0.006	0.356	0.095	0.012	0.162	0.374	-0.466	-0.452	-0.457
S. zeylonica	-0.583	-0.274	-0.068	0.241	-0.184	-0.317	0.361	0.380	0.374
M. cordifolia	-0.496	-0.204	-0.377	-0.190	0.108	-0.081	0.210	0.216	0.214

** Correlation is significant at the 0.01 level (2-tailed).* Correlation is significant at the 0.05 level (2-tailed). [a] Cannot be computed because at least one of the variables is constant.

There was a positive and highly significant relationship between *Polygonium lanigerum* R.Br. *africanum* and Biochemical Oxygen Demand (BOD), (r=0.789), Chemical Oxygen Demand (COD), (r=0.802) and Total Oxygen Demand (COD), (r=0.801). However, the relationship of this weed and DO (after 5 days of collection) was negatively significant (r=-0.625). No other relationship existed between this weed and the other water quality Parameters.

There was also a similar trend where positive and highly significant relationship existed between *Heliotropium indicum* and BOD (r=0.815), COD (r=0.838) and TOD (r=0.836) respectively. A negative

and highly significant (r=-0.767) relationship however existed between this weed and DO (after 5 days of sample collection).

There was also a negative and significant (0.653) relationship this weed and the odour of water at the study locations.

A positive and highly significant relationship between *Persicaria decipens* and BOD (r=0.815), COD (r=0.822) and TOD (r=0.820) was observed respectively. There were also negative and significant relationships between this weed and DO (after 5 days of water collection (r=0.677). No other relationship was observed between this weed and the other water quality parameters.

There was a positive and highly significant (r=0.815) relationship between *Ludwigia hyssopifolia* and *Sacciolepis africana* with turbidity of water. No other relationship was observed between these weeds and the other water quality Parameters.

There was a positive and highly significant relationship between *Ludwigia hyssopifolia* and *Sacciolepis africana* with turbidity of water.

The occurrence or presence and affinity of *Cyperus erecta*, *Eleocharis calva*, *Limnocharis flava*, *Cyperus haspan* and *Anredera cordifolia* to only River Benue (as against the other locations with acidic to slightly acidic water conditions) and the dominance of *Pteridium esculentum, Rorippa nasturtum-aquaticum, Ludwigia abbysinica, Myriophyllum aquaticum* and *Scleria naumanniana* at the locations with acidic to slightly acidic water conditions indicated the preference of these weeds to grow and flourish under varying water conditions. Their relationship to dissolved oxygen at time of water collection indicated the favorable disposition of these weeds to thrive and do well under conditions of relatively higher dissolved oxygen.

Ngodhe et al. (2013) had reported that the structure and function of aquatic organisms reflect physical/chemical conditions and further, that the main physico-chemical factors that affect aquatic environments are temperature, discharge, DO, pH, nutrients and conductivity. Temperature and DO levels usually fluctuate and regulate the amount of DO in water (Kalff, 2002) as increased temperatures lower the solubility of DO resulting in low values. The abundance of these weeds in slightly acidic to alkaline water situations corroborates the findings of Ngodhe et al. (2013) that natural differences in pH and alkalinity may be important determinants of aquatic structure and low acidities reflect better buffering and higher productivity (Busulwa and Bailey, 2004). It implies therefore, that these weeds thrived and will most likely to do better at higher (alkaline) pH levels. Higher levels of DO at time of water collection were also found to be responsible for the higher occurrence and distribution of these weeds.

The presence of high BOD may indicate faecal contamination or increases in particulate and dissolved organic carbon from non-human and animal sources that can restrict water use and

development, necessitate expensive treatment and impair ecosystem health. Measurement of BOD has long been the basic means for determining the degree of water pollution (Hach et al., 1997). COD is commonly used to measure the amount of organic compounds (or pollutants) in water or oxygen depletion in water.

Polygonium lanigerum, Heliotropium indicum and *Persicaria decipens* were found predominantly at the point of effluent disposal at BBL and River Benue close to the point of effluent disposals from BBL, Berbesa and Tyumugh. Their presence and preponderance at these places and their strong responses (or increases in density) in the presence of high levels of BOD, COD and TOD indicated their affinity (tolerance), occurrence and effective water utilization under mainly highly contaminated water sources depleted of oxygen and replete with organic compounds. This further confirms why they were found only at these points.

The inverse relationship of *Polygonium lanigerum, Heliotropium indicum* and *Persicaria decipens* with DO showed that as the amount of dissolved oxygen decreased, the occurrence and distribution of the plant also decreased. This trend is not generally uncommon as most plants are not likely to survive under oxygen deficient conditions. Also, as odour increased, the occurrence of *Heliotropium indicum* also decreased. This trend is assumed to have occurred because odour is most likely to create conditions of foams and scums that are capable of causing the extinction of biological activities that may facilitate respiration and sustenance of oxygen in the water for the thriving of aquatic flora and fauna.

The uninhibited occurrence and distribution of *Ludwigia hyssopifolia* and *Sacciolepis africana* at Berbesa 1 and 2 under turbid water conditions indicated that other than nutrients turbidity will not limit the growth, distribution and perhaps photosynthetic ability of these plants. On the other hand, it is possible that some of the inputs arising from the sources of turbidity at this location (agriculture, rearing of animals along the shores of this water body, sediments from storm water, human defecations and soil excavation activities), (Jimin et al. 2014) improved the fertility status of the water to levels that increased the ability of these weeds to survive even under turbid water condtions.

Conclusion

The mere presence of macrophytes in a body of water indicates that both its physical and chemical properties have been altered through contamination or increases in particulate and dissolved organic carbon from human, non-human and animal sources that can restrict water use and development, necessitate expensive treatment and impair ecosystem health. The results of this study which have indicated an increasing and threatening trend in the rate at which invasive aquatic macrophytes are colonizing river Benue and its floodplains calls for action. This action is both in terms of limiting riparian and

catchment activities capable of altering the physical and chemical status of River Benue and its floodplains and controlling the aquatic macrophytes already infesting them before economic thresholds are attained.

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