

Estimating Macrophyte Load for Water Hyacinth in Kolo Creek, Niger Delta

Gobo A. E.^{1,*}, Amangabara G. T.², Etiga G. E.¹

¹Institute of Geosciences and Space Technology (IGST) Rivers State University of Science and Technology P.M.B.5080 Port Harcourt, Nigeria

²Dept of Environmental Technology, Federal University of Technology, P.M.B.1526 Owerri, Nigeria

Abstract The invasion and inconveniences caused by Water Hyacinth (*Eichhornia crassipes*) in the Niger Delta was investigated. Many streams and creeks in the region are heavily impacted by this water weed. Studies show that the rapid growth rate and the luxuriant nature of its vegetation have defied all forms of control so far by local communities. This study focuses on measuring the percentage area covered by the macrophyte, its biomass and macrophyte load as necessary steps in water hyacinth control in Kolo creek, Bayelsa state. The macrophyte area covered ranged from 24.47% in October to 89.3% in March 2007. The differences in mean macrophyte area covered between wet and dry seasons were statistically significant [$t\text{-stat} = 11.856 > p = 1.36_{(0.05)}$]. The macrophyte load however ranged between 13.116 of dry weight (DW)/ ha and 5.38t of DW/ha for dry and wet seasons respectively.

Keywords Biomass, Water Hyacinth, Invasive weeds, Aquatic Vegetation, Macrophyte

1. Introduction

Water hyacinth originated from the Amazon basin in Brazil and was introduced into many parts of the world as an ornamental garden pond plants due to its beauty. It has proliferated in many areas and can now be found in all continents of the world apart from Europe[1]. Its introduction to the Niger Delta region is speculated to be via the inland waterways from Lagos or through River Niger. According to Abam[2] River Niger drains a large part of West Africa and discharges its waters, sediments and other loads including exotic species into the Niger Delta and its extensions into the Atlantic Ocean and could possibly be the path through which the water hyacinth and other exotic species find their way to the Niger Delta drainage system.

Factors such as eutrophication, pH, nutrients, climate, light penetration, pollution etc, have been fingerprinted as creating the enabling environment for the survival of water hyacinth in the Niger Delta. However, flow reduction, has been attributed as a major causal factor in the spread of aquatic vegetation, not just in the Niger Delta drainage system but across the globe. According to Haslam[3] the migration, growth and distribution of aquatic macrophytes such as water hyacinth *Eichhornia crassipes* and other aquatic species is primarily dictated by current. This is in

agreement with Walker[4] suggesting that the alteration of natural flow regimes of rivers and streams is recognized as a significant factor contributing to the loss of biological diversity and ecological function in aquatic ecosystem.

The growth of water hyacinth is largely exacerbated by nutrient rich waters particularly those rich in Nitrogen phosphorus and potassium. Mats also deposit a large amount of organic matter which increases the organic content of the sediments and greatly accelerate succession patterns, allowing emergent and riparian vegetation to colonize[5].

The environmental, socio-economic as well as the health Hazards on stream users and affected communities due to water hyacinth infestation have been reported, diseases and illnesses associated with the presence of aquatic weeds in developing tropical countries are among those that cause the serious health problems for example malaria, schistosomiasis and lymphatic filariasis[1]. Economic losses include man - hour lost in removing the weeds from the creeks, the huge financial loss in the hiring of equipment etc. for example, manual removal of the weed in China alone cost an estimated 100 million RMB Yuan (US \$12m) each year but were neither economic nor effective[1]. The basic objectives of this study were to:

(1) Estimate the extent of spread of water hyacinth in Kolo creek.

(2) Measure the macrophyte load of Kolo creek and present it as a necessary step for water hyacinth management in the Niger Delta.

(3) Establish a relationship between macrophyte areas covered and cross sectional area of river channels.

* Corresponding author:

safeearthconsult@yahoo.com.au (Gobo A. E.)

Published online at <http://journal.sapub.org/ije>

Copyright © 2013 Scientific & Academic Publishing. All Rights Reserved

2. Methodology

The study was conducted at Kolo creek, a small, narrow stream which bifurcates from the Orashi River (Okarki Town) in Rivers State and courses through fifteen communities in Ogbia Local Government Area of Bayelsa State, down South into the Brass River System (NEDECO, 1961). As an integral part of the Niger Delta (covering an area of 70, 000 sq/km), Kolo Creek shares the same environmental and

climatic conditions with the region. The climate of the area is characterized by a dry season (November – March) and wet season (April – October). The annual rainfall varies from 2500 – 3000mm in the Warri to Port Harcourt axis. Mean temperatures are as high as 32°C with humidity of about 81% between January – March and about 92% in the months of July – August[7].

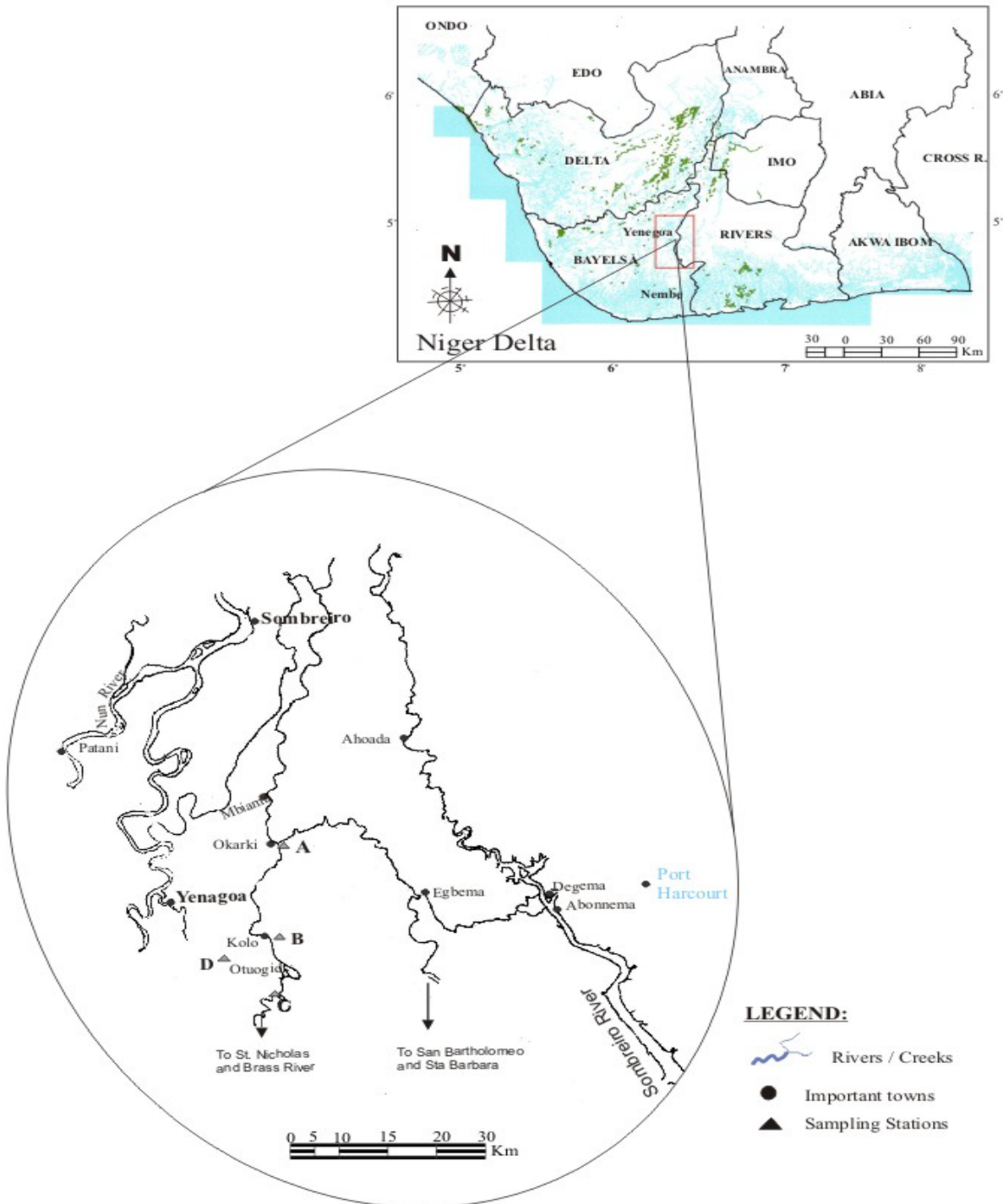


Figure 1. Map of Niger Delta (Nigeria) showing the Sampling Stations in Kolo Creek and Esoghoni creek

2.1. Determination of macrophyte coverage

A survey of the Creek during the Dry Season shows that the Creek is approximately 20m wide, the length 2000m (2km). The Creek was then divided into four sampling stations of A (500m), B(500m) C(500m) and D(500m). Sampling Station A, B and C are located at Okarki, Kolo and Otuogidi respectively while station D is located at Esoghoni Creek an arm of Kolo Creek (Fig. 1). Each sampling Station was further divided into 10 strips of 50m each in length. Three of such strips were then sampled from each of the sampling stations.

The Esoghoni Creek which is our Sampling Station D measures about 2m wide 150m in length. This sampling station was also divided into 10 strips out of which three (3) strips were sampled. This brings our total sampling strips for macrophyte to twelve.

The percentage area of the stream covered by macrophyte was determined *in situ* using the strip method[8]. If we divide a complete figure up into a series of strips, then the total area is given approximately by the sum of the areas of these strips.

$$A = \int_a^b y dx = \int_a^b f(x) dx \quad (1)$$

The Simpson's rule and the trapezoidal were used for odd numbered y.

$$A = 2/3[(F + L) + 4E + 2R] \quad (2)$$

While the trapezoidal rule was used for even numbered ordinates.

$$A = d/2[h_1 + h_n + 2(h_2 + h_3 + h_4 + h_5 + \dots + h_n)] \quad (3)$$

This was done for the entire 12 sampling strips for both Dry and Wet Seasons and the results tabulated (table 1).

2.2. Weight measurements

To measure the weight of macrophyte, 1m x 1m quadrat was thrown randomly on the stream and the bulk weed within the quadrat area was harvested by hand into baskets and transported by canoe to the river bank. The wet weed was then carried safely to where it was weighted using the spring balance and the reading taken. The weeds were then air dried for 14 days and then weighed on the spring balance and reading taken as dry weight of macrophyte harvested and recorded as table 2. The biomass, as well as the macrophyte load of the Kolo creek was then estimated from the results.

2.3. Measuring the Cross Sectional Area of the Creeks

The cross sectional Area (CSA) of the creeks at various stations was measured using the strip method. In Kolo creek (Sample stations A, B, C) measurement was done both in dry and wet seasons and mean value obtained. The same was done in Esoghoni creek (Sample station D) and results tabulated tables 4 and 5

3. Results and Discussion

The summary of the results from the measurement of percentage area covered by macrophyte, the weight of macrophyte as well as seasonal macrophyte load is represented in the tables 1, 2, and 3.

Table 1. Mean Percentage Area covered by Macrophyte in Dry and Wet Seasons

Stations/Month	A	B	C	D	Mean	% Dry & Wet
Dry Season Months						69%
February	60	78.53	58.6	83.32	70.11	
March	66.4	83.47	64.6	89.33	75.95	
Wet Season Month						28%
September	28.1	31.8	26.42	44.53	32.7	
October	27.51	30.15	24.98	42.4	31.26	
Mean Dry Season	63.2	81.0	61.6	86.3		
Mean Wet Season	27.8	31.0	25.7	43.5		

Table 2. Wet and Dry Weight of Water Hyacinth

Sampling Station	Wet Weight of Macrophyte (Kg)	Dry Weight of macrophyte (kg)	Weight of moisture	Percent weight of moisture in plant	Sin ⁻¹
A	15.8	1.80	14.0	88.6	62.4
B	16.2	1.92	14.28	88.15	61.82
C	14.4	1.68	12.62	87.64	61.21
D	17.6	2.2	15.4	87.5	61.0
TOTAL	80.0	9.5		440.02	
MEAN	16.0	1.9		88.05	61.7

Table 3. Seasonal Macrophyte Load in Kolo Creek and Esoghoni Creek

Seasonal Weight (wt) of Macrophyte (Kgm ⁻²)	Dry Season		Wet Season	
	Mean Dry Weight	Mean Wet Weight	Mean Dry Weight	Mean Wet weight
Channel				
Kolo Creek	1.311	11.04	0.536	4.513
% Wt(ton.ha ⁻¹)	13.11	110.4	5.36	45.13
Esoghoni Creek	1.64	13.81	0.827	0.96
% Wt(ton.ha ⁻¹)	16.4	138.1	8.27	69.6

Wt = Weight, % = percentage

3.1. Macrophyte Cover in Dry and Wet Seasons

Dry season mean values ranged from 58.6% in station C in February, 2007 to 89.33% in Station D in March, with mean 72.5% = 9.72

Similarly, wet and dry season values ranged from 44.53% in station C in September 2007 to 24.47% in October of the same year.

Wet and dry means had the same distribution pattern demonstrating a perfect positive correlation ($r = 1$) and the ratio of dry to wet means being 2.5.

The differences in mean macrophyte area covered between dry and wet seasons were statistically significant.

[$t\text{-stat}=11.856 > p=1.36_{(0.05)}$]

The mean area covered by macrophyte in station D showed consistently higher values than the mean values observed for A – C in both wet and dry seasons (table 1)

The differences in the wet season mean macrophyte area covered between the Esoghoni creek (station D) and Kolo Creek (A – C) were however statistically significant.

($t\text{-stat} = 11.63 > p = 2.13_{(0.05)}$).

Also, differences in the dry season mean macrophyte area covered between Esoghoni creek and Kolo Creek were statistically significant.[$t\text{-stat} = 6.486 > p = 2.13_{(0.05)}$]

The mean percentage macrophyte area covered of about 69% for the Kolo creek and 86.5% for the Esoghoni creek during the dry season period shows the level of infestation of the streams showing strong capacity to obliterate these and other adjoining creeks[9].

3.2. Biomass

The wet weight of macrophyte ranged from 1440-1760g/m² for all the stations, with mean 1600g \pm 116g/m². The dry weight (biomass) of macrophyte, however, ranged from 168g – 220g/m² for all the stations with a mean value of 190g \pm 19.3g/m². The moisture content of macrophyte for all the samples varied slightly from 60.4 – 62.3g/m² with a mean value of 61.64 \pm 0.61g/m² (table 2).

The macrophyte load in both seasons varied significantly both in Kolo creek and Esoghoni creek. In Kolo creek the mean macrophyte load ranged between 13.11t of dry weight (DW)/ha and 5.38t of DW/ha for dry and wet seasons respectively (table 3).

Comparing the macrophyte area covered (y) with the cross

sectional area x during the dry season for stations A – D (table 4) demonstrated a negative relationship ($r = -0.677$) and $R^2=0.5757$ Also, comparing the variable Y_1 and X_1 (table 5) gives a negative correlation ($r = -0.978$) and $R^2=0.959$. This is an indication that the size of the channel is no less a significant factor

Table 4. Macrophyte Area covered (Y) on CSA (x_1) in the dry season

Variable	Station A	Station B	Station C	Station D
X	21.1	21.7	21.8	6.7
Y	63.6	70.34	81	86.3

Table 5. Macrophyte Area covered (y) on CSA (x_1) in Wet Season

Variable	Station A	Station B	Station C	Station D
X_1	102.6	100.1	102.8	37.9
Y_1	27.8	28.3	31.0	43.5

There was no much deviation with the works of Junk and Pedade[10] on their studies carried out in Brazil. That variation in water level is one of the principal factors responsible for alteration in the biomass, detritus and total biomass of macrophyte. During the dry season discharge is low, resulting in shallower wetted perimeter and sluggish flow that encourages the deposition of sediments leading to sand bars and enabling environment for water weeds to thrive mainly as a result of the reduction of mechanical flushing effect of a good flowing river.

During the wet season, due to the interconnectedness of rivers and streams in the Niger Delta which is low lying (in some places just 3meters above sea levels), the overflow (flooding of the principal river systems) - The river Niger, as a result of release of water from the Kainji dam on the Niger upstream, the entire delta is flooded. The floodwater provides the mechanical flushing effect on Orashi River, Kolo creek and Otuogidi creek leading to reduction biomass cover. The Esoghoni creek (sample Station D) bifurcates from Kolo creek, is a shallower, sheltered fresh water body with average velocity of about 10 m³/s, this may account for its higher macrophyte load compared to Kolo creek

4. Summary and Conclusions

The work here presents the impact of macrophyte on the river system of the Niger Delta. Macrophyte area covered demonstrated a consistent negative correlation with the cross sectional area in all the sampling stations ($r = -0.677$) and $r =$

(-0.978) for both dry and wet seasons respectively. The Esoghoni creek (station D) also shows consistently higher values of mean macrophyte area covered. This shows that smaller streams like the Esoghoni creek with low gradient and altered by upstream activities that affect flow velocity (such as river impoundment) are at risk of macrophyte infestation. The implication is that the macrophyte may cause a variety of problems when its mat-like vegetation covers streams, rivers and creeks clogging intakes of irrigation and hydropower systems, blocking of canals and river which may lead to localized flooding. Other possible effect include increased evapotranspiration and destruction of spawning sites for fish as well as the obliteration/blockage of transport/access routes and creeks for fishermen and their canoes. The absence of mechanical flushing as a result of reduce flow during the dry season may account for its prevalence especially in sample Station D which is a sheltered creek.

REFERENCES

- [1] Intermediate Technology Development group (ITDG). Water hyacinth control And possible uses. 2005.1-15pp.
- [2] Abam TKS. Regional hydrological research perspectives in the Niger Delta. Hydrologist's science *Journal-des sciences* 2001, 46.13.
- [3] Haslam SM. River plants; vegetation of water courses London: Cox and Wymal Ltd. 1978
- [4] Walker KF. A review of the ecological effect of flow regulation on the lower River Murray, Australia. *Regulated Rivers Research and Management* 8: 1985.103-419pp.
- [5] Gopal B. Water Hyacinth: Aquatic plant studies. Amsterdam: Elsevier Science Publishers. 1978.
- [6] Niger Delta Environmental Survey (NDES) - Phase 1 report 1-4, DES, Lagos, Nigeria. 1995
- [7] Netherlands Engineering Consultants (NEDECO): The waters of the Niger Delta. The Hague, the Netherlands. 1961
- [8] Straud 1995
- [9] Etiga, GE. The flow effect of the Kainji Dam on the Distribution of Water Hyacinth in Kolo Creek, Bayelsa state, An unpublished M.Phil thesis submitted to RSUST, Port Harcourt. 2008
- [10] Junk, W Piedade, MTF. Biomass and Primary production of herbaceous plant communities in the Amazon flood plain. *Hydrobiologia* 263. 1993 155-162 pp.
- [11] ISSG. Invasive species Ecology. *Eichhornia crassipes*. (Aquatic plant) 2005 1-18pp.