3 Aquatic Macrophytes: Ecology, Function, and Services in Niger Delta, Nigeria

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Abstract

Aquatic macrophytes are crucial within the inland waters of the Niger Delta as they enhance the surrounding, act as a dwelling region for minute water creatures, and make a contribution considerably to fisheries productivity. Aquatic macrophytes also provide substrates, meal, and habitat for aquatic animals, in addition to enhancing habitat physical structure and organic complexity, which will increase biodiversity in our water bodies. Macrophytes have crucial characteristics in our water bodies. Nonetheless, rather mild attention is paid to their protection, and if they are not properly managed, they can become out of control and cause issues. This article looks at the ecology, benefits, and drawbacks of common aquatic macrophytes in Nigeria's Niger Delta, in addition to great strategies for controlling the macrophytes in the inland waters of the Niger Delta. Managing aquatic macrophytes in this region is to accomplish stability in the environment by controlling extreme foray of plant species. A thorough assessment of the nature, scope, and potential of aquatic macrophyte problems is required before implementing control measures. Management actions in this region must raise awareness among the local population.

Keywords

Aquatic macrophyte · Management · Classification · Water bodies · Ecology

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3.1 Introduction

Inland water basins in Nigeria offer crucial habitat for a variety of flora and aquatic fauna, which support the areas they surround. However, activities (synthetic and native) that caused ecological concerns have recently damaged the connected ecological system, affecting the provided natural resources. Despite this, not much is established as regards aquatic bodies with plants and wildlife, stock-taking, socioeconomic, and conservation in Nigeria (Daddy et al. 1993). Nigeria's Niger Delta is among the significant deltas with natural resources such as crude oil, gas, animals, beneficial plants, and other resources abound in the region. It is the world's sixth largest producer and exporter of crude oil. It encompasses a diverse range of natural zones, including sand ridge barriers, brackish mangroves, and freshwater swamps (Udo 1987). The Niger Delta spans 20,000 km^2 and is surrounded by 70,000 km^2 of natural wetlands. The physically generated flood plains cover 7.5% of the 923,800 km^2 entire surface. This incredibly well-endowed ecological system harbors great biodiversity around the sphere. It also sustains abundant species, with additional species of freshwater organisms than any other ecological system in West Africa (Akinbode 2005; Vida 2010).

3.1.1 Aquatic Macrophyte Ecology

Macro-flora with roots that grow constantly or intermittently in aquatic environments is usually referred to as "aquatic macrophytes." They are a category of big, macroscopic photosynthetic organisms that grow in an aquatic environment (Jones et al. 2012). They are floras that grow in the presence of standing water that is at or above the soil's surface. Different water bodies and culture systems are examples of standing water. Plants having photosynthetic components that are always or occasionally underwater or detached in water and evident to the naked eye are known as macrophytes (Cook 1990). Macrophytes are significant parts of the brook environment since they boost the structure of habitats and increase biodiversity (Wetzel 2001; Pelicice et al. 2008). Furthermore, both animate and inanimate aquatic macrophytes can serve as food sources for other creatures (Lopes et al. 2007). They are important in the hydro-environment because they provide a spawning substratum for species such as fin fish, insects, and plankton, and they also help as fish diet (Ratusshnyale 2008). Excessive macrophyte growth might have detrimental consequences in most rivers and lakes (Bini et al. 2005).

Many individuals are unaware of the relevance of macrophytes in our aquatic environment. Macrophytes have an important function in water bodies and pastoral populations. Sadly, minute attention is given to their conservation. Aquatic macrophytes have not been given attention, and this is regrettable as fluctuations in macrophyte assemblage could be particularly predictive key urban stress classes. Water quality is thought to be influenced by the health and structure of macrophyte populations (Suren 2000; Balanson et al. 2005).

Despite the current focus on fisheries research and development in Nigerian waters, little attention has been paid to the non-fish resources that go with them (aquatic macrophytes). Aquatic plants, particularly in freshwater ecology, have a scarcity of information. The current trend of fully destroying these resources without first gaining a thorough understanding of their ecology, population dynamics, and socioeconomic significance could signal doom for other aquatic resources that rely on them. They offer recreational and medical value in a well-balanced environment. However, with a case study of the Niger Delta region and knowledge of the ecological characteristics and possible uses of these resources, better management, protection, and conservation of aquatic macrophytes in Nigerian water bodies would be required (Ita et al. 1985). This article looks at the ecology, species, distribution, and abundance of macrophytes in the Niger Delta region, Nigeria.

3.2 Macrophyte Taxonomy Groups

Macrophytes are a wide range collecion of taxonomic groups that come in a variety of forms and dimensions, in a particular, totally submerged, and others drift on the water's surface. Despite the fact that they are vital to our aquatic ecology, many still don't value them. The location of the plant in relation to the surface and substrate. Macrophytes are frequently divided into four categories: floating unattached, floating attached, submerged, and emergent (Puijalon et al. 2008). Aquatic macrophytes are aesthetically beautiful and environmentally beneficial when used in moderation. They are described as essential components of a river's aging process. Though they can be found in deep, clean lakes and rivers, their presence is not guaranteed. An abundance of aquatic macrophytes represents a sign of "middle" or "old" age. In large quantities, they can interfere positively or negatively with some water uses (Okaeme et al. 1999) (Fig. 3.1) (Table 3.1).

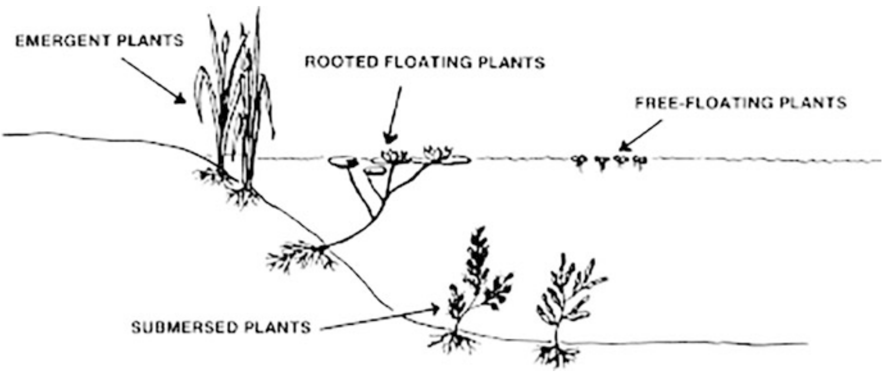

Fig. 3.1 Macrophyte categories based on their habitat of growth (Davidson et al. 2005)

Table 3.1 Taxonomy and zonation of aquatic flora in Niger Delta

Family	Species	Common name	Emergent	Floating
Araceae	*Pistia stratiotes*	Water lettuce	+	
	Lemna minor	Duckweed	+	
Asteraceae	*Aspilia africana*	Wild sunflower	+	
Athyriaceae	*Diplazium sammatti*		+	
Commelinaceae	*Aneilema beniniense*	Aneilema	+	
Cyperaceae	*Cyperus difformis*	Small flower umbrella	+	+
	Rhynchospora corymbosa	Matamat	+	
	Cyperus iria	Rice flat sedge	+	
Lamiaceae	*Platostoma africanum*	Asirisiri	+	
Nymphaeaceae	*Nymphaea lotus*	Water lily	+	
Onagraceae	*Ludwigia decurrens*	Water primrose	+	
Poaceae	*Sacciolepis africana*	Wild rice	+	
Pontederiaceae	*Eichhornia crassipes*	Water hyacinth	+	
Tiliaceae	*Triumfetta cordifolia*	Burweed		

Source: Dienye (2015)

3.3 Ecological Functions of Aquatic Macrophytes

Various forms of aquatic ecosystems rely heavily on macrophyte plants. Aquatic macrophytes are present in a variety of aquatic habitats, and their occurrence is of benefit to fisheries and pastoralism in the basins. Macrophytes are important for not just the biological community but also the natural processes, which take place in the aquatic environment. There are benefits to macrophytes' performance in an aquatic ecological system. The commonly found macrophytes in the Niger delta region is shown in Plates 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12.

3.3.1 Fisheries Production

Aquatic plants are regarded as undervalued components of the aquatic ecosystem. It does, however, play an important part in the fishing industry. Herbivorous fishes like *Tilapia zillii*, locally farmed, rely on aquatic plants as a food source. Some fishes consume *Lemna paucicostata* species (Mbagwu and Adeniji 1988). According to known information, 37 freshwater herbivorous fish species feed on macrophytes and belong to 24 families (Opuszynski and Shireman 1995). More specifically, periphytic algae that grow on the surface of aquatic plants serve as food for some fish species. Oreochromis eats coarser things, such as macrophytes, than other members of the genus (Ezeri et al. 2003). Macrophytes have been shown to provide breeding sites and refuge for fish. Carnivorous fish fingerlings feed on aquatic plants till their intestines mature to take animals, according to Agbogidi et al. (2000).

3.3.2 Habitat for Water Organisms

Smaller animals use aquatic macrophytes as a home. These little animals play an important role in ecology because they feed fish. Studies have shown that vegetated regions harbor fewer organisms than non-vegetated ones (Agbogidi et al. 2000). Many fishes find shelter, spawning substrates, and nursery sites under the leaves of *Ceratophyllum demersum* and *Myriophyllum spicatum.* Aquatic macrophytes provide cover for juvenile fish from predatory fish, making them a vital nursery for baby fish (juveniles). Water lettuce provides a safe haven for fish and crustaceans from predatory fish (ICAAE 1992). *Heterotis niloticus* makes its nest out of aquatic macrophytes, but *Gymnarchus niloticus* spawns in stagnant waters containing macrophytes and then migrates to flowing waters (Meske 1985). Freshwater and marine plants have an impact on animal and aquatic organism communities through a series of habitat-related mechanisms, such as providing nurseries, dwelling spaces, and feeding areas (Hyndes et al. 2018).

3.3.3 Healthy Ecosystem/Nutrient Cycling

In the aquatic environment, some macrophytes perform a dynamic function in a healthy ecosystem that produces oxygen via photosynthesis and provide a substrate and cover for various species. They also help stabilize the sediments together. This helps increase water clarity and reduce the volume of pollution released into the environment through sediment erosion (Kumar et al. 2020).

Agbogidi et al. (2000) reported that the sewage is channeled through macrophytes in order to assimilate and decrease the nutrient concentrations prior to discharge inside the water body. Macrophytes are exploited in bio-manipulation to boost fish culture (Dar et al. 2011). They absorb large amounts of nutrients as a means of removing nutrients from effluent (Uka et al. 2009). Macrophytes are used in phytoremediation procedures of polluted water bodies and in engineered structures known as “constructed swamps” for the treatment and decontamination of wastes (Vymazal 2013). They are also an indicator of water quality by absorbing excess nutrients (Petre 1990).

3.3.4 Source of Alternative Medicine

Traditional communities also use a variety of macrophytes in healing therapy. As a result, a significant portion of these ethnobotanical materials may yield molecules that could be employed as modern medicine and pharmaceuticals (Olayide 1981). *Polygonum senegalense* is mashed with soda ash and used for rheumatoid arthritis, according to Kio and Ola-Adams (1987). Water lettuce is also employed for treating “flu,” according to Obot and Ayeni et al. (1999). According to Bubayero (1986), most Nigerians patronize traditional healers. Most of these macrophytes produce chemicals that are extremely promising for application in current medications and pharmaceuticals. The species fever in youngsters and is used as a dewormer and eye ointments. It's regularly used with clay in Ghana to prevent abortion. The root of *Ethulia conyzoides* is used to relieve constipation when blended with red pepper.

3.3.5 Industrial Uses

Aquatic macrophytes variety of resources that could be beneficial in industries, construction, matting, bedding, and pulp or paper. In Northern Nigeria, the dry root of *C. maculatus* is used for perfume, and the ripe silky inflorescences of *T. australis* are utilized in padding pillows (Ita 1993). The leaves of *C. asticulatus* have mosquito resistance, and their stems are utilized in multicolored mats (Kio and Ola-Adams 1990). *Vossia cuspidata*, *Cyperus papyrus*, and *Eichornia crassipes* have monetary value for pulp, paper, and fiber. *Raphia vinifera* is used as a raw material for brushes, brooms, and mats (Okojie 1995).

3.3.6 Sources of Energy

Aquatic flora as a source of energy, according to, Edewor (1998), is primarily used as a fuel for fish smoking and residential energy. Aquatic floras can become liquid, gaseous, or stable fuels through bio-methanation, fermentation, and pyrolysis, in line with reviews from different growing countries. *Eichornia crassipes* is digested without delay in China and India to make biogas, which is used to generate electricity to rural regions at a low cost. Stems of *Aeschynomene crassicaulis* and *Cyperus papyrus* are used as fuel for domestic cooking and fish smoking (Kio and Ola-Adams 1987).

3.4 Aquatic Macrophytes as Nuisance

Macrophytes produce an explosively excessive population, when the environment changes as a result of pollution. Aquatic macrophytes play an essential function in maintaining the richness and role of the aquatic environment. Several of these macrophytes can be unsafe when in abundance. When non-native species are purposely or by accident brought into places where they have no natural enemies to limit their growth, they are able to produce massive, uncontrollable populations. Plants developing in an aquatic environment can become dense (Chambers et al. 2008). The nuisance macrophytes cause:

3.4.1 Effect on Water Body

A floating mat of macrophyte vegetation can hinder sunlight from reaching the surface of water, which results in low natural food, eventually affecting fish production. The bloom of macrophyte vegetation causes enormous fish mortality due to the excessive oxygen requirement and contest for available nutrients. These invasive aquatic macrophytes have a negative effect on water condition and biodiversity (Uka et al. 2009). Submerged macrophytes degrade breeding grounds (particularly almonds). Dense macrophytes can cause a huge variation in oxygen, putting several fish species at risk. Similarly, when photosynthesis is lower than respiration, fish death may occur.

3.4.2 Hindrance to Navigation

Towering macrophytes above and submerged in water prevent entry, impede navigation, and damage hydroelectric infrastructure, and floating mats obstruct watercraft transportation routes. The lifestyle of a floating mat makes the aquatic surrounding insecure due to the hazard of craft, the penetration of massive predatory aquatic animals, and additional mechanical problems. It additionally has an effect on fish nets within the surrounding. Macrophytes halt boats through the means of winding round their propellers. Macrophyte mats, inclusive of water hyacinth, may even block a ship (Mandal 2007).

3.4.3 Habitat for Spread of Diseases

While certain aquatic macrophytes prevent disease-supporting organisms, others create the best surroundings for them. Most individual ailments are spread through transitional hosts, which are reliant on certain macrophytes for completion of their cycle. Blocked waterways as a result of floral vegetation or infestation of *Pistia stratiotes* harbor *schistosomiasis* (African sleeping sickness). An aquatic snail that dwells among flora serves as the intermediate host. Anything that brings this deoxygenated water to the surface (such as high wind) reduces the oxygen level in the water column, resulting in fish fatalities. As a result of this, even if the fish does not die, continuous low oxygen levels weaken the fish, and it grows to be extra susceptible to illnesses. The tranquil aquatic surrounding that macrophyte growth can create is optimal for mosquito larvae development (Bromilow 2010).

3.5 Interaction Between Macrophytes and Environmental Variables

This interplay is a considerable function of the aquatic surrounding that is vital for aquatic movement and ecological function (Xia et al. 2010). Though increase and spread are regular occurrences in water bodies, actions like agriculture, building, and development initiatives have increased concern about aquatic macrophytes and water quality in recent years (Wang et al. 2009). According to Dienye et al. (2017), the interplay confirmed that as pH and dissolved oxygen decreased through the wet season, the extent of macrophyte abundance increased while salinity increased. Dense macrophytes were slightly influenced by salinity in the Niger Delta vicinity. As the temperature rises, fewer species become abundant, while macrophytes in the vicinity decline in abundance. Chemical oxygen demand was negatively correlated with all species, and biological oxygen demand was positively correlated with all species of macrophytes. BOD increases due to dead organic matter, which supports macrophyte abundance. Therefore, pH, dissolved oxygen, and chemical oxygen demand affect the distribution and abundance in the region.

3.5.1 Methods of Managing Macrophytes

The number one goal of coping with flora in the Niger Delta is to create a balance in the ecological system through monitoring the intense invasion of various macrophyte species. The ways of controlling aquatic macrophytes include:

3.5.2 Precautionary Control

There are special ways by which macrophytes get into our waters: fishermen's nets, boats, ballast waters, wind, birds, and more. However, precautionary measures begin with either reduction or total eradication of the sources. Plants should never be rinsed into aquatic surrounding wherever they can develop and regrow.

3.5.3 Machine-Driven Control

It involves uprooting or raking the macrophytes out of the soil. Some aquatic floras are recurrent and possess roots that could resprout, and harvesting growth beneath is vital for efficient management. Mechanical weed harvesters with submerged blades are beneficial for larger bodies of water, according to McComas (1993). The principle of the operation these harvesters used is like that of lawn mowing. The macrophytes will not be eliminated but cannot get to the surface and cause problems. Crop the harvested flora and discard it appropriately, so it won't be re-introduced into the water while mechanically regulating the aquatic macrophytes. If left to float in a body of water, the harvested flora fragments can sprout new ones.

3.5.4 Biological Control

For biological management, lots of strange and natural organisms have been used. Beneficial organisms are used to prevent the spread of macrophytes in this approach. People could also rely on introducing animal or microbe that can feed on poisonous floras. Nevertheless, when the incorrect type of management is implemented, this process could have terrible effect for the environment (Gallagher and Haller 1990). Biological control measures are:

3.5.4.1 Water Plants (Macrophytes)

Introduction of certain desirable aquatic flora has the capacity to eradicate aquatic nuisance species. Native macrophytes, on the alternative, are generally desirable since they have more control with the surrounding ecosystem. Invasive species can effortlessly displace desirable macrophytes, and this approach can be tough, but when the invasive plants are eliminated, this method works well.

3.5.4.2 Herbivorous Fish Species

Herbivores can help to keep aquatic flora abundance under check; to help decrease aquatic flora, grass carp is adopted. They've been advanced genetically to stop breeding to consume the flora. When the surroundings are advantageous, the Chinese grass carp (*Ctenopharyngodon idella*) will eat up aquatic macrophytes, and this is temperature dependent. Their activities have minute result below 16 °C but attain a peak at 25 °C. Grass carp are choosy eaters, desiring soft flora over fibrous ones (Wells and Clayton 2005).

3.5.4.3 Microorganisms (Bacteria)

Bacteria and fungus are also used to regulate macrophyte richness. Those that live on different floras can be exploited to control the flora selectively. These macrophytes die due to contamination when the microorganisms are introduced, while the more needed plants will be spared.

3.5.5 Chemical Control

When rightly applied, herbicides overpower aquatic macrophyte plants without inflicting damage to fish or wildlife. In few instances, herbicides can be employed to manage definite floral species while sparing others. It can function as part of an aquatic plant control approach when treating few vegetative areas leaving others untreated. "Contact herbicides" kill the contact plant part. Translocated herbicides do no longer kill plant as swiftly but alternatively enter the plant itself. Generally, only the latter groups are efficient for decreasing perennial floral regrowth. They are separated as selective (killing definite plants) and non-selective (killing all plants).

Herbicide remedy can be expensive and may only afford temporary result from the fundamental problem, which is habitually enriched waterways. One should also note that when pesticides destroy aquatic flora, they decompose and discharge their stored nutrients into the aquatic surrounding, and it encourages successive growth of aquatic plants, which repeatedly necessitates additional medications. The following are examples of treatment:

3.5.6 Diquat Herbicide

This is a contact herbicide that is principally active at managing aquatic weeds and algae in a short period of time, and it's normally sprayed on aquatic plants. This treatment will make the treated flora to quickly die and turn brown. REWARD is a standard diquat herbicide logo that works effectively on floating macrophytes and is absolutely safe to use. When the water is muddy, diquat herbicide should no longer be used as soil debris absorb it in the water (Netherland et al. 1997).

3.5.7 Fluridone Herbicide

The herbicide fluid-like non-touch herbicide that is more gradual in method than diquat. Fluridone principally controls submerged flora, and its brand tag is SONAR. It works for 30–90 days. When it is applied, it demonstrates signs for 1–2 weeks. The plants lose its green color and change to white.

3.5.8 Glyphosate

Glyphosate is available only as liquid and it controls plants above water. It is not effective for submerged plants. AquaMaster, AquaPro and Rodeo are trade names. It is prohibited to use glyphosate chemicals not explicitly branded for aquatic use (Getsinger 1998).

3.6 Commonly Found Macrophytes in the Niger Delta Region, Nigeria

Plates 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, and 3.12

3.7 Conclusion and Recommendations

In spite of the opinion about aquatic plants causing a nuisance to the surrounding, they can be ecologically welcoming, when combined with mechanical method of control, which permits riparian communities to sustain dependable but long-term aquatic flora control at a reduced cost and with added economic benefits. Industrial activities in the Niger Delta vicinity should be thoroughly monitored since they have an effect on macrophytes, which are important for fish production. They offer substrates, food, and habitat for aquatic animals, in addition to enhanced habitat physical structure and biological complexity, which increases biodiversity in water bodies. The plants can only be managed and kept within tolerable limits if they are controlled properly, with some used on a long-term basis. Aquatic macrophyte utilization can only be successful on a long-term basis if their habitat is correctly

Plate 3.1 *Cyperus difformis* spp. (Source: Dienye 2014)

Plate 3.2 *Nymphaea lotus* spp. (Source: Dienye 2014)

handled, and this necessitates preservation of the environment. Management initiatives, on the other hand, should create awareness among the local populace. A thorough assessment of the nature, scope, and potential of aquatic macrophyte problems is required before implementing control measures.

Plate 3.3 *Sacciolepis africana* spp. (Source: (Dienye 2014)

Plate 3.4 *Rhynchospora corymbosa* spp. (Source: Dienye 2014)

Plate 3.5 *Aneilema beniniense* spp. (Source: Dienye 2014)

Plate 3.6 *Cyperus iria* spp. (Source: Dienye 2014)

Plate 3.7 *Platostoma africanum* spp. (Source: Dienye 2014)

Plate 3.8 *Aspilia africana* spp. (Source: Dienye 2014)

Plate 3.9 *Triumfetta cordifolia* spp. (Source: Dienye 2014)

Plate 3.10 *Eichhornia crassipes* spp. (Source: Dienye 2014)

Plate 3.11 *Ludwigia decurrens* spp. (Source: Dienye 2014)

Plate 3.12 *Diplazium sammatti* spp. (Source: Dienye 2014)

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