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Original Research Article

Evaluation of the Diversity and Influence of Non-native (invasive) Plants on the Metropolitan areas of Akwa Ibom State, Nigeria

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Human activity and globalization have increased over the last few decades, consequently, the introduction and spread of species from one place to another has also increased. Emerging species have greatly influenced our environment as well as native species. This study aims at evaluating plant characteristics of non-native species that makes them invasive, it reveals new invasive species and elucidates the hazards imposed on human health and economic loss in the metropolitan areas of Akwa Ibom State. This research also aims at making special mention of *Hydrangea* species – a new invading species as well as other plants that pose environmental problems in this area. This study was conducted in three metropolitan areas of Akwa Ibom State between June 2013 and January 2015. These areas are characterized by diverse plant types, biologically stressed conditions and polluted sites. However, wide portions of land often utilized for agricultural purposes have been affected as a result of industrialization and life developments that have brought about the introduction of new species mainly for ornamental purposes. Three areas were studied (based on their high degree of human activity). Species at these sites were identified; plant characteristics were investigated in relation to the prevailing conditions. Influences of species identified to be non-native were investigated in relation to the natives; this was in order to ascertain which species were invasive. Photographs were taken. This study, therefore, evaluated the potential hazards of these species on human health, agriculture and economic loss and therefore proffers possible solutions and appropriate recommendations made.

Keywords: Non-native, Invasive, Hydrangea species, Native, Environmental problems.

INTRODUCTION

Non-native species are those present in a specified region only as a direct or indirect result of human activity. Other terms that are often used as synonyms for non-native include alien, exotic, introduced, adventives, acclimatized immigrant, non-indigenous, and non-aboriginal (Morse *et al*., 2004). Non-native species, maintaining themselves outside of cultivation or other human care may be considered naturalized (Randall and Hoshovsky, 2000). A recent study indicates that not all non-native species exhibit detrimental impacts on the invaded ecosystem. In some instances, the potential for being beneficial or detrimental in the long run remains unknown (Sax and Gaines, 2008). An invasive species is therefore defined as one whose migration and subsequent growth and spread have detrimental effects on the native biota in its new range (Mack, 1996). Some scientists define it as those introduced species that spread widely or quickly and cause harm to the environment. Such species are introduced either deliberately or accidentally. Deliberate introductions include species used for food and other products (crops, aquaculture, timber, fur), as games, for ornamental purposes (private collections), as garden plants, or for biological control. Accidental introductions have arrived in cargoes or have been otherwise carried on ships, airplanes or other vessels (Manchester and Bullock 2000).

Non-native plants have been reported to become aggressive invaders outside their home ranges for a number of reasons, including release from native, specialized antagonists (Mitchell and Power, 2003), higher relative performance in a new site (Simberloff, 2001), direct chemical (allelopathic) interference with native plant performance (Callaway and Ridenour, 2004), and variability in the responses and resistance of native systems to invasion (Levine and

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D'Anthonio, 1999). Many invasive species are not dominant competitors in their natural systems, but competitively eradicate their new neighbors (Callaway and Aschehoug, 2000). Virtually all countries in Africa are affected by invasive species. In 2004, the International Union for Conservation of Nature – world conservation identified 81 of these species in South Africa, 49 in Mauritius, 44 in Swaziland, 37 in Kenya, 28 in Egypt, 26 in Ghana and Zimbabwe, and 22 in Ethiopia (IUCN/SSC/ISSG, 2004). In Nigeria there are very scarce reports and literatures concerning the quantification of non-native species, yet great ecological impacts are emerging in the country which has significantly affected the agricultural and economic sector of Nigeria as well as human health.

Invasive plants have attracted much attention because of their economic costs as weeds and because they may reduce native biodiversity (Daehler and Strong, 1994, Wilcove *et al*., 1998) or alter ecosystem functions (D 'Antonio and Vitousek, 1992). Invasive plants also threaten the effectiveness of agricultural and natural systems throughout the world. Because only a small fraction of introduced species become invasive (Williamson, 1996), and many invasive species can be considered pests, much effort have been focused on understanding what makes some species invasive (Kolar and Lodge, 2001, Rejmainek *et al*., 2003). Research in the past decade improved our knowledge of the patterns of invasion and substantial progress in understanding the mechanisms of invasion has been achieved (Rejmanek *et al*., 2005). Ecologists, conservation biologists and managers widely believe that invasions by non-native species are a leading cause of recent species extinctions (Gurevitch and Padilla, 2004; Ricciardi, 2004).

The success and impacts of invasive species depend on their biological attributes, the environmental characteristics of the invaded ecosystem and the biotic interactions with the receptive community (Vila` and Weiner, 2004). Understanding which environmental factors and plant traits contribute to the success of invasive species is important to management efforts aimed at preventing and controlling their spread (Pattison et al., 1998). Factors thought to render habitats invisible include low intensities of competition, altered disturbance regimes and low levels of environmental stress, especially the high resource availability, (Alpert *et al*., 2000). The initial entry of non-native species into Nigeria was mainly through the introduction for forest tree plantations or for ornamental purposes, this took place during the post-independence era and is now increasing as the economic activities in the country increases. Today, many of these introduced species have become invasive, resulting in the loss of our medicinal and economic crops. This study aims at evaluating plant characteristics of non-native species that makes them invasive, it reveals new invasive species and elucidates the hazards imposed on human health, agriculture and economic loss in the metropolitan areas of Akwa Ibom State.

Materials and Methods

Akwa Ibom is a state in Nigeria named after Qua Iboe River. It is located in the coastal South-south part of Nigeria lying between latitudes 40321 and 50331 North and Longitudes 70251 and 80251 east. It covers an area of 8412.00Sq Kilometres. This study was conducted in three metropolitan areas of Akwa Ibom State between June 2013 and January, 2015. These areas are characterized by diverse plant types, biologically stressed conditions and polluted sites. However, wide portions of land often utilized for agricultural purposes have been affected as a result of industrialization and life developments that have brought about the introduction of new species mainly for ornamental purposes. Three areas were studied: Uyo, Eket and Ikot Ekpene (based on their high degree of human activity). Species at these sites were identified; plant characteristics were investigated in relation to the prevailing conditions. Influences of species identified to be non-native were investigated in relation to the natives; this was in order to ascertain which species were invasive. Photographs were taken.

Results

Hydrangea species

This plant was observed to occur mostly in large colonies and occupied highly disturbed sites. The plant has been reported as native to Southern and Eastern Asia (China, Japan, Korea, Himalayas and Indonesia). Accidentally introduced first as an ornamental, now welcomed as a snake repellant. It was observed that two of the three cities studied (Eket and Uyo). The plant was dominant at four locations (Plates 1a-d), where they were observed to displace previously growing plants at the location due to their better competitive ability and ability to withstand high disturbance by pollutants. It was also found growing in disturbed residential area (Plate1e). At another site it was persisting after several eradication attempts (Plate1f).

Allamanda cathartica

This is a shrub of the family *Apocynaceae*. It was observed to have invaded a wide area in this region and constitute a major nuisance to agricultural land. This plant was also observed to grow in colonies, rarely occur singly and it was noted to grow rapidly occupying large portions of land. It is widespread in Akwa Ibom and was noted at all three study cities (Eket, Uyo, Ikot Ekpene).

Bambusa vulgaris

This plant was identified as a member of the family *Poaceae*, However, it was observed to easily invade farmlands (Plate 3a) and defiled diverse eradication techniques carried out by farm owners (Plate 3b). It is reported to be native of South China and has spread throughout East Asia. This plant is naturalized in Nigeria. It was noted at all study Locations (Eket, Uyo and Ikot Ekpene). Its characteristic high growth rate and ability to form a thick canopy (Plate 3c) has affected under storey plants, also its root system disrupts the growth of other plants.

Chromolaena odorata (Syn.*Eupatorum odoratum*)

Native of North America (Florida, Texas, Mexico, Caribbean). It has been reported that this plant was accidentally introduced to Nigeria with forestry seeds and it contains carcinogenic pyrrolizidine alkaloid which is toxic to cattle (Uyi et al., 2014). It has invaded agricultural land and is now naturalized in Nigeria. This plant was observed to affect native species diversity at the sites studied (Plate 4a &b). It was abundantly present at all study Locations.

Plate 1a: ***Hydrangea spp*** at the first site

Plate 1b: ***Hydrangea spp*** blooming at the second site

Plate 1c: ***Hydrangea spp*** at the third site

Plate 1d: ***Hydrangea spp*** at the fourth site; this was the most disturbed site of all.

Plate 1e: ***Hydrangea spp*** growing near residential area surrounded by pollutants

Plate 1f: ***Hydrangea spp*** still growing in a farmland after several eradication attempts

Plate 2a: ***Allamanda. cathartica*** dominating a farmland

Plate 2b: ***A. cathartica*** on a farmland near residential area with no coexisting crop

Plate 3a: ***Bambusa vulgaris*** on a farmland

Plate 3b: Young ***B. vulgaris*** on a farm after several clearing attempts

Plate 3c:***B. vulgaris*** forming thick canopy structure on an agricultural land

Plate 4a: *Chromolaena odorata* outgrowing other species

Plate 4b: *C. odorata* forming a thick cover of biomass thus displacing other crops.

Canna indica: This plant is commonly known as Canna lily, Achira or Indian shot. It is native of Southeastern United States (Florida, Texas, Louisiana, South Carolina) Mexico, Central America, and West Indies. It was introduced to Nigeria as an ornamental plant, while that has been achieved; this plant has escaped into the environment and has caused diverse ecological problems. It grows very fast and spreads widely (Plates 5c &d). It was present at all the study cities and dominated even highly disturbed sites (Plates 5a & b).

Plate 5a: ***Canna indica*** growing near gutters

Plate 5b: ***Canna indica*** in a disturbed site

Plate 5c: ***C. indica*** growing in large colony on a farmland

Commelina diffusa

Commonly known as spreading day flower, an herbaceous plant is a native of Asia. This plant is widespread on farmland and has a high competitive influence on crops. Weeding of this plant has proved abortive in eradication attempt as the nodes on the creeping stem still germinate in days. It is not affected by season and so has become a nuisance to agricultural land (Plates 6a &b)

Plate 6a & b: Thick ground cover of ***Commelina diffusa*** on a farmland

Plate 6c: *Large cover of* ***C. diffusa*** *in a disturbed site (near gutter)*

Alternanthera brasiliana

This is a Brazilian perennial herb that has extended throughout the tropical Americas and Asia. A noxious weed of many agricultural crops. It was noted as an invasive weed that could out compete and degraded native habitat on the locations studied. However, it is reported to produce allelopathic compounds that injure other plant, including crops (Tanveer et al., 2013).

Plate 7a& b: ***Alternanthera brasiliana*** invading farmlands and degrading native plant habitats

Arum italicum

This is an herbaceous perennial plant in the family Araceae with a wide species range including the Mediterranean region (Southern Europe, Northern Africa and Middle East), Great Britain, Netherlands, Crimea, and the Azores. It is native of Italy and is also naturalized in Argentina and United States. It is cultivated as an ornamental plant (Plate 8a) for traditional gardens, but was noted to have escaped into the environment, creeping along gutters (Plate 8b), by the roadsides and in polluted sites (Plate 8c), on farmland (Plate 8d). It was prominent in two of the three studied cities (Eket and Uyo).

Plate 8a: *Arum italicum* as an ornamental growing

Plate 8b: *A. italicumin* escaped state near gutter

Plate 8c: *A. italicum* in a disturbed site.

Plate 8d: *A. italicum* forming understorey cover in a farmland

Arundo donax

This is a prominent plant of the grass family recognized as a resemblance of bamboo or sugar cane. This plant was observed to grow under multiple conditions; on damped soil, beside gutters, on plain farmland and on highly polluted site. It blooms within a short period of time and could colonize the sites they were found. They reproduced both vegetatively; by its node underground rhizome and rarely by seeds. They grow very tall, up to 8m.

Plate 9a&b: *Arundo donax* dominating heavily polluted and disturbed sites

Plate 9c: ***Arundo donax*** invading and dominating a farmland

Table 1: Summary for species studied showing their family, origin and degree of invasiveness.

Species Studied	Family	Origin (community)	Degree of invasiveness
Hydrangea species	Hydrangeaceae	Southern and Eastern Asia	++
Allamanda cathartica	Apocynaceae	Tropical South America	+++
Bambusa vulgaris	Poaceae	South China	+++
Chromolaena odoratum	Asteraceae	North America	+++
Canna indica	Cannaceae	Southeastern United states	++
Commelina diffusa	Commelinaceae	Asia	+++
Althernanthera brasiliana	Amaranthaceae	Brazil	++
Arum italicum	Araceae	Italy/Great Britain	++
Arundo donax	Poaceae	Asia	+++

Keys: + = Rarely Invasive
++ = Moderately Invasive
+++= Very Invasive

Discussion

The effects of these species to the native biota and agricultural system of Akwa Ibom cannot be overemphasized. The formation of thick vegetation cover and the difficulty experienced in the removal of these plants (such as *Allamanda cathartica, Hydrangea* species, *Bambusa vulgaris*, etc) has resulted in the increasing breeding of disease causing organisms in the environment which are harmful to human health. Also, the characteristic covering of the ground storey by some of these invasives (*Arum italicum, Commelina diffusa, Alternanthera braziliana, Chromolaena odorata*, etc.) has greatly affected agriculture and crops; it has led to a drastic reduction in the production of food and cash crops.

The characteristic repellent odor of *Hydrangea* species is a suspected cause of the displacement of other plant species in its area of invasion. This is because it could contain several compounds that exhibit allelopathic influence on other plants as supported by some studies (Overcast and Cox, 2001). Alternanthera brasiliana is also reported to also exhibit this allelopathic effect and its high growth rate as well as competition with farm crops can affect production significantly.

Also, the aggressive root system and a thick canopy of *Bambusa vulgaris* were capable of causing damage to the species found on farmland. Also, the high rate of growth and spread of Chromolaena odorata has caused a reduction in the survival and yield of crops due to competition. However, the fast rate of growth and the ability to occupy a wide area of land by *Arundo donax* is recognized as the major cause of species displacement at the sites of invasion.These characteristics can be predicted to result in the native species endangerment and if not controlled may result in extinction.

From this study, we found that as invasive species increased in abundance on invaded sites, the diversity of other species decreased. This could lead to the alteration of the community structure and biodiversity. It was also found that these invasive grow mostly in colonies even on highly polluted sites and were highly competitive on farmland where they occur as weeds. Thus, it can be said that these species have better ability to utilize resources for survival than native species.

Moreover, since most of these species (*Bambusa vulgaris*, *Chromolaena odorata, Canna indica, Commelina diffusa*,etc) have a wide native range, they are mostly resistant to the pest and diseases that attacked crops on such sites, therefore they had better advantage over the previously occurring species. In general, there are scarce explanations to the mechanism backing the influence of invasive species on the environment. However, for some species (*Hydrangea species, Canna indica, Allamanda cathartica, Arundo donax, Arum italicum*), colonization is possibly facilitated by the high rate of anthropogenic disturbance on their sites of invasion as supported by some studies (Riley et al., 2003).

Conclusion

The intent of humans to introduce species as a means of incurring some benefits has been realized, while this has resulted in huge costs particularly when non-native species have become invasive. However, it can be said that the rate of invasion on these locations has been as a result of their best advantage over natives (i.e. species characteristics) to adapt to adverse environmental changes, ecosystem disturbance and also as a result of the absence of the natural predators (i.e. Pest and diseases). Here, we have shown that a number of invasive species can affect native plant communities, human health and agriculture and have favored economic loss significantly. This research will help in the quantification of the detrimental impacts of invasive species locally and regionally.

Recommendations

From the above study, the following are recommended:

- Adequate educational programs should be put in place in order to enlighten indigenes of Akwa Ibom state about the ecological problems caused by invasive species in order to reduce their introduction and spread as this would consequentially help in conserving native species as well as agricultural land for the purpose of food production, economic growth and general enhancement of livelihood.
- Although it has been known that the success of natives is now precluded by invasive species, eradication programs should considerspecies that are introduced for genetic conservation by conserving them under conditions that prevents escape.
- Efforts should be geared towards achieving an effective quarantine.
- A technical committee that will help identify these invasive plants within each community should be set up.
- Intensive and regular monitoring of non-native species in their respective ecosystems along with Government policies should be strong.

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