



Invasive Plants of West Africa: Concepts, Overviews and Sustainable Management

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Abstract

Invasive species are considered as one of the most environmental challenges of the 21st century. They constitute the second cause of biodiversity loss and lead to high economic disruption and public health. Despite significant, financial and human investments made by countries and world conservation of biodiversity agencies, there are not strategies that lead to appropriate measures for sustainable management and control. The objective of this study is to assess the state of knowledge on invasive plants in West Africa and to promote knowledge and exchange information. It contributes also to establish in Western African region, a coordinated early warning system through a network of intervention. The paper discusses concepts and bio-ecology of invasive plants, gives precise indications on their diversity and distribution. To achieve the objectives, a literature review was carried out to collect data on invasive species from Western African countries. Therefore, different information sources included floras, database and collection were consulted.

The results show that in West Africa, the information collected on invasive plants indicate that 113 invasive species are reported, distributed in 94 genera and 43 families. The most represented families are Poaceae (17 species) and Leguminosae (16 species). They are followed by Cyperaceae (9 species) and Asteraceae (6 species). Euphorbiaceae, Solanaceae and Nymphaeaceae have 4 species each one. The most common invasive species in West African countries are present in, at least, eight countries. They are: *Chromolaena odorata*, *Eichhornia crassipes*, *Salvinia molesta*, *Typha domingensis* and *Pistia stratiotes*. Depending on data availability, the presence and importance of invasive plants vary from one country to another. It must be noticed that there are few data related to Cape Verde, Guinea Bissau and Nigeria.

Recommendations were formulated to improve knowledge and sustainable management of invasive plants in West Africa. The expected results of this work should improve the understanding of issues related to invasive species at national and regional levels.

Keywords: Invasive plants; Diversity; Distribution; Sustainable management; West Africa

Introduction

Invasive species are recognized as one of the main causes of erosion of global biodiversity [1]. They represent one of the major environmental challenges of the 21st century and the second cause of biodiversity loss, just after habitat destruction [2]. The importance and scope of the problem made are increasingly studied worldwide. This has led to the convention on Biological Diversity to include the issue of invasive plants among its main sectorial themes with a strong objective of prevention and management of their introduction as well as their propagation.

Many countries have studied the problem and found no ideal solution. Indeed, when invasive species are already well established in the environment, the control becomes nearly impossible and requires considerable financial and human investments. Moreover, the most effective strategies currently proposed are to set management priorities on ordering the danger of exotic species present in the area, and on assessing the impact of risks on ecosystems [3]. Thus, there are several actions, plans, strategies or methods of management and control for decreasing the major impact of this phenomenon which is relatively new for some authors and just a natural phenomenon for others in the geological time scale.

In fact, man directly interferes with this process by introducing intentionally or not allochthonous [4] or by changing habitats, thereby promoting invasive events. But the problem of invasive plants is not only environmental. It also has unsuspected social and economic

backgrounds because many invasive plants are sold in trade for decorative purposes.

Beyond the loss of biodiversity, the installation of these species induces strong economic dislocation in practice or local activities as well as problems related to public health for some of them. Faced with these major problems that invasive species set around the world and especially in West African countries, an awareness of this phenomenon has started in all countries and international organizations of biodiversity conservation. It is important today to wonder about the nature of the problem and its understanding to envisage the most appropriate measures for control and management.

The objective of this work is to assess the state of knowledge on invasive plants in West Africa. It aims to promote knowledge and to exchange information to establish early and coordinated warnings through a network of intervention in West African region.

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It discusses; concepts of invasive plants biology, bio-ecology, the mode of introduction and the strategies and means of control and current situation in West Africa and at least, formulates suggestions and recommendations.

Materials and Methods

Information comes mainly from references

- 1.1. Floras [5-8],
- 1.2. Scientific articles and reports,
- 1.3. Herbaria: Herbarium IFAN and Herbarium DAKAR and
- 1.4. GBIF databases.

This work is to gather information on invasive species in different West African countries. Lists have been established specifying the scientific names of species, their ecology and the countries where they are registered as invasive plants. A distribution map of all species was developed.

Results and Discussion

Definitions and concepts on biological invasions

The definitions related to biological invasions are numerous and listed in many references. The great variability of expressions that result is partly due to the different actors involved and the multitude of perceptions [9]. However, some definitions are accepted as a consensus at the international level, such as those proposed by [10]. Two essential criteria are considered: origins and impacts of species [11].

Invasive species: An invasive species is an exotic (or alien) species whose introduction, deliberate or accidental by man, establishment and dissemination threaten ecosystems, habitats with negative consequences on ecosystem services and/or socio-economic and/or health (Figure 1) [12-15].

Strictly speaking, it would be more convenient to talk about invasive exotic populations and not of invasive exotic species. In this sense, "species" gathers all populations, those of the original area as well as those of the area of introduction [16]. Therefore, the definition could include the term "population" to replace the term "species". Moreover, all populations introduced with the same species are not likely to become invasive.

Native or indigenous species: A species is called native of a geographical entity for a period when it is represented with this entity

by populations considered as perennial in the beginning of this period. This species grows and lives naturally in the area without having been imported by man and his activities. It can also be characterized by having a distribution area that does not apparently depend on dispersion by man.

Allochthonous, exotic or exogenous species: A non-native species is one which, absent in a biogeographic entity has subsequently colonized this one by creating sustainable populations there. In other words, this species lives in an entity outside its natural range.

Introduced species: A species is called introduced when a non-native species is unintentionally or accidentally presents in a territory or part of territory where it was previously absent.

Naturalized species: A naturalized species is an introduced species into a host territory where the ecological conditions are favorable for its sustainable establishment. It multiplies regularly in its new geographical zone and remains in the long term.

As far as plants are concerned, [17] propose a definition close enough stating that these species can be maintained with or without direct intervention of man into natural, semi-natural or anthropogenic ecosystems. It is important to make this distinction. Beyond the underlying regulatory issues that arise during the implementation of management interventions, there are many interactions between native species. These interactions result from a long co-evolution process and these communities can be disrupted by the emergence of new species [18-20].

Ultimately, it can be assumed that a species is considered as invasive when allochthonous, its introduction into an ecosystem leads to its uncontrolled development and causes negative effects for the economy and/or the environment. However, native species can also become invasive.

Biology and ecology of invasive plants and the invasion process

There is no typical profile of the invasive plant. These invasive species or "invasive" may be herbs, vines, shrubs, trees and aquatic plants from different botanical families (including grasses, legumes, Compositae, Bignoniaceae, etc.), annual or perennial plants.

However, the ability of species to colonize an environment depends on complex relationships between the intrinsic capabilities of species, physicochemical environment and human activities (food, medicinal, ornamental etc.). The intrinsic capabilities of species are the ability to colonize the environment, to remain and to spread, the ability to grow and their covering power, the efficiency of photosynthesis and the importance of growth (large biomass) and to reproduce rapidly (generally vegetative), effective competition, production of allelopathic substance and the species' survival ability in adverse conditions.

Impacts and strategies for controlling

Impacts or nuisances: The deliberate introduction of new species is sometimes justified by what people can get from them (food value, ornamental, agricultural, hunting). Nevertheless, when these species become invasive, the nature and extent of the expected gains no longer outweigh the disadvantages resulting from their proliferation. All exotic species do not cause so important and considered consequences, such as significant changes in state/operating in ecosystems in which they settle. But apart from this, it is the source of very significant direct or indirect impacts observed at different levels. The impacts of invasive alien species can be grouped into four categories [21].

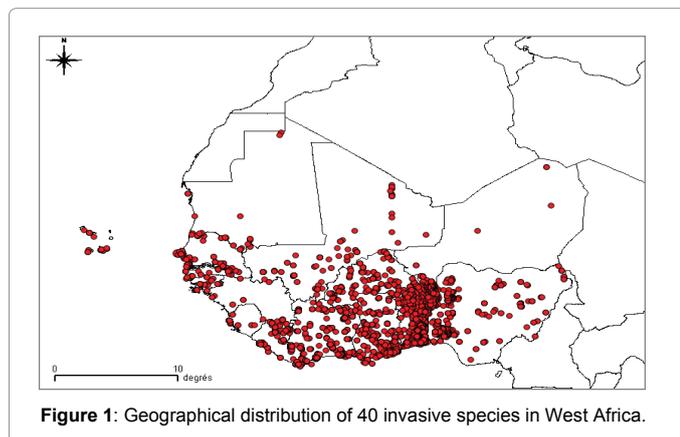


Figure 1: Geographical distribution of 40 invasive species in West Africa.

Impacts on biodiversity: Invasive Alien Species (IAS) are currently considered as the second leading cause of extinctions of documented species and the third threat coming for species at risk of extinction [22]. Invasive alien species can impact on the biodiversity at genetic, species and ecosystemic scales, but also on the community level, inducing effects on their structure and composition [23] by hybridization between an introduced species and native species *via* gene transfer, predation, competition, transmission of pathogens and parasites.

Impacts on the ecological functioning of ecosystems: It is a modification of the food chain, changes runoff and sedimentation, overdrive evaporation of surface water.

Impacts on human health and security: as disease vectors, or may cause skin burns.

Socio-economic impacts: Among these impacts we can quote: loss of production for some industries (down fisheries or aquaculture production) because of "aquatic weeds", loss due to the costs of prevention and fight against these invasive plants, a reduction in the availability and accessibility of water for industries, block vents pipes or vents exhaust or intake, a physical nuisance for fishing, an obstacle to navigation, a penetration in flooded rice fields.

Furthermore, it is important to emphasize that the immediate impact is to put into perspective the impact coming with the requirement of a medium to long-term management, which can be also called "deferred impacts".

Invasive plants often form dense canopies (herbaceous cover, cover creepers, thickets and forests known single species is to say composed of a single species) that smother native vegetation and remove native and endemic plants. They also affect the functioning of the ecosystem by promoting soil erosion, causing impoverishment and drying, increasing the risk of fires, decreasing the light that reaches the ground. Some species are harmful for crops, pasture, forest and fruit plantations and have a significant socioeconomic impact (referred as "pests" or "plant pests").

There are other species present only in our gardens and are known to be extremely invasive plants in other tropical islands or regions. These are potentially invasive plants, kinds of "time bombs" that should be eliminated quickly before they can expand. These plants called spontaneous should be paid a special attention.

Fight against invasive plants: To fight against an invasive species, it's important to know the biology, ecology and habitat and to set achievable goals on a small scale. In some cases, biological control is possible.

The fight against invasive species is most effective when it occurs early in the invasion. As long as a proliferation is limited, it is possible to envisage eradication. Eradication means the total elimination of the species in a given area. If an invasion has gained ground, the eradication would not be possible. Only the control of the species might be therefore considered. There are various ways of controlling invasive plants. The choice of methods to be used is to be determined in a diagnosis considering the history of the invasion, population flows, ecological, heritage interest, the use of the invaded area and management objectives. Thus, three main types of control are available: manual and mechanical control, chemical and biological control, or in some preferred situations, combinations of two or more of these techniques called "integrated control".

Manual and mechanical control: This type of control is concerned with terrestrial and aquatic species. It is based on pulling, mowing

and harvesting, stripping or wood cuts. The costs of this method are often very high but their effectiveness is total (removal of the species), provided that the transaction affects small populations at an early stage of invasion. If the invasion is too large, the goal is restricted to temporary limitation of nuisance caused by blooms. Fire can also be used separately or as a supplement to mechanical removal by tools and machines [24,25].

Chemical control: The use of herbicides for terrestrial and aquatic species, like mechanical control, has partial and temporary results. This technique is rather used with combination of other methods. Moreover, the impacts on biodiversity and the environment (soil residues and water) are not negligible. Plant hormones that can disrupt the growth, flowering and seed production are also used especially where herbicide use is prohibited. Local applications using manual sprays or mechanical sprayers can cover large areas with herbicide, while very large areas can be covered by aerial spraying with the small plane spraying crops provided the non-target plant species and waterways are avoided.

Biological control: Biological control (biocontrol) is by far the form of management of the invasion more sustainable and more profitable because, once established, it usually maintains its own population of biocontrol agents. Biocontrol principle is that invasive plants are often exotic and have been introduced into new areas and new ecosystems without their "natural enemies": herbivorous insects, plant parasites (fungi, bacteria, etc.), plant diseases, competing plants. It is then to control their populations in their home environment. Native enemies are selected in the original habitat of invasive plants and released into/on invasive plants to control the invasion of the plants characteristics. This removes the characteristics that allow the invasive alien plant to compete with native species and dominate them. This technique has proven itself in America and Africa, where it is considered the most effective.

Integrated control: The integrated control is used when one or the other technique does not reach some parts of invasion or when the methods are not effective everywhere or cannot physically reach all overgrown surfaces. All methods and invasive plant management or control programs must be followed to see their effectiveness and make the decision when they are effective, or continue to reduce efforts.

Ecological control: Natural or human disturbance of ecosystems favor the development of many invasive species. Stopping these disturbances and restoring the communities may be possible with relevant methods.

Current situation in West Africa

Distribution of invasive species in West Africa: Based on documents from the research work carried out in different countries of West Africa, information on invasive plants are collected. The compilation of these data leads to the establishment of a list of invasive plants from West Africa (Table 1). In the list are given: scientific names of invasive plants, their ecology, and the country in which they are registered as invasive species [1,26,27]. This list reflects the state of knowledge at a given time for each country. It appears from the analysis of the results of this Table 1 that a total of 113 invasive species have been identified in West Africa.

Importance of invasive species from one Western African country to another: There is little information on invasive plants in some countries such as Cape Verde, Guinea Bissau and Nigeria.

The exploitation of this table allowed us to obtain other information contained in Tables 2-4.

Families	Number of Genera	Number of Species
Poaceae	15	17
Fabaceae (Caesalpinioideae, Faboideae, Mimosoideae)	12	16
Cyperaceae	6	9
Asteraceae	6	6
Euphorbiaceae	4	4
Nymphaeaceae	2	4
Solanaceae	3	4
Araceae	3	3
Malvaceae	1	3
Scrophulariaceae	2	3
Verbenaceae	3	3
Amaranthaceae	2	2
Asclepiadaceae	2	2
Azolaceae (Fougère)	1	2
Convolvulaceae	1	2
Lamiaceae	2	2
Lythraceae	2	2
Onagraceae	1	2
Potamogetonaceae	1	2
Salviniaceae (Fern)	1	2
Alismataceae	1	1
Arecaceae	1	1
Bignoniaceae	1	1
Boraginaceae	1	1
Calophyllaceae	1	1
Ceratophyllaceae	1	1
Commelinaceae	1	1
Dipterocarpaceae	1	1
Hydrocharitaceae	1	1
Lauraceae	2	1
Meliaceae	1	1
Moraceae	1	1
Najaceae	1	1
Orobanchaceae	1	1
Phyllanthaceae	1	1
Pinaceae	1	1
Polygonaceae	1	1
Pontedariaceae	1	1
Portulacaceae	1	1
Turneraceae	1	1
Typhaceae	1	1
Urticaceae	1	1
Ulvaceae (ALGAE)	1	1
43	94	113

Table 3: Distribution of genera and species by family.

strictly aquatic species. It also appears that among these species which present more than 25% or common to 5 countries or more, aquatic and wetland species are more represented. These plants include *Eichhornia crassipes*, *Salvinia molesta*, *Pistia stratiotes*, *Typha domingensis*, *Azolla filiculoides*, *Mimosa pigra*, *Echinochloa colona* and *Lantana camara*. These observations could be explained by the fact that West Africa is crossed by a system of rivers (Senegal, The Gambia, Niger, Volta, Comoe) and the importance of its maritime coast stretching from Mauritania to Gulf of Guinea.

To these species can be added, the marine environment proliferation of macrophytes which are the main problems associated with eutrophication in the tropics, mainly in Africa, unlike in temperate areas where Cyanobacteria occupy a prominent place [28]. Also,

species of the genus *Sargassum*, *Enteromorpha* fail increasingly, die and accumulate in the form of "golden Tides" in Sierra Leone, Benin, Ghana and Ivory Coast.

Conclusions and Recommendations

At the end of the present work of bibliographic research, the following conclusions can be made. In general, there is little information on invasive plants in West Africa. When they exist, they are not always available. Information collected on invasive plants indicate that in West Africa:

6.1. 113 species of invasive plant are identified and divided into 94 genera and 43 families.

6.2. The most diverse families are Poaceae, Fabaceae, Cyperaceae,

Species	Number of times reported	%
<i>Chromolaena odorata</i>	10	58.8
<i>Eichhornia crassipes</i>	9	52.9
<i>Salvinia molesta</i>	9	52.9
<i>Pistia stratiotes</i>	8	47
<i>Typha domingensis</i>	8	47
<i>Nypa fruticans</i>	6	35.3
<i>Azadirachta indica</i>	6	35.3
<i>Striga hermonthica</i>	6	35.3
<i>Azolla filiculoides</i>	5	29.41
<i>Leucaena leucocephala</i>	5	29.5
<i>Mimosa pigra</i>	5	29.5
<i>Echinochloa colona</i>	5	29.5
<i>Lantana camara</i>	5	29.5

Table 4: Importance of the distribution of some invasive species in West Africa.

Asteraceae, Euphorbiaceae, Solanaceae and Nymphaeaceae.

6.3. The most common invasive species in the countries of West Africa are: *Chromolaena odorata*, *Eichhornia crassipes*, *Salvinia molesta*, *Pistia stratiotes* and *Typha domingensis*.

6.4. West Africa is potentially invasive species in marine or aquatic or terrestrial freshwater which should be given special attention.

Therefore, some recommendations from a perspective to have common management and sustainable management of the problem of biological invasions in West Africa can be formulated:

6.5. Strengthen research to a better understanding of biological invasions and threats.

6.6. Strengthen the research system (inventory, taxonomy, biology, ecology, status, management).

6.7. Improve technics of identification and monitoring of exotic species and invasions by alien species.

6.8. Establish a pragmatic system and assess risk of invasion and potential impacts of alien species.

6.9. Share experience on available prevention and management techniques.

6.10. Develop sub-regional management strategies of invasions (the species cannot recognize administrative boundaries).

6.11. Emphasize prevention and increase the control of trade and the movement of potentially invasive species.

6.12. Promote information and awareness and engage people in knowledge of efforts, prevention and management of invasions.

6.13. Create a sub-regional working group, multi-actor and multi institutional.

6.14. Strengthen financing mobilization capacity and organize advocacy with decision makers.

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