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The relevance of mangrove forests to African fisheries, wildlife and water resources

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Mangroves v1.0: a new taxonomic tool to characterize mangroves The case of South East Indian and Sri Lankan mangroves and potential application to African mangroves

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Summary

In this paper we present an innovative tool for plant identification conceived to reinforce the national capacity building in taxonomy. We introduce ***Mangroves v1.0****, built up on a species identification system called IDAO (Identification Assistée par Ordinateur). This software allows the identification of 50 mangroves species of South East India and Sri Lanka, with the perspective to adjust and extend to other of the world. This software provides and facilitates dissemination of scientific and traditional knowledge. Corollary, it appears as a good support to training, research and development actions and its applications, from awareness to practical management of trees and the ecosystem, could benefit African mangroves and contribute to their renewed interest.*

Introduction

Ecological and socio-economic importance of mangrove trees and forests has been largely acknowledged in various coastal areas of the tropical zone, especially in Asia and Africa where mangroves are the most extensive (21 and 39 %, respectively of the world mangrove area, FAO, 2007) and rich in plant and animal species.

In these areas, they notably contribute in the protection of the marine and terrestrial environment and are a major source of food, fuel, timber, fodder, medicine, etc, for the local communities -especially fishermen who are among the poorest people (Dahdouh-Guebas *et al*., 2006). Mangroves in the Tropics are also characterized by a high human pressure and their poor management: overexploitation, of the trees notably, conversion of mangroves to other land use systems (prawn ponds, rice and salt fields…), pollution, etc.

Adequate legislation – or effective application of it - to protect, conserve and manage the mangrove in a sustainable manner are still missing in many African countries. On the other hand, although important studies have been carried out during these last decades to better know about the unique and fragile ecosystems these mangroves constitute, a lot remains to be done regarding their functioning and dynamics, in relationship with their exploitation and the possible impact of climatic changes. Therefore, scientific knowledge is needed to guide and rationalize the management of mangroves, their exploitation and reforestation, and adequately preserve their biodiversity.

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Finally, available information is not sufficiently disseminated, and the existence of several local languages makes the task more difficult (Taylor *et al.*, 2003). In this framework, lack of species identification capabilities is a major handicap for implementing the measures recommended by the Convention on Biological Diversity (CBD) in many parts of the world. The drastic reduction in the number of taxonomists throughout the world and the irremediable loss of their knowledge has made the task more difficult for ecologists and non specialists. This 'taxonomic impediment' is a serious issue hindering the full implementation of the CBD.

In mangrove ecosystems, one of the most urgent needs, despite major contributions from great diversity of disciplines (ecology, eco physiology, hydrology, soil science …), remains the identification and education on species biology. Without knowledge base containing information on this particular flora, one cannot assess its biodiversity and define priorities in terms of species conservation and, as a whole, sustainable management of mangrove.

To answer this challenge, at least partly, we conceived ***Mangroves v1.0*** that was built up on a species identification system called IDAO (*Identification Assistée par Ordinateur*, Grard, 1996). It was applied to the mangrove of South East India and Sri Lanka - with the perspective to adjust it and extend it to other mangroves of the world.

Mangroves v1.0 (Prosperi *et al.* 2005*)* was developed by the French Agricultural Research Centre for International Development (CIRAD) in co-operation with the French Institute of Pondicherry and the University of Andhra, India, and the University of Ruhuna in Sri Lanka, partners in the European funded project "Assessment of mangrove degradation and resilience in the Indian subcontinent: the cases of Godavari Estuary and South-West Sri Lanka".

Materials and methods

Classical keys for plant identification are difficult to use for non specialists. Their systems are mainly based on flower characters (not always easy to obtain when collecting samples), use technical terms and they impose the choice as well as the order of questions to obtain the identification.

IDAO is different from other computer-based species identification systems because

- It uses only drawings instead of technical jargon and provides users the freedom to choose the character that needs to be described.

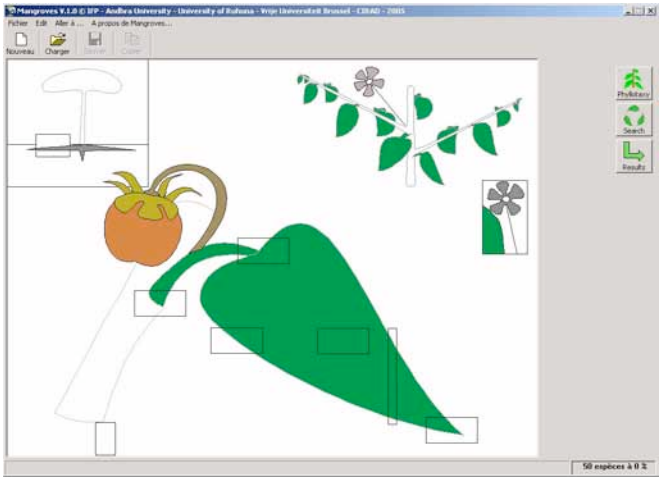

Figure 1: Mangroves v1.0 user interface

- Missing information or data are permitted, thus allowing for the identification of incomplete samples.
- A certain level of observational error is also tolerated and, at each step of the identification process, a probability of resemblance is calculated for each species. Thus, species are sorted by decreasing order of similarity.
- The users can access the photos, the description and the botanical illustrations of the species at any moment. In case users encounter doubt in the choice of characters (for description), they could ask the program for the most pertinent one. If the probability of a species identified is less than 100 per cent, the program indicates the characters that contain observation errors by the user.
- The descriptions of the species can be available through the Internet website with any type of browser.

Results

The identikit

In this article we will concentrate only on the characteristic of the "identikit" that is quintessential to the software. It comprises all the characters and all the states of these characters and helps the end-user to cross-match any character to any others, making all kinds of combinations possible. The realization of the "identikit" requires a fine expertise of the botanical characters between listed species in order to select the most pertinent vegetative and sexual ones. It uses a graphic interface based on a system of layers, which reconstitutes the plants using vectorized drawings. For *Mangroves v1.0* we have analyzed and drawn 108 botanical characters states belonging to 15 characters, representing the different layers (Table 1), and 5400 drawings necessary to identify 50 species of mangroves. These species belong to 34 genera and 26 families; they cover proper and associates mangroves species.

Table 1: Identikit characters of Mangroves v1.0

1- Habit	9 - Stipule types
2 - Roots	10 - Leaf or leaflet apex
3 - Pneumatophores	11 - Leaf or leaflet base
4 - Leaves arrangement	12 - Leaf or leaflet margin
5 - Leaves types	13 – Leaf or leaflet section
6 - Inflorescences	14 - Venation
7 - Flower colour	15 - Exudation - Sap
8 - Fruit types	

The identikit is organised around three zones represented by three main drawings of the interface: the habit, the stem with leaves and a closer view of the leaf and fruit. These drawings are simple, generic and theoretical in order to be easily comprehensible by the users, and help them in the process of plant identification. We have privileged the vegetative characters (80% of all characters, mainly linked with leaves and stems) because they are always present and more accessible than sexual ones.

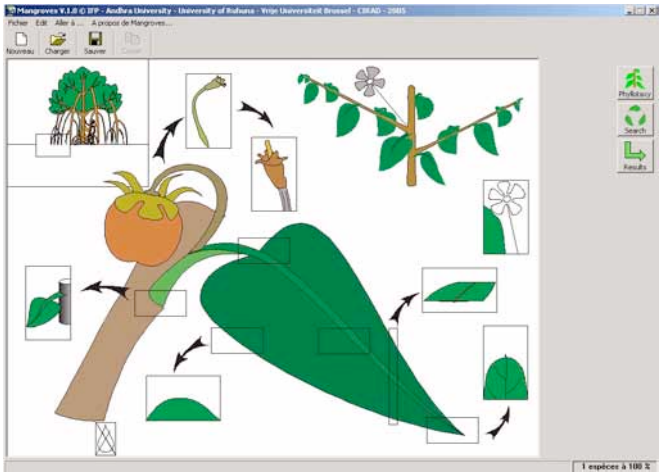

Figure 2: Mangroves identikit for the identification of one species of Rhizophora

This system allows the user to access of these characters by three ways of “point and click”:

- the rectangles represented on different organs of the plants
- the colours covering bigger surface in the identikit
- the buttons placed at the right side of the identikit

During the process of identification, the user clicks on the identification screen drawings to select one character corresponding to the plant he/she wants to identify. The software

based on the calculation of similarity coefficients, provides a probability of similarity calculated for each species.

The users can access the photos, the description and the botanical illustrations of the species at any moment during the process of identification. Among 50 species, the users can learn more about botanical aspects checking with more than 500 pictures and 21 botanical plates. The description file of each species includes information about: diagnostic characters, botany & morphology, regeneration, reproductive biology, ecology, distribution and uses (see http://umramap.cirad.fr/amap2/logiciels_amap/Mangrove_web/Mangrove_list.html). All the technical terms used in the description file are highlighted and, at a click, a hypertext illustrated definition is accessible.

Mangroves v1.0 is available on CD-ROMs for personal computer platforms, through the net and we are working towards developing an open source web-based application in a Scalable Vector Graphics (SVG) format (see http://www.ifpindia.org/Identification-des-plantes-de-mangroves.html).

Conclusion and perspectives of application to African mangroves

The many students, scientists and development agents who used the taxonomic tool ***Mangroves v1.0*** we developed for the mangroves of South-East India and Sri Lanka found it innovative, easy to operate and appreciated very much its interactive iconographic component allowing the user to quickly get a reply in an illustrative and educative manner.

The identikit – and its discriminating process to identify a species- is certainly the most original part of the software, thanks to its graphic interface. And at any moment, comprehensive information on each of the 50 mangrove species can be accessed independently from the important data base we constituted.

An interesting point related to the capacity of this software and the constituted data base is the integration of both scientific and traditional knowledge – of which the multiple uses of the species. The restitution is voluntarily given in a synthetic way (species description files), but could be developed, enriched or corrected, if needed, in next versions of ***Mangroves v1.0***.

Since Ellison (2000), and others before him, reminded us the need for mangrove information clearing houses, development of international databases and improved communication among researchers, managers, planters and residents, making use of the world wide web and related information technologies, ***Mangroves v1.0*** appears as an appropriate contribution to this challenge. It notably may help managers in planting a larger number of tree species as planting methods in mangrove restoration projects focus on only a few species – hence allowing, through improved richness, to get more products and services and better conform to the original ecosystem.

From this South Asian experience, and considering the advantages of this tool in terms of information exchange, learning and capacity building, support to research and decision making for the restoration and management of mangroves, one could favourably extend

its application to other mangroves and notably to African mangroves which are among the most degraded and are locally very much endangered where they have not vanished. Incidentally, ***Mangroves v1.0*** covers most of the mangrove species of Africa, and all the 16 East African and Middle East species identified by Spalding *et al.* (1997) and Saenger (2002).

Practical applications of this tool to African mangroves, through appropriate development of its data base and integration of specific information could include:
- awareness on environmental and socio-economic importance of mangroves tree and ecosystem;
- diffusion and popularization of tested techniques of tree plantation and mangrove rehabilitation;
- integration of scientific and traditional ecological knowledge with the view to promote best practices of management and long term values of the ecosystem;
- large dissemination, worldwide and notably African wide, of the data collected, processed and made available through networking, exchanges of information, case studies, etc;
- policy, rules and regulations regarding mangroves, along with information for decision makers.

The very structure of the Web (Internet, notably) offers new opportunities for information organization and provide universally accessible, hyperlinked, multimedia information, and offer an appropriate niche for the development of this tool and its various applications.

In the perspective of a renewed interest in African mangroves and to initiate the process, major issues such as baseline information needed for environment impact assessment and management plans, dissemination of information and education, could be discussed through workshops with the assistance of international organizations, like FAO, and concerned stake holders. In this framework, ***Mangroves v1.0*** could be presented and discussed for its possible development and applications in Africa.

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