Final Evaluation Report

Your Details	
Full Name	Yetein Houénagnon Marius
Project Title	Plant diversity and carbon stock mapping in the coastal lagoon landscapes at the site Ramsar 1017 in Benin: implications for its biodiversity conservation
Application ID	39810-1
Date of this Report	June 21st 2024

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Assess the botanical diversity of the CLL and describe the vegetation patterns; therefore, providing a baseline for monitoring environmental and anthropogenic degradation and forest dynamics				Forest inventories carried out from February to July 2023 provided information on 48 plant species (tree and herb) belonging to 46 genera and 27 plant families in the coastal lagoon landscape (CLL) at the 1017 Ramsar site. Arecaceae (19%) were the most represented family followed by Anacardiaceae, Annonaceae, Bignoniaceae, Caesalpiniaceae, Fabaceae and Moraceae.
Produce plant species checklist of CLL area with a red data list highlighting the conservation status of species with a high-value conservation				We have produced plant checklist of 48 plant species from IUCN Red List and according to local population perception.
Map the distribution of these species of high conservation priority and locate priority habitat for biodiversity conservation				The findings from the plant checklist from IUCN Red List and local perceived threatened species allowed for the distribution pattern mapping of high value conservation (HCV). This project objective provided solutions to two of the actions mentioned in the 1017 Ramsar site management plan. There are: - Mapping and characterisation of priority areas for biodiversity conservation in the 1017 Ramsar site. - Elaboration of conservation plan

				for threatened species in the 1017 Ramsar site.
Map above and below biomass carbon stock (regulation services) in the CLL, these data will allow the development of a REDD+ pilot project and provide a tool for communities to monitor carbon biomass and expand their scientific knowledge				Using land use/land cover map coupled with carbon density in three pools in integrated valuation of ecosystem services and tradeoffs (InVEST) model, carbon storage maps of the project area were produced. Carbon storage maps produced could be used to help policy makers and land use management researchers as decision support tool to implement more effective land use policies in the project area.
Provide recommendations for the conservation and sustainable management of its natural resources and threatened species.				Workshops/village assemblies were organised in several villages of each municipality (Ouidah and Abomey-Calavi) that share the authority of the project area to present the outcomes of the project. Local stakeholders were informed and sensitised on their role in the implementation of policies for the conservation and sustainable management of priority areas for biodiversity hence conservation strategies of high priority species. Moreover, during these workshops/village assemblies, management measures/strategies for the sustainable conservation of the priority areas identified were participatory defined.

2. Describe the three most important outcomes of your project.

a). The implementation of the project helped to improve understanding of plant diversity distribution and carbon (above ground and below ground) storage potential and conservation concern in the coastal lagoon landscape (CLL). Therefore, one of the most important outcomes of this project was the capacity

building of local experts (from Benin Agency for Environment (ABE), General Direction for Waters, Forests and Hunting (DGEFC), CorDE NGO, ECO-Benin, the local NGOs working in biodiversity conservation in the study area) in the field data collection (approach used to the installation of plots, carry out a botanical inventory, the use of a GPS to take the geographical coordinates of the trees within the framework of an inventory, and the methods of socio-economic surveys) and entry process to ensure the biodiversity and carbon storage monitoring and reporting. In addition, at least two local guides from the project area were involved in the project and benefited from this capacity building.

Photo 1: (**A**) total height (H; m) measurement using a digital hypsometer (Nikon Forestry Pro II Laser) and (**B**) diameter at breast height (DBH) of mangrove (tree measurement on the field.

b). Survey with local population highlighted that the main threats to the conservation of CLL ecosystems were mangrove forest degradation for fuelwood need, trees collection for basket making and salt production, wood harvesting as building and handicraft material, land requirement for farming.

Photo 2: Socio-economic surveys with local people of the project area.

Table 1 provides a list of some threatened plant species in the project area (Coastal Lagoon Landscapes at the 1017 Ramsar site) according to IUCN and national red data list.

Table 1. List of some threatened plant species according to IUCN and National red data list

Common name (in French)	Scientific name	IUCN red list	National red list of Benin
Saucissonnier ou faux baobab	*Kigelia africana*	LC	VU
Teck africain	*Milicia excelsa*	NT	EN
Canique grise	*Caesalpinia bonduc*	LC	EW
Lingué	*Afzelia Africana*	VU	EN
Cerise bord de me	*Scaevola plumieri*	NE	NT
Palétuvier rouge	*Rhizophora racemosa*	LC	VU
Palétuvier blanc	*Avicennia germinans*	LC	VU
Palétuvier gris	*Laguncularia racemosa*	LC	VU
Prune icaque	*Chrysobalanus icaco*	NE	NE
Chêne Guadeloupe	*Conocarpus erectus*	LC	EN
Liane à barrique bord de mer	*Dalbergia ecastaphyllum*	NE	VU
Fagara	*Zanthoxylum zanthoxyloides*	LC	VU
Ronier	*Borassus aethiopum*	LC	VU
*	*Rauvolfia vomitoria*	LC	NT
*	*Voacanga africana*	LC	VU

Legend: EN = Endanger; NT = Near threatened; LC = Least concern; VU = Vulnerable; NE = Not evaluate; CR= Critical endanger, EW= Extinct in wild.

c). The spatial distribution pattern of carbon stock estimated from the InVEST model displayed that the high-value areas of C_above, C_below and C_soil storage were distributed in the mangrove with 97.97 Mg. ha^{-1}, 22.78 Mg. ha^{-1} and 64.31 Mg. ha^{-1} respectively. This ecosystem was followed by swamps forest/savanna with C_above (Table 2).

Table 2. Carbon pool: above-ground carbon (C _above Mg. ha^{-1}), below-ground carbon (C_below Mg. ha^{-1}), total carbon (C_total Mg. ha^{-1}), area (ha), and total carbon (Mg) in 8 LU/LC.

LU/LC class	C_above (Mg.ha^{-1})	C_below (Mg. ha^{-1})	C_soil (Mg. ha^{-1})	C_total (Mg. ha^{-1})	Area (ha)	Total carbon (Mg)
Farmland/fallows	7.82	1.59	21.96	30.37	3682.96	111848.03
Swamp forest/savanna	30.59	7.13	31.31	69.03	1674.47	115584.43
Settlement	0	0.00	19.68	19.68	4426.18	87107.22
Mangrove	97.75	22.78	64.31	184.84	635.75	117509.33
Water body	0	0	0	0	1813.37	0
Forest plantation	18.39	4.28	21.49	44.16	418.9	18500.66
Shrub land	16.99	3.96	24.59	45.54	2239.24	101972.01
Sandy coast	1.17	0.17	15.34	16.68	257.78	4299.77
Sum	171.71	39.91	198.68	410.29	15148.65	556821.45

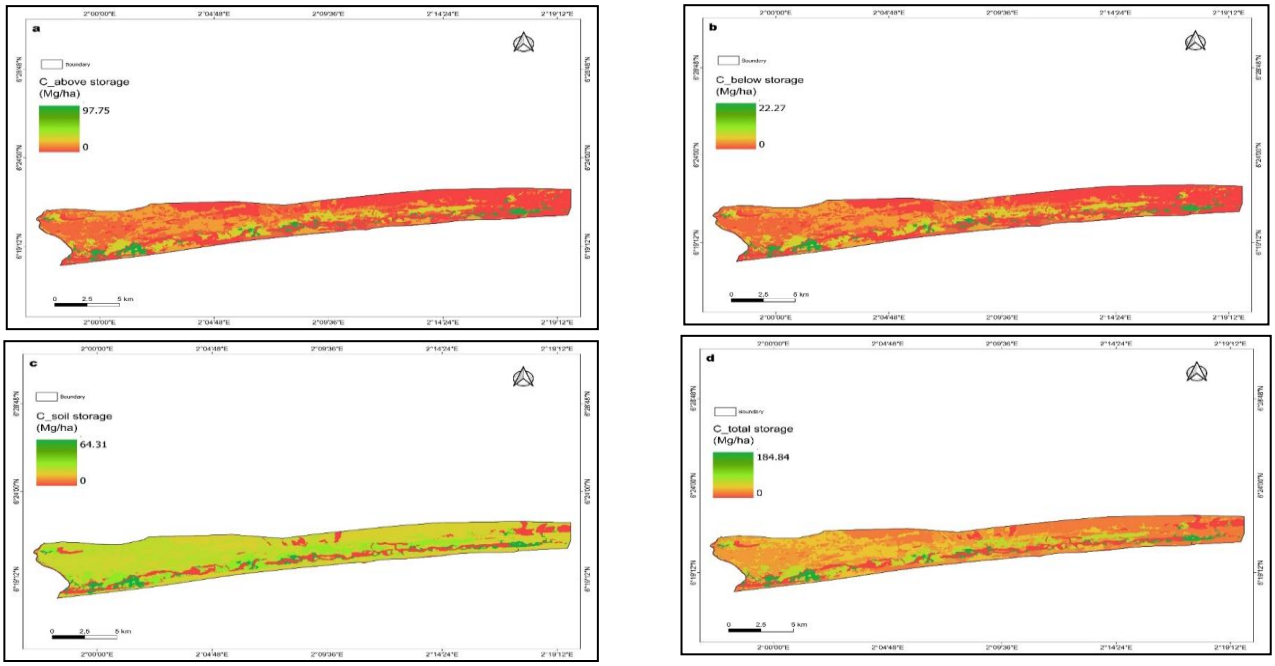

Figure 1. Spatial pattern of carbon stock (Mg.ha-1) estimated from the InVEST model: (a) aboveground carbon (C_above), (b) belowground carbon (C_below), (c) soil carbon (C_soil) (d) total carbon (C_total) in the coastal lagoon landscape (CLL

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

The major difficulty encountered during the project was the rainy season. This period meant that the schedule for field activities had to be rearranged. However, we have managed to ensure that all activities are carried out.

4. Describe the involvement of local communities and how they have benefitted from the project.

As mentioned above, local experts from Benin Agency for Environment (ABE), General Direction for Waters, Forests and Hunting (DGEFC), members of the local NGOs working in biodiversity conservation in the study area namely, CorDE NGO and ECO-Benin, as well as local guides were involved in all project activities and thus had their capacity strengthened in various areas such as:

(i) Carbon pool field inventory data through the installation of plots, carrying out a botanical inventory, the use of a GPS to take the geographical coordinates of the trees within the framework of an inventory, the diameter at breast height (DBH) of the trees and the total height (H; m) measurement using specific device (digital hypsometer) to estimate aboveground carbon, soil sampling using stainless-steel gouge auger in the field to estimate soil carbon;

(ii) Socio-economic survey techniques through individual face to face interview (FFI) and focus group discussions (FGD).

Furthermore, the presence of these local experts at the workshop where we shared our experiment improved their awareness of conservation techniques and/or best practices for implementing a sustainable high priority for conservation species.

In addition, during the project results dissemination workshops/village assemblies were organised in several villages of each municipality (Ouidah and Abomey-Calavi) that share the authority of the project area (Photo 1). Each workshop was attended by local communities, local authorities, NGO working on environment purpose. They were informed and sensitised on the priority areas for biodiversity at the costal lagoon landscape (CLL).

Moreover, during these workshops, management measures/strategies for the sustainable conservation of the priority areas identified (Photo 2) were participatory defined with these different stakeholders. The workshops also helped to determine the activities to be implemented to reduce the causes of biodiversity degradation in the coastal lagoon landscapes at 1017 Ramsar site.

Photo 1: Workshop to sensitise, raise awareness and define management strategies for sustainable conservation od priority areas identified with local community.

Photo 2: Animator of CoRDE NGO showing the priorities areas on the map during workshop with local community.

Photo 3: Village assembly to sensitise, raise awareness and define management strategies for sustainable conservation of priority areas identified.

5. Are there any plans to continue this work?

Yes of course, there are some plans to continue this work. During this project, very close links have already been established not only with the local populations of the coastal lagoon landscape area but also with the responsible of Benin Agency of Environment (ABE) in charge of the Ramsar Convention and NGO working on environment purpose.

Given that this project objective provided solutions to two of the actions mentioned in the 1017 Ramsar site management plan (1. mapping and characterisation of priority areas for biodiversity conservation in the 1017 Ramsar site, and 2. elaboration of conservation plan for threatened species in the 1017 Ramsar site), we noted a particular enthusiasm of them to work with us for future projects of biodiversity conservation and sustainable management as they have begun to understand such project need for the natural ecosystems of the area such as mangrove ecosystems swamp forest/savanna, coastal lagoon, sandy coast. The importance of the continuity of this work is justified by the fact that conservation and sustainable management strategies are unlikely to succeed in the long term if local community natural resource needs are not quantified and integrated into relevant policies. As a result, the project's outcomes allow us to anticipate an urgent need to continue this work on new project titled: ***Community involvement in biodiversity conservation and monitoring through participatory mapping of ecosystem services in the Costal Lagoon Landscape at the 1017 Ramsar site in Benin***. By achieving this new project, the pressure on the exploitation and conversion of natural ecosystems (habitats) will be reduced, which should undoubtedly benefit biodiversity in the coastal lagoon landscape at the 1017 Ramsar site.

6. How do you plan to share the results of your work with others?

The main results of this study have already been the subject of two scientific presentations at international conferences (6th International Scientific Conference of the University of Parakou and Biodiversity week Conferences in Benin). In the coming months, we will continue to present the outcome of this project at other scientific international conferences.

In addition, for result dissemination, workshops were organised in each of the municipalities (Ouidah and Abomey-Calavi) that share the authority of the project area. At least 100 people were invited to each workshop. Each workshop was attended by local communities (60 people), local authorities (10), forest managers (10), Benin Agency of Environment (ABE) in charge of the Ramsar Convention (10), and NGO working on environment purpose (20).

Furthermore, two scientific publications from the project are currently being finalised. These results will also be subjected to public defence during the presentation of my doctoral thesis research work as this project is one of my specific thesis objectives.

Lastly, we will share our work via social networks for conservation in Benin such as "Pro Environnement" and "Forum Biodiversité" Whatsapp group. These forums bring together persons from the world of conservation (national and international NGOs, researchers, policy makers, local communities, public services in charge of wetland biodiversity conservation). The project outcome will also be published on the websites of the Laboratory of Ecology, Botany and Plant Biology (LEB), CoRDE ONG and on my Research Gate and Facebook page.

7. Looking ahead, what do you feel are the important next steps?

The important next steps are:

This project has enabled the mapping of regulating services, specifically the carbon stocks, without focusing on other services, particularly provisioning and socio-cultural services, which are often the most perceived by populations and determine their interest whether in habitat and species conservation. Furthermore, highlighting these services will allow to identify areas of pressure on resources and the solutions required to ensure their sustainable conservation. In addition, ecosystem services assessment and mapping can be seen as a powerful tool to help guide conservation planning, land use planning strategies and decision making for management.

Given that, it is crucial to:

(i) Map in addition to carbon stock, the other ecosystem services, specifically provisioning and cultural services in the coastal lagoon landscape at the 1017 Ramsar site. This will allow us to examine geographical patterns of these perceived ecosystem services based on multiple approaches using landscape metrics and participatory mapping.

(ii) Determine the degraded ecosystems (habitats) of species with high conservation priority and therefore restoration activities of these environments could be welcome.

(iii) Carry out restoration activities of the degraded ecosystems (habitats) of species with high conservation priority.

(iv) Continue to sensitise the local community and raise their awareness on conservation and alternatively activities other than those which can reduce habitat loss and therefore promote conservation of biodiversity.

8. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

Yes, we have used the logo of The Rufford Foundation during workshops/villages assemblies. The logo of The Rufford Foundation has been and will continue to be used during the presentation of the project results. We used the logo of The Rufford Foundation at the scientific conferences mentioned above. The Rufford logo will feature in my presentation during my thesis defence.

Furthermore, the project outcomes will be shared as scientific publications, which in the two manuscripts in finalisation, The Rufford Foundation is well acknowledged. When published, copies will be made available to The Rufford Foundation. In addition, the Rufford Foundation logo will be posted on the website of the LEB as the funder of the project.

9. Provide a full list of all the members of your team and their role in the project.

Collaborators or resources persons:

- **Dr. Laurent G. HOUESSOU** is Associate Professor in the Department of Natural Resource Management at the Faculty of Agronomy (FA), University of Parakou (UP), he is the Ph.D. supervisor of the Principal Investigator (PI). He is the

coordinator of Biomonitoring and Conservation of Protected Areas and Wildlife Research Unit within the Laboratory of Ecology, Botany and Plant Biology (LEB) at Faculty of Agronomy. His expertise provided a significant contribution to field inventory and conservation strategies. He is one of a former Rufford grantee in Benin. To this end, permanent contact was kept with him to benefit from his experience.

- **Prof. Romain GLELE KAKAI** is Full Professor of Biostatistics and forest estimations at the Faculty of Agronomic Sciences, University of Abomey-Calavi (Benin). He is the Head of the Laboratory of Biostatistics and Forest Estimations (LABEF). His expertise also provided an important contribution to forest inventory and statistical analysis.

- **Prof. Toussaint O. LOUGBEGNON**, is Full Professor at School of Tropical Forestry, National University of Agriculture (Benin). He is the Ph.D. co-supervisor of the Principal Investigator (PI). He has extensive expertise in wetland areas management (restauration and valorization). His expertise was valuable during stakeholder awareness of sustainable conservation and the management of priority areas for biodiversity conservation in the project area.

Academics in the field team

- **Marius H. YETEIN** (PI) is a member of LEB with expertise in natural resource management, biodiversity conservation and monitoring, forest ecology and data analysis. He is responsible for coordinating all field activities and for ensuring that all methodologies are followed correctly during the project.

- **Dr Aliou DICKO** is a forest engineer working on diversity and systematic. He has extensive expertise in systematic acquisition during the multiple field inventory with the Benin National Herbarium (BNH). Therefore, his expertise provided a significant contribution to the identification of plant species in the field and at the Benin National Herbarium.

- **Jacques AGON** is a Ph.D. student in forest ecology and biodiversity monitoring and conservation. He provided assistance with plot installation and soil sampling.

- **Geoffroy KAKE** is an engineer working on forest inventory. He provided assistance with plot materialization, diameter at breast height (DBH) of the tree measurements.

- **David SEMEVO** is a Msc student and Field team member and environmental socio-economist. He was responsible for the management of logistics and human resources during the socio-economic survey phase of the project.

All above team members are members of the LEB with the PI

Local experts in the field team

- **Eric APITHY** is from CoRDE NGO working in biodiversity conservation in the study area. He was field animator during the socio-economic survey phase of the project.

- **Mikhail PADONOU** is from Eco-Benin NGO working in biodiversity conservation in the study area. He was very helpful in getting in touch with local people, especially during the focus group discussions.
- **Peras HOUENOU** is native to the study area. He has significant knowledge about plants and their uses in the locality, and hence he was very helpful in determining the actual threats to the species.
- **Médéssè KPOGUE** is native to the study area. He has significant knowledge about plants and their uses in the locality, and hence he was very helpful in determining the actual threats to the species.
- **Marius DEGLA** is the director of Benin Agency for Environment (ABE). Field time member and environmental specialist.
- **Camille HOUNGBEDJI** is from the General Direction for Waters, Forests and Hunting (DGEFC).

10. Any other comments?

We are grateful to The Rufford Foundation. Their support in this project was essential for the conservation of habitats and species with high priorities in the coastal lagoon landscapes in 1017 Ramsar site in Benin.

We would like to thank Jane, the Rufford Foundation's Trust Administrator as well as his entire work team for their attention and facilities. We remain open to future collaborations and new goals to achieve.

We would remind you that currently, we are in progress for finalising two scientific papers from the project which will be submitted by probably next month.