Biodiversity avoidance and wetland restoration in Cotonou, Benin

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Abstract

The latest of Intergouvernemental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) report estimates that approximately 1 million animal and plant species are now threatened with extinction, an unprecedented event in human history. However, the report also indicates that this crisis is still reversible through immediate local and global actions aimed at preserving and restoring nature. In alignment with this call for local action to preserve ecological biodiversity, the Benin - Stormwater Management and Urban Resilience Project, funded by the World Bank, has implemented a biodiversity avoidance strategy as part of its water drainage infrastructure construction efforts. This paper details the approach and initial outcomes of the biodiversity avoidance and wetland restoration plan in the PA3 rainwater retention basin in Cotonou, Benin. Utilizing tablets and smartphones equipped with field navigation applications, along with drones for aerial imaging, this strategy has successfully preserved three enclaves of natural habitats covering an area of 9,420.55 m². These enclaves are home to numerous plant and animal species of significant socio-cultural, economic, and ecological importance. The next phase of this initiative will involve developing monitoring protocols for these biodiversity avoidance zones. By applying Artificial Intelligence (AI) and drone technology, the project will allow to accurately assess environmental changes in preserving habitats and optimize wildlife monitoring.

Keywords: Ecological biodiversity, wetlands, urban resilience, rainwater, Cotonou

1 Introduction

In the context of urban development, wetlands are targeted and destroyed to make way for massive remediation projects such as drainage and stormwater retention structures, the construction of which completely alters the structure of wetlands. The city of Cotonou, the economic capital of Benin, is the country's largest megalopolis with a population density of 17,936.74 inhabitants/km². This port city is located within Ramsar 1018 and is therefore an international wetland. In urban areas, significant biological transformations occur that alter the ecology (Lougbegnon *and al*. 2011). Today, ecological concerns in urban areas are increasingly important given the consequences that human activities have on the health of city dwellers. As a result, within the framework of the Cotonou City Stormwater Sanitation Program (PAPC), funded by Financial Partners, including the World Bank (WB), compliance with Environmental and Social Standards is increasingly required.

Considering these objectives, the thorny issue of nature arises, specifically the original habitats and ecosystems of Cotonou, through this ambitious project. Indeed, in the exposed and habitable areas where Cotonou was built, natural vegetation has almost entirely disappeared due to human activity. The current remnants of Cotonou's natural ecosystems constitute the marshy areas, listed as a Ramsar 1018 site, and currently constitute the natural retention basins to be developed, as well as the water drainage outlets. For decision-makers and elected officials, the primary interest of Cotonou's population lies in sanitation and the installation of water drainage structures. Therefore, anything that may be "cumbersome," such as marsh vegetation, must be cleared and removed. However, the ecological vision of a sustainable city, in the ecological objectives and directives, imposes a share of "green" or natural to be preserved in terms of ecological and sensitive habitats so that the city and its inhabitants continue to benefit from basic ecosystem services. It is therefore imperative to establish, within the framework of the PAPC, an innovative approach reconciling environmental and social standards and urban sanitation works decided by elected officials. This is what justifies the development and implementation of a biodiversity avoidance plan during the construction of the various drainage and water retention structures.

2 Material and Methods

2.1 Study area

2.1.1 Biophysical framework of the Pa3 rainwater retention basin in Cotonou

The study area is the city of Cotonou, specifically the Pa3 retention basin. Figure 1 shows the location map of the Pa3 basin. The Pa3 basin benefits from a Guinean climate, better known locally as a subequatorial climate (Houeto, 2013), characterized by the annual succession of four seasons: 2 rainy seasons and 2 dry seasons alternating and of unequal durations (Bessan, 2013). Cotonou is one of the wettest cities in southern Benin with an average precipitation of 1346 ± 307 mm over the last thirty years (1990-2019) (Meteo-Benin, 2020). June is the wettest month with a rainfall of 329.30 mm. The average maximum monthly temperatures vary between 28.19° and 32.35°C at Cotonou station. In terms of hydrography, the Pa3 basin is part of the vast floodplain of Lake Nokoue.

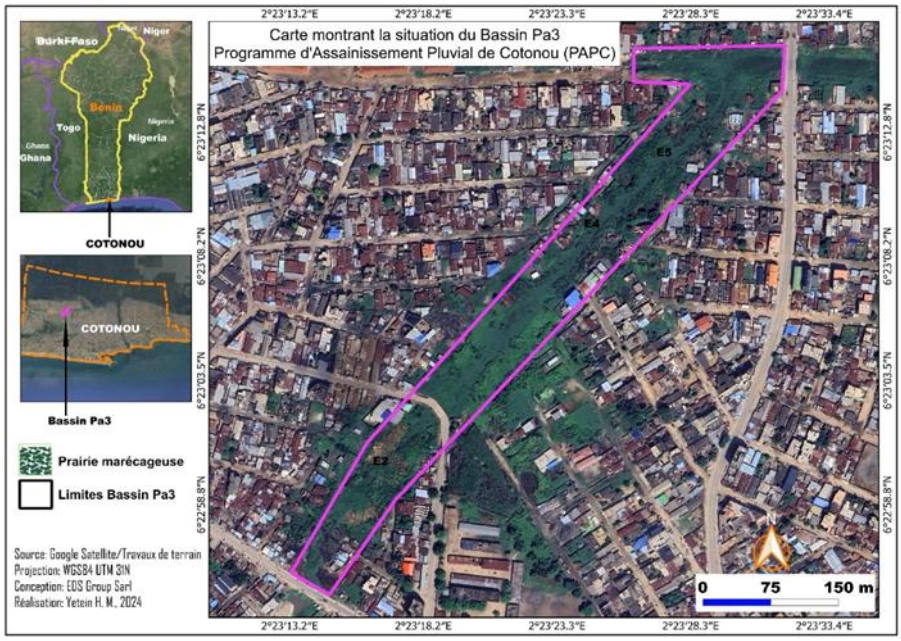

Figure 1 : Geographical location of the Pa3 basin.

2.1.2 Socio-economic framework

The population living around the Pa3 basin is cosmopolitan, with several ethnic groups, practicing various beliefs. The activities practiced by these populations are mainly in the tertiary sector (trade, catering, administration, etc.) and the secondary sector (agri-food processing, mechanics, electricity, etc.). Less than 1% of this population still practices market gardening and fishing activities. During rainy periods, these activities are disrupted by cyclical flooding, making these populations vulnerable for a good part of the year.

2.2 Methodology for conducting work

2.2.1 Data collection equipment

The equipment used to carry out this work included tablets and smartphones equipped with the ODK Collect V1.30.1 and Locus Map 4.2 applications for navigation in the field and recording survey sheets; fluorescent tape for demarcating avoidance zones; a digital camera for taking photos in the field; a pair of binoculars for bird watching; the analytical flora of Benin (Akoegninou and al, 2006); a bird identification guide (Borrow & Demey, 2001); a mammal identification guide (Kingdon, 1997); a taxonomic identification guide for West African fish (Smith and al. 2009; Paugy and al., 2003). Also, topographic and occupation maps of the Pa3 basin; flora and fauna survey sheets and a DJI Phantom 4 pro V2.0 drone for taking aerial images were used. The use of drones

will help to identify wildlife and monitor nesting or breeding areas of wildlife providing data without disturbing them. The photo 1 below shows the type of drone used.

Photo 1 : Phantom Pro 4 V2 used in this study (Lougbegnon, 2023).

2.2.2 Methodological framework

A methodological framework session for the implementation of the strategy and protocol for the implementation of the biodiversity avoidance plan (flora and fauna) in the Pa3 basin was organized in the premises of the Urban Work Execution Agency with the presence of representatives of the PAPC steering team and Delegated Project Owner, the company in charge of the works and the control mission.

2.2.3 Awareness-raising and communication

After the ethnobiological surveys, various awareness-raising and communication on identified avoidance zones, international wetlands and the importance of their protection were organized for both local stakeholders and authorities, populations, including workers and technicians from the company in charge of the works and the Control Mission.

3 RESULTS

3.1 Identification and marking of natural habitats

The natural habitats to be spared have been identified and marked clearly and precisely in the Pa3 basin. This makes it possible to delimit these sensitive areas and guarantee their preservation (Photo 2).

Photo 2 : Partial view of the Hypha domengensis meadow to be spared (E4) (above) and avoidance zones delimited and marked (bottom) (Houessou, 2023).

3.2 Mapping of natural habitats and area of avoidance zones

A total of three avoidance zones were mapped, with a total area of 9420.55 m^2. These areas, named E2, E4 and E5, were clearly demarcated, marked and identified to ensure that they are not disturbed during the work. The mapping of the natural habitats to be spared has been successfully completed. The location and characteristics of these habitats are now available as map data. In addition, the land use in the Pa3 basin has also been mapped.

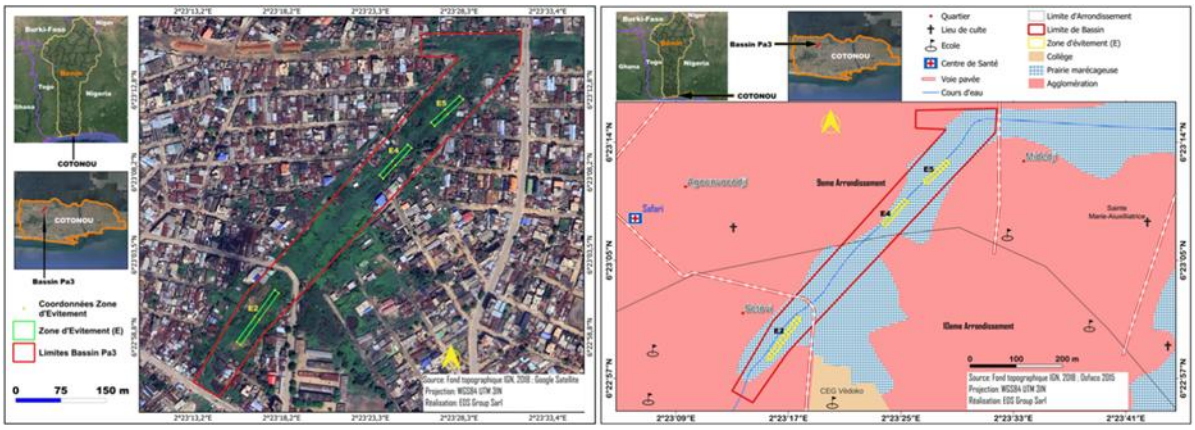

Figure 2 : Final mapping of natural habitats (left) and that of occupations (right) to be spared.

3.3 Identification and protection of important species

Species of great socio-cultural and ecological importance were identified and protected. Measures were taken to delimit and materialize the avoidance zones using fluorescent strips and indicative plates. Several plant species are found in these ecosystems and are essential for documenting the biodiversity of the Pa3 basin and are useful for conservation. In particular, the conservation of Thalia geniculata, a plant species used as packaging leaves (Plate 1) and having cultural and economic values.

Plate 1 : Collection and piling of Thalia geniculata leaves for marketing (Houessou, 2023).

The Pa3 basin is home to a remarkable diversity of birds typical of the lake, lagoon and river environments of southern Benin. These birds are often associated with aquatic habitats and play an important role in the local ecosystem by feeding mainly on fish and other aquatic organisms. The count of 17 bird species around the Pa3 basin is evidence of the richness of the avian fauna of the basin. This diversity of bird species can be an indicator of the health of the ecosystem and the quality of the habitat. It is essential to monitor and preserve the enclaves to ensure the conservation of these avian species.

3.4 Awareness/training for stakeholders in the Pa3 retention basin

This session took into account technicians, machine operators, site managers, team leaders, workers from the company and the control mission whose objective is to prepare these stakeholders to: (i) know the three enclaves of the Pa3 basin delimited as avoidance zones; (ii) raise awareness among these field stakeholders on the precautions to take to safeguard and protect the three avoidance zones delimited during the work.

3.5 Raising awareness among the population on measures to avoid probable incidents related to the dredged areas

In search of fish and other resources, the population, especially young people and children, often try to enter the dredged portions. To avoid any possible damage from such practices during the work, the populations surrounding the basin were made aware by the team of experts and the company of the dangers to which they may be subjected when entering the site and going near the open drain for any activity. Plate 2 presents the situation of this event and the presence of an awareness team.

3.6 Barricade and installation of signage in the access areas to the site

In addition to raising awareness, other measures were taken. These measures include the installation of barricades and the installation of danger signage to prevent access to the sites by the populations. The team of experts accompanied the company team in the installation of these various signage structures. Plate 2 shows some images of the installation of prohibition signs.

Plate 2 : Installation of signalization panels along the Pa3 basin (Lougbegnon, 2023).

4 CONCLUSION AND RECOMMENDATIONS

This article presents a summary of the methodology adopted and some salient results of the activities carried out during the implementation of the biodiversity avoidance plan and the restoration of wetlands in the rainwater retention basin Pa3 of Cotonou. As part of the avoidance mission, it should be noted that most of the activities carried out are focused on the delimitation of the avoidance zones, their securing and awareness-raising activities. Thus, three enclaves of natural habitats to be spared have been delimited and marked. These enclaves cover an area of 9420.55 m2 with well-defined characteristics. A distribution map of these enclaves has been produced. Added to this, there are awareness-raising sessions for key stakeholders who should help leading the process. Natural habitats are identified and clearly marked in the basins financed by the World Bank and the avoidance zones are marked and monitored during the works, the mapping of natural habitats to be spared is carried out and available and species of great socio-cultural and ecological importance are identified and protected. However, it will be interesting in the short and medium term to develop biodiversity monitoring protocols around this Pa3 basin to properly assess i-) environmental changes in the avoidance zones; ii-) optimal monitoring of wildlife. Given that these basins are migration sites for Palearctic or intra-African migratory birds, the use of drones will also make it possible to monitor and make rapid counts of birds in these basins after the work to know the rates of colonization of ecosystems because birds are good indicators for this purpose.

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