URBAN NATURE-BASED SOLUTIONS IN THIES, SENEGAL

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Practical ACTION

Contents

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List of Abbreviations

ADT-GERT	Association pour le Développement des Technologies et la Gestion de l'Espace et des Ressources des Terroirs
EPT	Ecole Polytechnique de Thiès
FRMC	Flood Resilience Measurement for Communities
GIS	Geographical Information System
GRAIM	Research and Support Group for Mutualist Initiative
IUCN	International Union for Conservation of Nature
MARP	Participatory Active Method of Research
NbS	Nature base Solutions
PA	Practical Action
PDC	Municipal Development Plan
PRECIT	Project for Strengthening the Resilience of Communities against Floods
UDP	Urban Development Plan
UNISDR	United Nations Office for Disaster Risk Reduction

Executive Summary

This study, entitled "Urban Nature-based Solutions in Thiès, Senegal", commissioned by the NGO Practical Action was conducted with the aim of reviewing and evaluating the effectiveness of local initiatives using nature-based solutions (NbS) to respond to environmental challenges, including flooding. The study looked at 11 categories of NbS implemented by 139 local developers, employing more than 950 people.

The study adopted a participatory and inclusive approach, involving field surveys, interviews with NbS promoters, and analyses of the environmental and socio-economic impacts of the initiatives identified. The categories of NbS analysed included, among others, market gardening, agroforestry, stormwater management, waste recycling, use of renewable energy, green spaces, and public gardens.

The main results of the study revealed the diversity of initiatives and a strong local dynamic aimed at greening the city of Thiès, fighting against floods, and improving the living environment. These initiatives have significant financial and economic benefits, generating an average of 150 to 200,000 CFA francs per month for the promoters. Finally, although these links to flooding are well established in the global literature, there is no evidence, yet that NbS has significantly reduced flooding within the context of Thiès.

The study also identified several barriers to the wider and effective adoption of NbS in Thiès due to low awareness of the ecological benefits of NbS, constraints in accessing finance, and the lack of institutional support and dedicated incentives.

The main recommendations to improve the impact of NbS in Thiès relate to capacity building and awareness-raising of stakeholders, the establishment of innovative financing and incentives, and a framework for dialogue, learning and harmonization for increased collaboration in favor of NbS.ype executive summary here. Note all reports should include this.

1.0 Introduction

Practical Action is an innovative international development NGO, with a core thematic area focuses on building resilience in the lives of people threatened by climate-related natural hazards, reducing vulnerability and minimising impact. It intervenes in Senegal, mainly in the field of floods, which have increasingly accentuated impacts due to rapid urbanization, growth, and migration.

In the context of climate change, Practical Action and its associates have, for three years, implemented at the level of the Commune of Thies Nord, the Project for Strengthening the Resilience of Communities against Floods (PRECIT). The aim was to strengthen the capacity of communities to cope with the risks of flooding induced by climate change. This initiative, which has placed participatory approaches at the heart of its implementation system, has made it possible to identify nature-based solutions as one of the most effective adaptation strategies in view of the many opportunities they offer both to communities and ecosystems, particularly in urban areas. Indeed, nature-based solutions, also known as ecosystem-based solutions, are increasingly recognized as effective adaptation strategies in urban settings.

These approaches seek to integrate nature into urban planning to strengthen the resilience of cities to environmental challenges. Of these, floods are the most frequent and recurrent, their number has steadily increased in recent decades, resulting in significant loss of life and economic damage. According to the United Nations Office for Disaster Risk Reduction (UNISDR), floods account for 43% of the 7248 natural hazard-related disasters identified between 1998 and 2017 worldwide.

Urban centres are particularly vulnerable to flood risk. Indeed, in Thiès and Dakar, the country's two largest urban centers, there were 5646 and 8596 people affected by floods respectively in September 2020. The increasing vulnerability and exposure of urban areas to the risk of flooding is caused by population growth and urban planning difficulties; coupled with rising climate change risks, including extreme weather events, and sea-level rise.

In the Senegalese context, nature-based solutions (NbS) can help address the overall environmental problems caused by climate change and its consequences. The city of Thiès was chosen for a review of participatory approaches to nature-based solutions in urban areas.

The report is structured around the following points:

1. The theoretical framework, including methodology used to collect and analyse data in the study.
2. The second part is devoted to a literature review on the scope of definition of NbS and its importance in urban areas, and the presentation of the city of Thiès and the main environmental and urban challenges.
3. The analysis of nature-based solutions in Thiès through the identification, description of NbS implementation sites, evaluation of effectiveness and sustainability.
4. The issues and main recommendations that promote NbS in Thiès, the obstacles to their adoption and their integration into public policies and economic and spatial planning.
5. Conclusions and lessons learned.

2.0 Framework of the study

2.1 Background

Nature-based solutions, also known as ecosystem-based solutions, are increasingly recognized as effective adaptation strategies in urban settings (Faye, 2018). These approaches seek to integrate nature into urban planning to strengthen the resilience of cities to environmental challenges such as flooding.

The city of Thiès is facing problems related to recurrent floods, pollution, air quality, deforestation, waste management, etc. NbS has the potential to help the city to identify, experiment, monitor, evaluate and capitalize on adaptation initiatives likely to make the city more resilient to climate change and specifically to be able to cope with the impacts of climate change, one of the strongest of which is that related to flooding in the city.

Nature-based solutions could help the city of Thies increase green spaces and help improve air quality, reduce stress, and provide spaces for recreation and relaxation. Green areas can also serve as buffer zones to absorb excess water during rainfall events.

As part of its intervention in Senegal, Practical Action wants to have a baseline study on nature-based solutions in the city of Thiès. Practical Action commissioned this study to understand the potential for NbS in Thies, as well as existing activities. The methodology focused on collecting information on initiatives led by the local community. It consisted of identifying and analyzing NbS in the city of Thiès. Local ownership is ensured through the effective involvement of residents, local authorities, and community actors, including women, young people, people living with disabilities, etc. The field mission also made it possible to strengthen awareness of climate issues, citizen participation and the implementation of nature-based adaptation initiatives.

The tools of the Active Method of Participatory Research (MARP) made it possible to give a voice to the actors of the city of Thiès by ensuring inclusion and not "leaving anyone behind". Thus, NbS initiatives could be identified as well as the constraints to their implementation. The research-action carried out in this way has made it possible to provide information about NbS in Thiès and to have a documented baseline that will make it possible to set ambitious but realistic targets for future intervention in favor of NbS.

2.2 The objectives of the study

The study set the following objectives:

1. Review existing participatory methods that could be used by Practical Action to work with communities to understand their perspectives, needs, and interest in nature-based solutions for Thiès, Senegal.
2. Develop and document a methodology to be implemented in Thiès to promote NbS.
3. Collect, analyze, and interpret field data collected with the support of field agents who have been previously trained on participatory approaches (MARP and FRMC).

4. Write and share research findings with the broader team, including Practical Action staff and external advisors.
5. Provide a comprehensive report of the project including the review of the NbS initiatives, the methodology used, key findings, recommendations, and conclusions.

2.3 Methodology

To achieve the objectives of the study, we propose an approach based on the tools of the Active Participatory Research Method (MARP). The latter is described as a methodology for the rapid collection of rich and reliable information on the ground through the combination of different tools and techniques that encourage and maintain the participation of communities throughout the process.

2.3.1 Participatory tools

In reviewing the participatory tools that promote stakeholder engagement and collaboration through a holistic and inclusive approach, we have selected the following:

1. **Focus groups and participatory mini-workshops:** These forums enable stakeholders to share ideas, experiences and resources on NBS. They encourage the co-creation and co-design of solutions by allowing participants to actively contribute to the discussion. Organised interactively, these mini workshops will bring together key players to discuss the opportunities and challenges of NBS.
2. **Participatory mapping and geographic information systems (GIS):** These tools enable stakeholders to map natural resources, ecosystems and NBS initiatives. With the support of the Ecole Polytechnique, we will be able to spatialize the NBSs identified.
3. **The NBS identification matrix:** These are double entry grids that will guide data collectors in identifying initiatives, describing them, the problems faced and the solutions found.
4. **The participatory feedback workshop:** this will bring together all the stakeholders in the study (heads of departments, town hall technicians, NBS initiative holders, academics, PA staff). This will be an opportunity to present and validate the results of the study, but also to develop future collaboration for the implementation of the nature-based solutions that will be deemed most relevant in the context of the city of Thiès.

Following this analysis, we decided to work with this method and tools:

1. **Method:** MARP (Active Participatory Research Method) and FRMC (Flood Resilience Measurement for Community)
2. **Tools:** Mapping and GIS - Interview guide - Participatory observation and photography - Semi-structured interview - Focus-group - Telephone interviews - by WhatsApp (voice messages) in case the respondent is not available, accompanied by note-taking and recording.
3. **Intervention approach:** Identification of initiatives by "snowball" survey, geolocation, and interviews with NBS initiative holders using the Kobotoolbox application, which enables us to geolocate sites and take photos at the same time (see appendix).

2.3.2 Methodological process

Our methodology is divided into three main steps.

Step 1 of the methodology

The kick-off meeting held on Friday, March 1, 2024 at the premises of Practical Action in Thiès. It brought together the consultant, the Practical Action staff and, the three field agents, selected from those who have already followed the training in Participatory Approach and the FRMC tool.

The meeting of regional technical services (Spatial Planning, Environment, Water and Forests, Regional Development Agency, Urban Planning) and projects and programmes, including the IUCN Ecosystem-Based Adaptation Project (the list of contacts, attached). In-depth interviews with these resource persons who have a real knowledge of their space made it possible to note the need to circumscribe the spatial scale of the study, to identify projects for nature-based solutions, to direct towards potential project leaders and localities.

Following these meetings, we decided to work at the scale of the city and its hinterland, because it is the identification of the leaders of NbS initiatives and their place of intervention that guided this study. Thus, we have already been able to identify a certain number of NbS and a "snowball" survey has enabled us to discover 139 initiative leaders that the data collectors have interviewed.

A visit to nature-based initiatives (fish farming, green wall, nursery, market gardening, school woods, public gardens, etc.).

Table 1: Nature based solutions inventory from study

Initiatives	Number	%	Jobs
Market gardening	54	39	365
Solar/wind energy	27	19	74
Improved cooking stoves	21	15	24
Green space/public garden	11	8	98
Fleuriculture	7	5	177
Waste recycling	8	6	140
Protective dike/retention basin	4	3	16
Fish farming	3	2	12
Bioclimatic building	2	1	17
Biodigester	2	1	11
Total	**139**	**100**	**934**

Step 2 of the methodology

The review of the literature and existing data on the city of Thiès and its surroundings: planning documents, including the presentation of the Thiès PDU project, the baseline status report of the Ecosystem-based Adaptation Project, research briefs were consulted.

The development and sharing of collection tools (collection sheet, interview guide, SWOT grid). Once the questionnaire was stabilized, it was integrated into the Kobotoolbox application, which allowed for digitized data entry and the geolocation of initiatives.

Step 3 of the methodology

The analysis and interpretation of the data constituted the third phase of the methodological approach. The first results of the project from the fieldwork were shared during a restitution workshop held on May 14, 2024, at the Ecole Polytechnique de Thiès.

The workshop was attended by municipal authorities, representatives of NbS initiative leaders, women's groups, EFA researchers and the Practical Action team. It was a time to present the results of the study, but also to collect suggestions for improvement and integration of the recommendations. The proceedings of the workshop are attached on annex.

2.4 Study limitations

The limitations of the study were the limited time for the inventory, the difficulty of clearly defining what an NbS is, and the use of the snowball survey method. These limitations limited the scope of the study's findings. Indeed, the lack of time prevented a thorough exploration and exhaustive coverage of the different nature-based solutions.

The diversity of NbS initiatives has made it difficult to identify and classify initiatives. Some investigators often wonder whether to list this or that initiative because they do not have a clear definition of an NbS. This can make the evaluation of certain initiatives subjective; investigators may include or exclude certain initiatives based on their own understanding.

3.0 Literature review

Nature-based solutions are defined as sustainable initiatives to address the environmental, social and economic challenges brought about by climate change and anthropogenic activities, including urbanization. They are positioned as alternatives to "grey" solutions that often use heavy investments to deal with floods, for example. In the specific case of the city of Thiès, the NbS aim to strengthen urban resilience, promote a healthy and more liveable environment for communities. This theoretical framework explores the conceptual foundations of NbS, their importance for urban areas plagued by recurrent flooding, and the challenges associated with their implementation in the context of the city of Thiès.

NbS are actions that protect, restore, and manage natural systems to address societal challenges adaptively, providing benefits to human well-being and biodiversity. Examples of NbS include clean energy (solar panels, improved cookstoves), environmental education and youth activism, reforestation, rainwater harvesting, and regenerative agriculture. Strong evidence demonstrates that NbS have a persistent impact on climate change remediation, food and water security, flood risk reduction, social and economic development, and human health (IUCN 2016). However, a common critcism of NbS is that they are not implemented fast enough or are not sufficiently engaged and shared with local communities.

3.1 Definition of nature-based solutions

The concept of nature-based solutions (NbS) was first mentioned in 2008 by the World Bank. The first research program on NbS was launched in 2013. The concept was born out of finding innovative solutions to manage natural systems in a way that balances the benefits for nature and society. In other words, by working with nature, rather than against it, human communities can develop and implement solutions for a resilient, resource-efficient economy (World Bank, 2013).

Over the past ten years, several attempts have been made to precisely define and clarify the term "NbS". In 2015, NbS were for the first time officially defined by the European Commission as "actions that simultaneously address environmental, social and economic challenges by maximising the benefits provided by nature (...) inspired, supported or copied from nature". (B.Sowińska-Świerkosz, 2022). These solutions include a diverse range of interventions such as the creation of urban green spaces, ecosystem restoration, urban agriculture, and green infrastructure such as green roofs and green walls (European Commission, 2015).

Another commonly accepted definition has been provided by the International Union for Conservation of Nature (IUCN) as "actions to protect, sustainably manage and restore natural or modified ecosystem resources that address societal challenges effectively and adaptively, while providing benefits for human well-being and biodiversity"(UICN, 2016).

The European Commission's latest report on NbS states that the "concept of nature-based solutions embodies new ways of approaching socio-ecological adaptation and resilience, also drawing on the social, environmental and economic domain."(B.Sowińska-Świerkosz, 2022).

In this study, we tried to translate the concept of NbS into the Wolof language. This resulted in the following variations:

- Sukkandi ku si aalam gi nguir yokh sunu ndegerlay
- Jefandiko aalam gi saafara soloss dekuwaay yi
- Saafara bi nu taataanee si aalam gi

In all three translations, the word "aalam" meaning nature recurs everywhere. Another interesting concept is that of "ndegerlay" which can mean resilience, in this case, resilience based on nature.

3.2 Importance of NbSs for urban flooding

After the implementation of the PRECIT in the commune of Thiès Nord, which improved the resilience of communities to flooding, through awareness raising and community mobilization, nature-based solutions (NbS) were identified as an approach that could strengthen the range of solutions for effective flood risk management. Indeed, these solutions harness natural processes and ecosystems to reduce flood risk, improve urban resilience, and provide various ecological and social benefits.

In the case of the city of Thiès, the vulnerability of its population to the severe impacts of flooding and the direct link between extreme climatic events and poor land use conditions on the Thiès plateau demonstrate the importance of NbS for urban management that combines environmental preservation and economic benefits.

In addition, for this study, the interviews with the technical services, in particular the Regional Director of the Environment and the Director of Urban Planning showed the importance of developing NbS in the city, particularly for the fight against floods, on the one hand, the degradation of plant resources, with the retreat of tall trees, at the level of the linear plantations that made Thiès, the city "with streets without sun", air pollution, with the scarcity of urban green lungs.

3.3 Data sources

To have a better knowledge of the city of Thiès and the context of the NbS that is underway there, we have mainly analyzed the following documents described here.

3.3.1 Monograph of Thiès

The monograph of Thiès is a document that gives a detailed description of the city, highlighting its relief, its climate, and its environmental challenges. The city rests on

the Thiès plateau, characterized by sedimentary deposits and complex geomorphology, which makes it vulnerable to flooding and erosion. In the case of that study, Nature-based solutions, such as wetland restoration and greening of urban spaces, are discussed to mitigate flood risks.

3.3.2 Economic and Social Situation of the Thiès Region

This document, published every two years by the National Agency for Statistics and Demography, highlights the importance of urban agriculture and natural resources for the local economy. Ecological initiatives, such as agroforestry and sustainable water resource management, play a key role in the region's economic and environmental resilience. The integration of nature-based solutions is discussed as ways to preserve biodiversity, support local livelihoods, and fight flooding (ANSD, 2023). The vulnerability of the district municipality of Thiès-Nord (city of Thiès) to flooding explores the urban challenges of Thiès, in particular the recurrent floods in the northern districts. It proposes solutions such as the creation of retention basins, the restoration of dry waterways, and the use of green spaces to absorb excess water (Ngom, 2013). These nature-based approaches are presented as alternatives that can reduce flood risks and improve the quality of urban life.

3.3.3 The Project Document on Ecosystem-Based Adaptation

This UNDP and IUCN-supported project aims to strengthen the resilience of biodiversity, ecosystem services and agropastoral communities to the impact of increasing climate change, and the associated risks of annual droughts and floods. Interventions such as reforestation, wetland management, and the creation of ecological corridors are proposed to mitigate the impacts of climate change and protect urban infrastructure.

3.3.4 Thiès-Carrefour City

This document describes Thiès as an important regional hub, requiring sustainable solutions to manage its rapid urban growth. Projects include the establishment of urban parks and community gardens to provide green space while reducing urban heat islands and improving stormwater management.

3.3.5 Outline of the Urban Development Plan of Thiès

The outline of the Urban Development Plan (UDP) highlights strategies for integrating nature-based solutions into urban design. This includes preserving existing natural areas, creating new green spaces, and using green building techniques to reduce the city's environmental footprint. The UDP remained at the project stage.

3.3.6 Montrolland Communal Development Plan

The Communal Development Plan (PDC) of Montrolland, a commune bordering Thiès, highlights the importance of the sustainable management of natural resources.

Initiatives include protecting forests, promoting agroecology, and improving waste management to prevent pollution and preserve local ecosystems.

3.4 The city of Thiès

In this section, we will present the geographical location of the city, its demographic evolution, its main environmental and urban challenges, to end by focusing on the problem of flooding in Thiès.

3.4.1 Geography and demography

The city of Thiès, the capital of the region located in the department of the same name, covers an area of 68.82 km². It is located 70 km east of Dakar and some 22 km west of Tivaoune, the Holy City. It is surrounded to the north and south-east by the commune of Mont Rolland, the commune of Fandène with a small opening to the north-west on the commune of Keur Moussa (Mbodj, 2020).

Decree No. 2008-1244 of November 20, 2008, gave birth to the City of Thiès with three (03) municipalities :

1. Thiès North: 21 districts.
2. Thiès East: 20 districts.
3. West Thiès: 18 districts.

At the end of the latter, the classified forest of Thiès begins, covering an area of 11600 ha at the time of its classification by decree/law No 1943 of 23 August 1934. Today, part of this forest has been declassified to make way for the Mbour 4 housing estate.

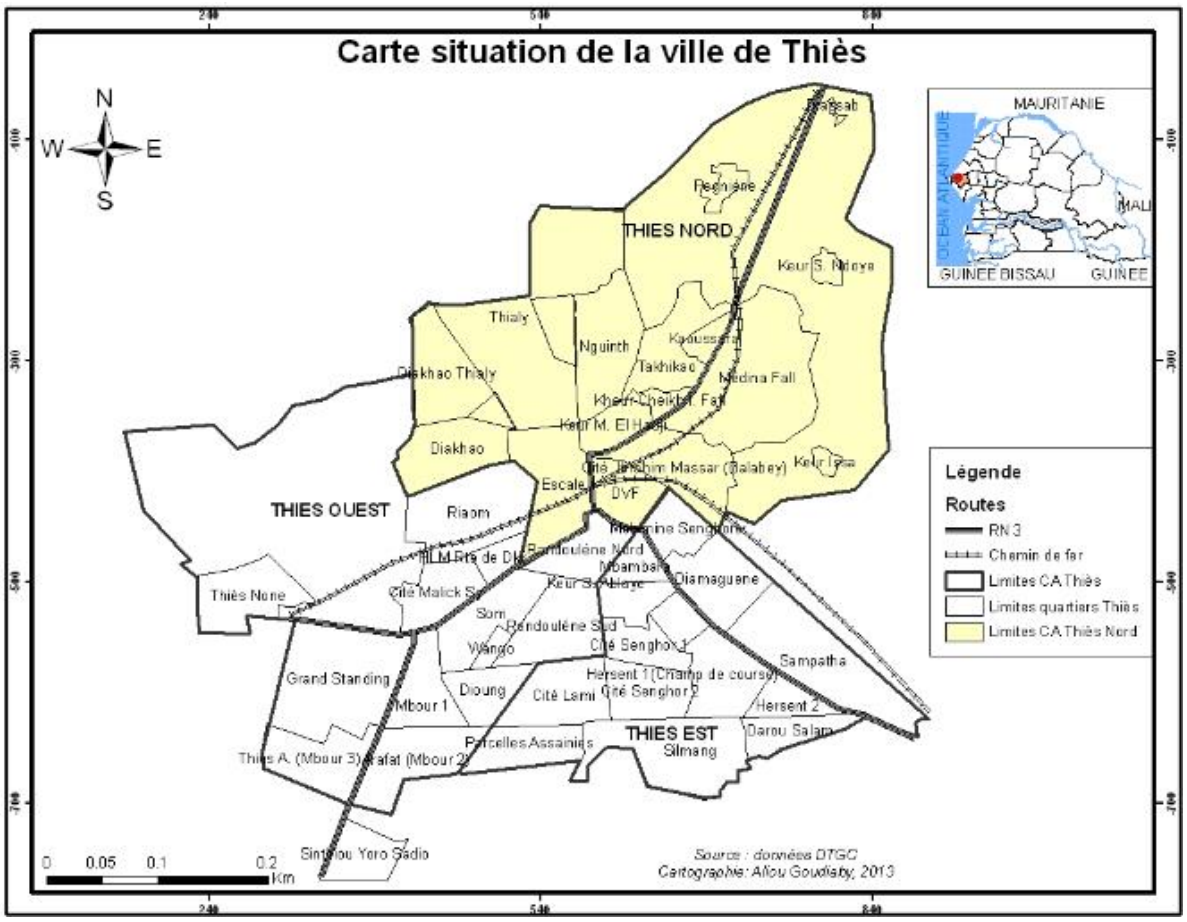

Figure 1: Location map of the city of Thiès (Gning, 2013).

Demographically, the city of Thiès has about 500,000 inhabitants, making it the 3rd largest city in Senegal behind Dakar and Touba. These inhabitants are unevenly distributed in the urban space with neighborhoods where the density of inhabitants per km² exceeds 10,000 inhabitants and others located on the periphery where housing is still scattered with less than 1500 inhabitants.

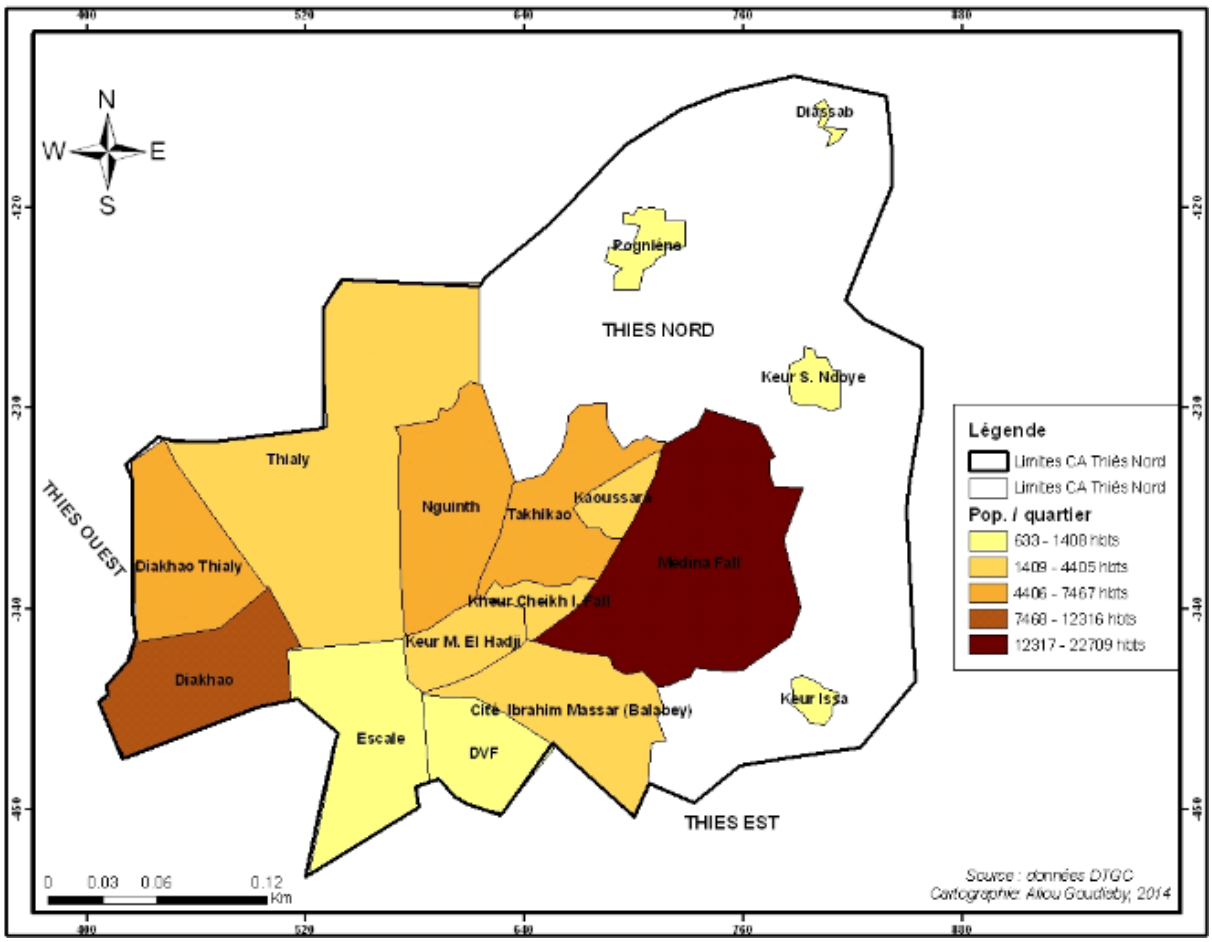

Figure 2: Map of demographic density (Gning, 2013).

The urban growth of the city of Thiès is characterized by an acceleration of population growth linked to birth rates combined with migratory movement. The relative proximity to Dakar, the dynamism of yesteryear, the presence of two of the largest railway stations in the country, and the existence of industries has made Thiès a migration zone. Today, with the toll highway, Thiès has become an area with extraordinary real estate stakes. Despite issues of flooding in the city, there is still rapid development and construction.

3.4.2 Flooding in Thiès

Flooding in Thies is a recurring problem. The rains that fell in the city of Thiès during the month of August 2022 caused significant flooding in the district commune of Thiès-Nord. This same situation was observed in August 2023 when 53 mm recorded on August 2 caused significant disasters and affected more than 150 families (Thiès info, 2023), particularly in the neighborhoods of the commune located in low-lying areas such as Nguinth and Medina Fall. These heavy rains, which are now following the dry episodes that the area was experiencing, occur in a very precarious urban context, like many other urban areas in the country. This rainfall dynamic is exacerbated by the city's watershed position, illustrated by the digital terrain model (figure 3). The city is in the hollow of the depression, especially its

neighborhoods that are more impacted by flooding, such as Nguinth and Medina Fall.

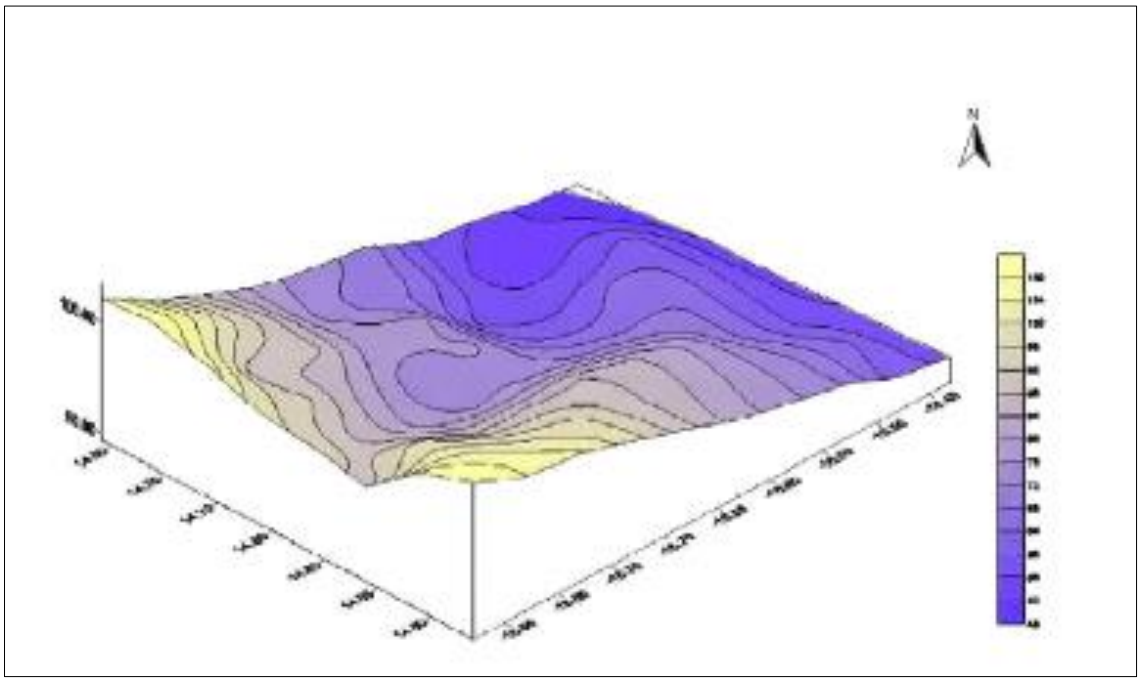

Figure 3: Digital terrain model of city (Gning, 2013).

This combination of rainfall events, the shape of the relief and the marl-limestone substrate exposes the city to flooding because it must be recognized that "the urban environment very often increases the climatic risks linked to exceptional types of weather" (Besancenot, 1997).

In addition to this vulnerability, there is an advanced degradation of vegetation, especially on the Thiès plateau. According to Mr. Gueye, coordinator of the NGO ADT-GERT, this heavy deforestation in the Thiès plateau has contributed to making the runoff faster, creating torrents of water that surge towards the city, because there are no more trees to slow them down. Another problem that was raised during our interviews was the obstruction of the natural waterways that served as an outlet for the overflow of water to the surrounding valleys. Today, a project implemented by the Municipal Council of Thiès to reconnect old waterways and rainwater drainage channels is underway and should eventually significantly reduce flooding.

A few testimonies collected during the implementation of the PRECIT make it possible to better highlight this situation of recurrence of floods and their consequences on communities and their property.

Aliou Diop, a 38-year-old farmer, was born and raised in Thiès Nord. The Thialy district in which he lives is suffering from serious flooding, mainly due to insufficient construction and the lack of resources of the population. During the rainy season, water enters homes and stagnates, leading to health and sanitation problems. Some families lose their homes, income, and resources. As an active member of his community, Aliou and his neighbors solve this problem by quickly removing the water with a pump. They borrow equipment from

the town hall, but it is often unavailable because it has already been assigned to another sector.

Extract from the blog: The reality of urban flooding in Thiès, Senegal, Feb, 2022. By Lydia Darby.

Ndeye Awa Beye, a 38-year-old mother of three, lives in Keur Mame El Hadj, another flood-affected neighborhood in Thiès North. Living near the canal, water enters her house during the rainy season, causing enormous damage and forcing her and her family to abandon their home. Because of the floods, Ndeye Awa lost his refrigerator and his provisions, especially rice. The floods also prevented her from going to work temporarily, as she had to prioritize finding shelter for her family.

Extract from the blog: The reality of urban flooding in Thiès, Senegal, Feb, 2022. By Lydia Darby.

4.0 Nature-based Solutions in Thiès

4.1. Inventory of NbS in the city of Thiès

The surveys carried out as part of this study made it possible to identify 139 NbS initiative leaders in the city of Thiès. Thanks to the GIS tool, they were able to be geolocated at the scale of the city and its hinterland.

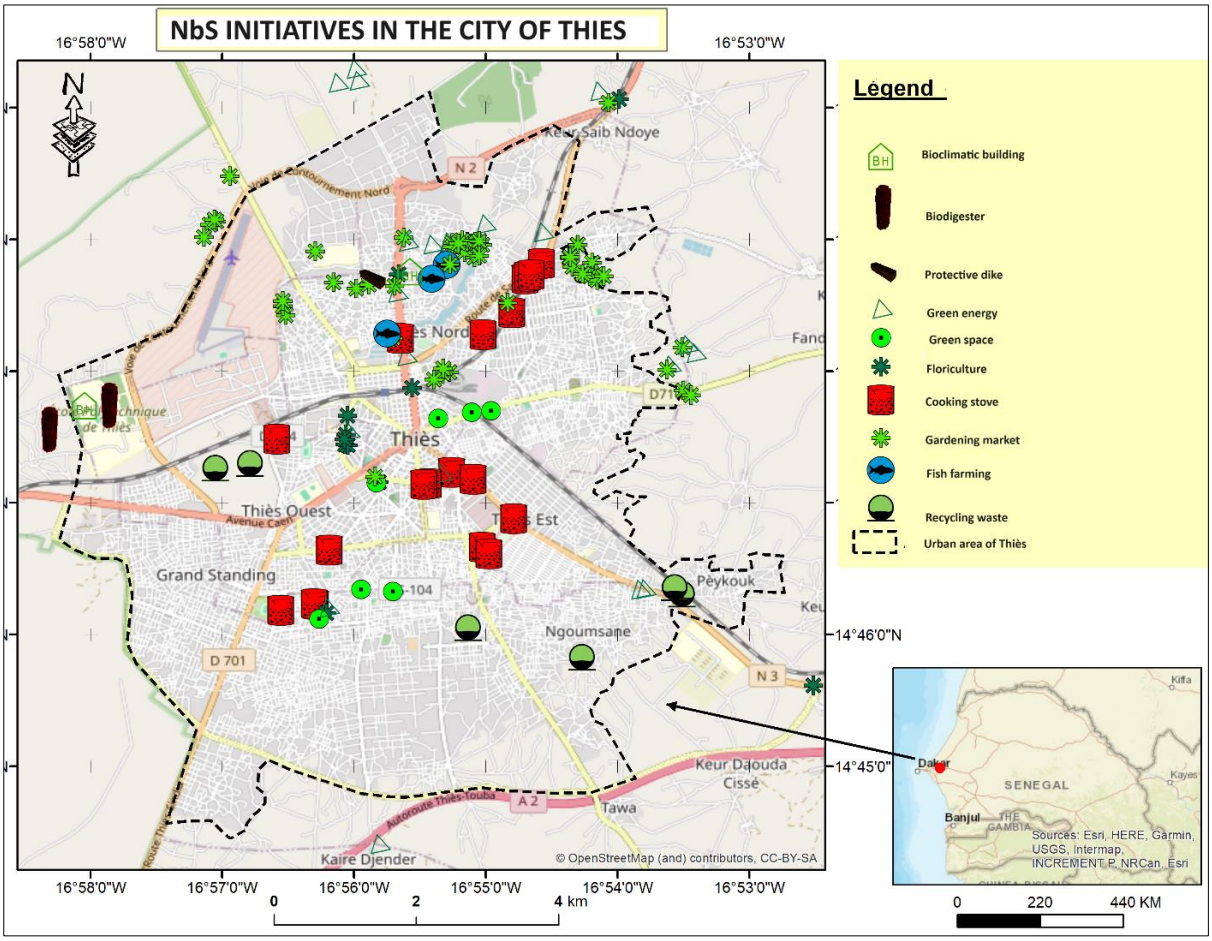

Figure 4: Map of the location of NbS initiatives in the city of Thiès.

The NbS have been grouped by category according to their thematic proximity thanks to the exploitation of the database.

Among the nature-based solutions (NbS) identified in Thiès is market gardening, which employs nearly 40% of project leaders, generating 365 direct and indirect jobs. The use of solar energy is booming (19% of the initiatives identified), particularly with the installation of solar motor pumps used for the dewatering system in the context of market gardening. Among the initiatives, those relating to flood control particularly caught our attention, because they are mostly located in low-lying areas where the water table is flush.

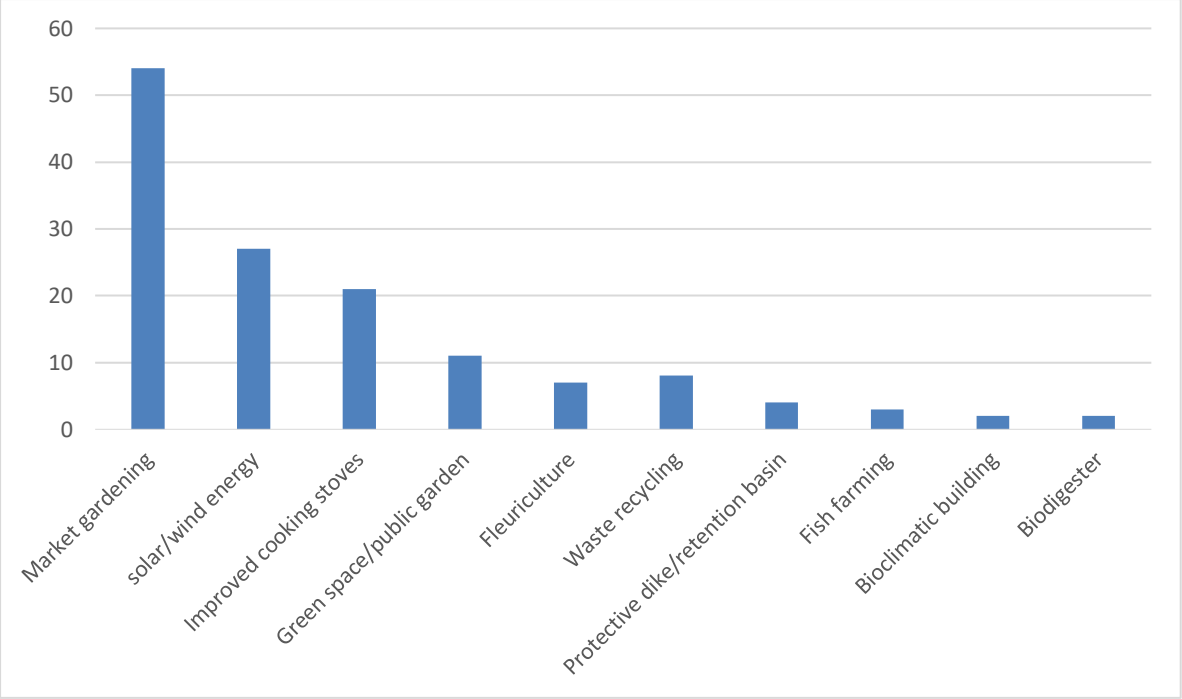

Figure 5: Percentage breakdown of Nature based Solution types in Thiès.

Among these nature-based solutions, those relating to flood control are the following:

- Market gardening
- Green space/public garden
- Fleuriculture
- Protective dike/retention basin
- Fish farming

4.2 Existing NbS initiatives

The main initiatives identified in the city of Thiès and the surrounding area focused on:

4.2.1 Aquaculture in flood-prone areas

Three aquaculture and fish farming initiatives have been identified in the city of Thiès. These initiatives have transformed ponds into buffer zones during periods of heavy rainfall with fish stocking, thus offering considerable income to project leaders, on the one hand and facilitating the supply of fresh fish to local communities on the other. In the city of Thiès, some flood zones are used for fish farming, particularly in the Nguinth district. The developer has set up an integrated system that reuses the water used for the fish farm to water the vegetable garden, but also serves as a swimming pool for duck farming, thereby improving the income from the activity.

Fish farming, an NbS initiative in the heart of a flood zone

This initiative is led by a young man from Thiès who has set up shop at the level of the old horticultural school in the Nguenth district, which is invaded by runoff water that combines with rainwater during the rainy season.

This initiative has a strong potential to fight flooding in the district. It is economically profitable and socially accepted; It employs more than 15 people. Aquaculture requires a large amount of water and by using groundwater it is possible to regulate groundwater levels. Indeed, the developer pumps water from the water table to supply the livestock basins, thus reducing the risk of soil saturation and flooding.

At the same time, it has integrated solar panels to power water pumps with a reliable, sustainable and greenhouse gas-free energy source. This approach is particularly relevant in a region like Thiès, where solar energy is abundant.

Source: NbS survey in Thiès, PA, 2024.

The project leader has tried to integrate aquaculture, livestock, and market gardening into a broader water management system. Fishponds can serve as temporary reservoirs to retain rainwater during periods of heavy rainfall, reducing runoff and flood risk. The water from the ponds is also used to fill the duck breeding pond and to water the market garden.

4.2.2 Market gardening and floriculture

These are very frequent activities in Thiès and they use water from the aquifer for watering. These activities also contribute to the fight against flooding by pumping water from groundwater, but also to the regreening of the city. They also generate income for more than 500 people.

By pumping this water for use in urban agriculture, water runoff is limited, and flooding in neighborhoods reduced. This is the case of these market gardening initiatives identified in the water valley, north-east of the Nguinth district.

Source: NbS survey in Thiès, PA, 2024.

4.2.3 Solar and wind energy

The interest of renewable energies in the field of NbS is that they facilitate access to energy in market gardening areas to allow water to be pumped and used for watering. As part of this study, we identified nearly 27 NbS initiatives integrating solar and/or wind energy.

4.2.4 The use of improved cookstoves

For the purposes of this study, the use of improved cookstoves is considered an NbS insofar as they contribute to improving environmental sustainability and mitigating negative impacts on ecosystems. This is because improved cookstoves are designed to burn fuel more efficiently, reducing the amount of wood or charcoal needed to cook food. This helps to reduce pressure on forests, as less wood is taken to meet household energy needs. They also help reduce emissions of harmful air pollutants such as fine particulate matter and greenhouse gases.

4.2.5 Green spaces and public gardens

The city of Thiès was for a long time reputed to be a green city, due to the numerous linear plantations of tall trees. Today, these trees are aging, and the branches often fall. It is in this context that The Initiative Leaders, including members of the Movement “Thies en marche” aim to contribute to the regreening of the city of Thiès through the establishment of green spaces and public gardens.

Source: Facebook page of the Thiès en Marche Movement, consulted on May 12, 2024.

The NbS in Thiès will help improve air quality, provide shade to mitigate heat, and protect against soil erosion and heavy runoff that cause flooding. An organization like "Thiès en marche" has understood the important role of green spaces in improving the quality of life through parks and leisure and relaxation areas; but also, green spaces are important for local biodiversity (fauna and flora).

Source: NbS study in Thiès, PA, 2024.

In the city of Thiès, the development of parks and green spaces is beginning to emerge more and more on the initiative of communities, sports and cultural associations, activist groups. These urban green spaces are water retention areas and improve the quality of life of residents. However, they are not integrated into an overall flood management strategy. The question of coordination of all these activities arises, between the three municipalities of Thiès and their technical services.

Source: NbS survey in Thiès, PA, 2024.

Our interviews with the representatives of "Thiès en marche" showed that they are very committed to a program of regreening the city, through the renewal of the "Khaya senegalensis" park, several hundred years old. However, they are not aware of the role that these urban green spaces can play in mitigating flood risks.

4.2.6 Protective dikes and stone barriers

In the city of Thiès, communities affected by the floods have erected sand dikes and stone barriers to protect themselves from the water. For example, the NGO GRAIM has implemented the "Dunda ak Kewbi" project consisting of developing community-based approaches to combat water erosion in the Thiès plateau, which is one of the main causes of flooding in the city of Thiès.

The stone barriers installed by the NGO ADT-GERT have helped to stabilize the soil and reduce rainwater runoff. This has also made it possible to recharge the water tables, thus promoting the development of market gardening activities.

Source: NbS survey in Thiès, PA, 2024.

Stone bunds help stabilize soils and reduce erosion, which can also help reduce flooding by slowing stormwater runoff. They are made up of an alignment of stones arranged in one or more rows along the contour lines. Stone barriers are structures that filter and break the force of runoff. They prevent a concentration of water upstream and facilitate downstream flow.

In the case of the city of Thiès, particularly at the level of the Thiès Plateau from which the water that floods the city runs, the experts recommended the installation of stone barriers following the contour lines to a depth of 30 cm. The excavated earth is placed downstream to form a bead to hold the water. These developments store enormous quantities of water and promote good infiltration and play a very important role in the recharge of the water table.

The construction of stone barriers is generally less expensive than that of dikes which are often built with reinforced concrete structures, as they can be built and maintained by local communities, which promotes the involvement and empowerment of the populations. However, they require regular maintenance to maintain their effectiveness, especially after heavy rains.

Source: NbS survey in Thiès, PA, 2024.

4.2.7 Bioclimatic buildings

We have identified two initiatives that focus on bioclimatic buildings because of their sustainability and energy efficiency, although they are not strictly "nature-based" like natural ecosystems, but rather on nature-inspired design principles. Indeed, Nubian vaulted buildings are inspired by ancient Nubia and their interest is that they are constructions without iron, concrete, or cement, just with earth. These buildings have shown their resilience to the adverse effects of climate change (https://www.lavoutenubienne.org/, accessed April 22, 2024).

Because of their potential to reduce their ecological footprint, we considered them to be NbS because they consume less energy, limit greenhouse gas emissions, and preserve natural resources.

Source: NbS survey in Thiès, PA, 2024.

4.2.8 Recycling and recovery of waste

Recycling and waste recovery is a very popular activity in Thiès. Data from our survey showed that there are more than 150 people engaged in waste recycling. Among them, there are 10 that are in the production of biogas from organic waste, thus avoiding methane emissions. Thus, our interviews showed that the potential of NbS is real in the recycling sector. However, as with most of the solutions implemented in Thiès, the leaders are not aware that they are implementing NbS.

Source: NbS survey in Thiès, PA, 2024.

4.3 Enabling environment

Nature-based solutions offer an integrated approach to solving environmental problems while providing social and economic benefits. Their success often depends on a good understanding of local ecosystems, active community participation, and adequate political and financial support (IUCN, 2022). With the Law on Decentralization, the environment and the management of natural resources is a competence transferred to local authorities which generally include resilience actions in their planning, in particular resilience to floods. The Municipal Secretary of Thiès North spoke about the commitment of his municipality to support and accompany NbS initiatives relating to the fight against floods.

In addition, it should be noted that the fast urbanization leading to an extension of housing into natural areas. The Mbour 4 housing estate, following the declassification of the classified forest of Thiès, is a perfect illustration of this. The only classified forest in Thiès has been subdivided, thus showing the prioritization of housing projects over environmental projects.

4.3.1 Political will

The involvement of public policy actors is often insufficient, which limits the adoption and effective implementation of nature-based solutions. Indeed, many policymakers are not sufficiently informed about the advantages of NbS over traditional grey infrastructure solutions. Interviewees reflected that policymakers may perceive NbS as less reliable or less effective, which can make them reluctant to support them. The interviews we had with the Municipal Secretary of Thiès Nord

tend to prove this situation. According to this technician from the local authority, they are aware of the problem of flooding, for example, but they first think of expensive civil engineering solutions that mobilize a lot of resources before thinking about soft solutions.

Due to the lack of support from political decision-makers and local authorities, more than 95% of project leaders have not received support from local authorities, projects, or programmes. In a regulatory and institutional framework, both the Environmental Code and the Urban Planning Code do not provide incentives to encourage NbS.

4.3.2 Economic considerations

Budgetary priorities (health, education, fight against poverty) are not always in favour of the NbS. Environmental policies are often not perceived as a priority in relation to the immediate objectives of expected results on the part of the municipal teams. The NbS is seen practically as a sub-activity whose results, in the short term, apart from the income they provide to their initiators, are not very perceptible. An evaluation carried out as part of the development of the National Strategy for the Preservation of Biodiversity showed that local authorities, on average, devote less than 5% of their budget to the environment.

There are economic and financial constraints to implementing NbS. The NbS project leaders often need money for the first investments and banks are reluctant to finance them.

An analysis of the three pillars of the NbS shows that it is first and foremost the economic pillar that is of primary interest to the initiators. It is then that the environmental pillar follows, albeit with an obvious environmental awareness. Indeed, to the question of what purposes the initiatives are implemented, 37% of respondents in the study answered that it was to preserve the environment and improve incomes and livelihoods. For most of the other actors, it is the financial income that interests them.

The diagram below shows the distribution of solutions surveyed in the study according to their objectives.

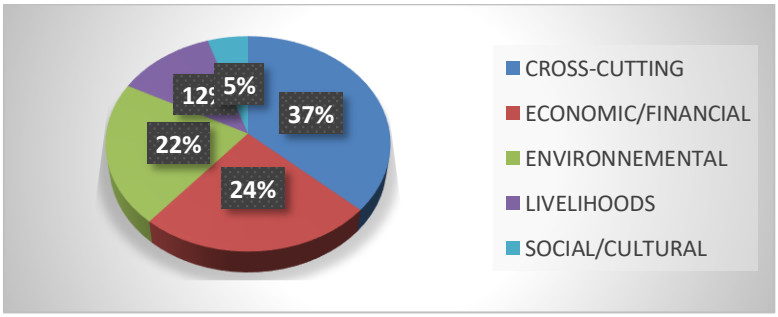

Figure 6: Distribution of NbS by sector. Source: NbS survey in Thiès, PA, 2024.

4.3.3 Evidence

Interviews with local stakeholders have shown that the NbS currently implemented do not collect data or analyse their effectiveness at reducing flood risks to provide evidence at the city level.

It is unclear on whether the NbS have reduced flooding in Thiès, especially in the Nguinth district as there is no evidence yet to answer this question because monitoring and evaluation is not taking place. The fact remains that during the 2022 and 2023 rainy season, the district experienced flooding, with 150 families affected.

4.3.4 Strengths, weaknesses, opportunities and threats

Table 2: SWOT analysis of NbS initiatives in Thiès, Senegal

Strengths	**Weaknesses**
• Significant number of actors mobilized. • Diversity of solutions implemented. • Project and programme support. • Existence of committed local organizations. • Environment and urban planning, competences transferred to local authorities. • Technical services aware of integrating NbS into urban planning. • Supporting university research with the Ecole Polytechnique de Thiès.	• Low financial commitment from local authorities to support NbS. • Semantic misunderstanding of NbS in their current forms. • Weak demonstration of links between NbS and flood control, e.g. lack of data, monitoring, and evaluation. • Weakness in terms of knowledge for the technical staff. • Scarcity of financial resources, with banks often doubting the solvency of NbS projects. • Weak integration of NbS in municipal planning documents.
Opportunities	**Threats**
• Growing interest of development partners. • The eligibility of NbS projects for climate finance. • The existence of financial incentive mechanisms. • Increase in NbS-related trades training centres.	• Climate change and its consequences that can hinder the success of certain NbS. • The recurrence of floods, despite the efforts of the. • Rapid urbanization and habitat programs that destroy ecosystems

5.0 Obstacles and recommendations

5.1 Obstacles

As part of the study, we identified several barriers that hinder the widespread and more efficient adoption of NbS. These different obstacles are related to:

1. **Lack of awareness and understanding** of the role of NbS in preserving urban ecosystems, managing floods, and improving the living environment of communities.
2. **Lack of support or incentives** from political decision-makers and local authorities.
3. **Economic and financial constraints** placing a barrier on local community members who want to implement NbS initiatives.
4. **The lack of intersectoral coordination** due to a lack of a forum for sharing, consultation and synergy between the actors who implement the NbS
5. **Weakness of technical capacities** (specific technical skills lacking), there is still no integration of NbS training into education and training curricula.
6. **Lack of monitoring and data** for existing NbS in Thiès, so there is a lack of evidence to support advocacy for implementing NbS to reduce flood risks to the city.

5.2 Recommendations

All the interviews that took place as part of this study ended with the following question: what recommendations can you make to us for the promotion of NbS in Thiès? The different responses were analyzed, interpreted, and synthesized to produce the following recommendations:

1. **Raise awareness.** The importance of raising awareness among local stakeholders, including policymakers, businesses, and citizens, about the benefits of NbS. Awareness-raising campaigns and educational programmes could be implemented in schools, training centers and universities. Ecole Polytechnique de Thiès (EPT) has already started a programme of teaching and research in the field, and this can be a first step towards better recognition of NbS. At the same time, municipal technicians and urban planners should be trained on the design, implementation, and management of NbS projects.

2. **Establish finance mechanisms.** The establishment of innovative financing mechanisms, such as payments for ecosystem services, green bonds, and public-private partnerships. The mobilisation of funds to support NbS is a need unanimously expressed by all stakeholders. The accreditation of La Banque Agricole to the Green Climate Fund is a real

opportunity to support NbSs because banks are increasingly aware of the economic, environmental, and social interest in financing NbS. For example, the “Womal Mbey” initiative supports agricultural project leaders who want to install solar panels for pumping irrigation water.

3. **Support policies.** Support for the implementation of NbS-friendly policies and regulations. This can include tax incentives, subsidies for green projects, and green building standards. Local authorities have a role to play, particularly at the level of their umbrella structures (Association of Senegalese Departments, Association of Mayors of Senegal) to raise awareness among parliamentarians, senior advisors, and members of the Economic, Social and Environmental Council to advocate with the highest decision-making bodies in the country.

4. **Encourage collaboration.** Networking and collaboration between NbS project leaders, the public and private sectors, NGOs, local communities, and research institutions would guarantee the effectiveness and efficiency of NbS initiatives, which would thus be sustainable. These partnerships will strengthen technical capacities, mobilize financial resources, and promote the exchange of good practices. For example, the NGO ADT-GERT is a champion in soil conservation/restoration and soil defense/restoration (CRS/DRS) and is only willing to share its knowledge and know-how.

5. **Generate evidence.** More evidence is needed, particularly in monitoring and evaluating the effectiveness of existing or emerging NbS. It would be relevant that from 2024, to monitor a range of physical social, environmental, and hazard-specific indicators in connection with the NbS recorded in the municipality, to better understand which interventions are most effective and why. For example, it would be useful to study the location of parks and urban green spaces, according to the topography of the city, the direction of rainwater flow and the "sponge" areas, which are commonly called "water catchment areas" to understand where green spaces currently do, (and in the future, could) have the most beneficial impact.

6.0 Conclusions and lessons learned

The city of Thiès is home to many local initiatives that, without being fully aware of it, are implementing nature-based solutions (NbS). These initiatives are often driven by immediate economic needs, but they also contribute significantly to environmental sustainability and climate resilience. However, one of the most threatening urban problems for the city remains flooding and it must be admitted that the NbS have not finished solving. However, real prospects are emerging if the municipal authorities manage to understand the importance of NbS and to support the promoters of initiatives. There is a need to strengthen their capacity on NbS and start to strengthen the sustainability of their activities.

To maximize the impact of these initiatives, it is crucial to collect evidence to understand, and increase awareness of the benefits of NbS among local and policy actors. Policymakers can play a key role in providing institutional and financial support, developing supportive policies, and facilitating coordination between different actors. By strengthening these local initiatives with an appropriate support framework, Thiès can better adapt to environmental and climate challenges while improving the economic and social well-being of its inhabitants.

In addition, the need to consider natural ecosystems in urban planning is an essential condition for integrating flood management in the city of Thiès through a holistic approach that transcends the administrative boundaries of municipalities. Thus, building with nature involves the integration of NbS into urban planning and development to create resilient and sustainable environments.

This study identified local initiatives based on or inspired by nature to strengthen the resilience of urban communities in Thiès to climate risks, including those related to flooding. The participatory approaches made it possible to listen to nearly 140 people, each of whom presented their initiatives, their motivations, the difficulties encountered, the prospects for consolidation and a probable scale-up.

Ultimately, by adequately improving evidence, awareness, training, financing and regulating NbS initiatives, Thiès could become a model of urban sustainability and climate resilience.

Bibliography

Bibliographical references on the city of Thiès

Cergy 2012. Thiès, ville carrefour vers une métropole d'équilibre, de l'échelle globale à l'échelle locale ; dossier de contexte ; 104p.

Dieng A. A.2018. « Dynamique d'urbanisation dans la ville de Thiès » ; mémoire de master 2 ; Université Cheikh Anta Diop ; 110p.

Djagoun B.1991. « Contribution à l'assainissement en eaux pluviales de la ville de Thiès ; projet de fin d'étude ; école polytechnique de Thiès…..

G. Savounnet, 1955. La ville de Thiès étude de la géographie urbaine.

G. Savounnet, 1956. Une ville neuve au Sénégal : Thiès ; extrait de la revue les cahiers d'outre-mer tome 9 ; p : 70-93.

Maitrise d'œuvre urbaine, 2012. Thiès, ville carrefour vers une métropole d'équilibre, de l'échelle globale à l'échelle locale ; cahier de session.

Tepe A. 2005. « Le lotissement à la périphérie de Thiès : problématique d'une gestion foncière entre la ville de Thiès et la communauté rurale de Fandene : enjeux, perspectives, et pratique des acteurs ; 24p.

Bibliographical references relating to the NbS

MEPN, 2008. Stratégie Nationale et plan National d'Actions pour la conservation de la biodiversité, 94p.

World BankClimate Change and Adaptation: Nature-Based from the World Bank Portfolio, Biodiversity, SolutionsWashington, DC, 2008 .

B. Sowi ń ska- Ś wierkosz , J. García , A new evaluation framework for nature-based solutions (NbS) projects based on the application of performance questions and the indicators approach, Sci. Total Environ. 787 (2021) 147615 .

Science for Environment PolicyThe Solution is in nature. Future Brief 24. Brief Produced For the European Commission DG Environment, Science Communication Unit, UWE Bristol, Bristol, 2021 .

Towards an EU Research and Innovation Policy Agenda for Nature-Based Solutions & Re - Naturing Cities, European Commission, Brussels, 2015 .

IUCNGlobal Standard for Nature-based Solutions. A User-Friendly Framework For the verification, Design and Scaling Up of NbS, 1st Edition, IUCN, Gland, Switzer- land, 2020 .

Nature-Based Solutions for Children (NbS4Children), Save the Children International, 2022

Appendices

CARE GUIDES

1. IDENTIFICATION OF NbS INITIATIVES IN THIES

Name of Initiative:

Consistency of the initiative:

Place of implementation: GPS coordinates

Initiative Leaders: Community – Individual

Issue(s) addressed:

Proposed solutions:

Difficulties:

Unmet Needs:

Perspectives :

Recommendations:

Last Name – First names and contact details of the contact person:

2. MEETING WITH SERVICE DEPARTMENTS AND PROJECT MANAGERS

NbS-based planning documents

……

NbS initiatives in Thiès:

……..

Technical analysis of the city's environmental problems

……..

Technical recommendations

…….

Perspectives

Last Name – First names and contact details of the contact person:

3. TO LOCAL ELECTED OFFICIALS AND MUNICIPAL AGENTS

Environmental problems at the municipal level

…….

Nature-based solutions that you know

……

Your appreciation of the nature-based solutions implemented

……

Difficulties

…….

Recommendations

Last Name – First names and contact details of the contact person:

LIST OF CONTACTS INTERVIEWED

- Regional Agency for Environment
- Regional Urban Planning Service
- Regional Planning Department
- Regional Agency of Water and Forests
- Ecosystem Based Adaptation Project – UICN
- Regional Development Agency
- GIE GIPSWAR
- Thies En Marche