



French Guiana Anchor Project report

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Summary

This report presents the results of the Anchor Project on ecosystem services carried out in French Guiana as part of the European consortium MOVE-ON. Tropical rainforest covers more than 96% of French Guiana and is home to many Amazonian species, (including the emblematic, jaguars, giant otters, tapirs, etc.) with a great ecological and biological richness. In this sparsely populated territory, the population is growing rapidly so are the related economic needs. Address this issue while maintaining the ecosystem health, requires an original sustainable development path. In this context ecosystem services are crucial. Thus, the main objective of this case study was to highlight these ecosystem services and show that it was possible to take them better into account, at the scale of the territory of a municipality of French Guiana (Montsinéry-Tonnegrande). Based on participatory mapping with stakeholders and inhabitants, supplemented by existing work and data, the French Guiana office of WWF France carried out this Anchor Project in collaboration with the municipality of Montsinéry-Tonnegrande. It has made it possible to establish a first map of ecosystem services related to tourism activities, natural and cultural heritage as well as traditional activities of collecting wild products (crabs, oysters, etc.) Eventually, these new data will help the development and planning orientations of the municipality.

Résumé (FR)

Ce rapport présente les résultats du travail d'étude de cas (Anchor Project) autour des services écosystémiques mené en Guyane française dans le cadre du consortium européen MOVE-ON. Couvert à plus de 96% de forêt tropicale humide, habitat de nombreuses espèces amazoniennes, dont les emblématiques, jaguars, loutres géantes, tapirs, etc. la Guyane possède une grande richesse écologique et biologique. Sur ce territoire peu densément peuplé, les besoins économiques d'une population en forte croissance amène à penser un mode de développement soutenable permettant d'y répondre. C'est dans ce contexte que les services écosystémiques prennent toute leur importance. Ainsi cette étude de cas a eu pour objectif principal mettre en lumière ces services écosystémiques et montrer qu'il était possible de mieux les prendre en compte, à l'échelle du territoire d'une commune de Guyane (Montsinéry-Tonnegrande). En s'appuyant sur des travaux de cartographie participative avec les parties prenantes et les habitants de la commune, complétés par des travaux et données existantes, le travail réalisé par le bureau Guyane du WWF France en collaboration avec la mairie de Montsinéry-Tonnegrande a notamment permis d'établir une première cartographie des services écosystémiques liés aux activités touristiques, au patrimoine naturel et culturel ainsi qu'aux activités traditionnelles de collecte de produits issus de la nature (crabes, huitres, etc.) A terme, ces nouvelles données pourront accompagner les orientations de développement et d'aménagement de la commune.

Table of Contents

1	INTRODUCTION	7
2	OVERVIEW OF THE STUDY AREA	8
2.1	The Guiana shield, a vast Amazonian tropical forest	8
2.2	The French Guiana overseas region	10
2.3	The Montsinéry-Tonnegrande municipality	15
3	ANCHOR PROJECT OBJECTIVES & RESEARCH QUESTIONS	18
3.1	Context & previous studies on ecosystem services in French Guiana	18
3.2	Research questions and objectives	19
3.3	Objectives and subtasks	20
4	METHODS AND MATERIALS.....	21
4.1	Literature review.....	21
4.2	Data inventory.....	23
4.3	Stakeholders interviews.....	24
4.4	Participatory mapping workshop.....	24
5	RESULTS	28
5.1	ES potential overview in Montsinéry-Tonnegrande	28
5.2	Focus on the participative Fauna monitoring.....	32
5.3	Local Ecosystem services mapping in Montsinéry-Tonnegrande	35
5.4	Spatial analysis of the participatory mapping results	37
6	DISCUSSION	40
7	CONCLUSIONS.....	41
8	REFERENCES	42
9	ANNEX.....	43

List of Figures

Figure 1. Situation map of the Guiana Shield	8
Figure 2. Gold mining deforestation up to 2018 in the Guiana shield.....	10
Figure 3. Map of the French Guiana outermost region (OR)	11
Figure 4. Land use & occupation of French Guiana & Montsinéry-Tonnegrade location.....	12
Figure 5. Protected areas in French Guiana	14
Figure 6. Location of Montsinéry-Tonnegrade in French Guiana	15
Figure 7. Montsinéry-Tonnegrade and the nearby city of Cayenne	16
Figure 8. Land use & Occupation of Montsinéry-Tonnegrade.....	17
Figure 9. Areas of ecological interest in (ZNIEFF) Montsinéry-Tonnegrade	18
Figure 10. Ecosystem services in French Guiana (adapted from Sieber et al., 2020)	22
Figure 11. List of potential ecosystem services in French Guiana	25
Figure 12. Picture of an ongoing participatory mapping session	26
Figure 13. Participants to the first participatory mapping session and preliminary results	27
Figure 14. Agricultural land in Montsinéry-Tonnegrade.....	28
Figure 15. Forest management in Montsinéry-Tonnegrade	29
Figure 16. Capacity (0 = None ; 5 = High) of ecosystems to supply carbon sequestration service in Montsinéry-Tonnegrade (Sieber et al. 2021)	30
Figure 17. Touristic sites in Montsinéry-Tonnegrade	31
Figure 18. Observation data of the Faune-Guyane participatory platform from 1992 to 2022 in MT.....	32
Figure 19. Location of observation data from Faune-Guyane platform.....	33
Figure 20. Density of observations from the Faune-Guyane platform	34
Figure 21. ES participatory mapping results (Red: Tourism; Yellow: fishing and hunting; Blue: Heritage or emblematic value; Green: others)	36
Figure 22. Cross analysis of ES GIS participatory results and LULC types.....	37
Figure 23. Land management plan of Montsinéry-Tonnegrade (2011)	38
Figure 24. Cross analysis of ES GIS participatory results and MT Land management plan.....	39

List of abbreviations

AP	Anchor Project
BEST	Biodiversity and Ecosystem Services in Territories of European overseas
CACL	Metropolitan Area of Cayenne, the capital city
ES	Ecosystem services
MT	Montsinéry-Tonnegrande
MAES	Mapping and Assessment of Ecosystem Services
ECOSEO	ECOsystem SErvices Observatory of the Guiana Shield
ZNIEFF	Area of ecological interest (<i>Zone Naturelle d'Intérêt Ecologique, Faunistique et Floristique</i>)

1 INTRODUCTION

French Guiana is a French outermost region with a very high coverage of natural habitats, representing almost 98% of the territory, largely untouched (Olson, 2001). The biological richness of its ecosystems is among the highest of the planet. With a vast territory and a low population density, the links between society and nature are inherently strong and ancient. Therefore, the livelihoods of lots of people depends at least partially on Ecosystem services (ES).

With a permanent field office in this region, WWF France led several projects to highlight the importance of those services, at the scale of the whole territory through the BEST initiative and even the greater region of the Guiana shield (ECOSEO). Those initiatives produced valuable results that confirmed the importance of the ES, but also highlighted the prevailing threats against it (Rahm et al, 2020; Sieber et al. 2020). Then, there is a critical need to better value and preserve ecosystems and their services by including it into economic and political decision-making.

As the WWF Guyane decided to join the MOVE-ON consortium, it aimed to produce a tangible, bottom-up approach. Therefore, it was decided to focus on a small scale, different to previous work done on the topic of ES and Natural Capital in the previous project. Due to the most diverse ecosystems in the environment and the sustainable development agenda of WWf, such an approach required to implement the Anchor Project on a municipal scale. This municipal scale also allowed for a better and closer interaction with the stakeholders and maximize the impact, locally as well as for informed policy and decision making.

2 OVERVIEW OF THE STUDY AREA

The French Guiana Anchor Project was implemented at small scale, a municipality called “Montsinéry-Tonnegrande” (abbreviated MT below). But, in order to understand the context, the challenges and issues that this specific territory faces, we need to understand the landscapes it belongs to, at every scale: from the Amazon and the Guiana shield, to the French Guiana Territory and eventually the MT municipality.

2.1 The Guiana shield, a vast Amazonian tropical forest



Figure 1. Situation map of the Guiana Shield

The Guiana Shield covers a third of the Amazon, including Guyana, Suriname, French Guiana, parts of Brazil, Venezuela and Colombia (Figure 1). It contains some of the most unique and intact Amazon ecosystems, including the amazing “tepui” table-top formations. Human population is low, mostly located in the coastal belt and poor inland transport services maintain the area remote. The region offers unique opportunities for conservation, but also faces several threats, namely related to gold mining activities (Boudou et al. 2006; WWF Living Amazon report, 2016).

2.1.1 The Guiana Shield, a region with exceptional natural capital

Covering an area of 270 million hectares, the Guiana Shield has an exceptionally rich natural capital. It includes a vast hydrographic network that, winding through

forests and savannahs, represents as much as 10-15% of the world's fresh water reserves (FAO-AQUASTAT, 2010). The forest, almost omnipresent, is considered as one of the most intact in the world (Dinerstein 1995, Olson et al. 2001). The biodiversity is spectacular, with a great wealth of species and high levels of endemism. The richness of these ecosystems and biological diversity provides the people of the region and even the humanity with very diverse benefits known as "ecosystem services" (Millennium Ecosystem Assessment, 2005). These include: provisioning services (e.g. food, fibre, fuel, water); regulating services (benefits obtained from ecosystem processes that regulate e.g. climate, floods, disease, waste and water quality); cultural services (e.g. recreation, aesthetic enjoyment, tourism, spiritual and ethical values); and supporting services necessary for the production of all other ecosystem services (e.g. soil formation, photosynthesis, nutrient cycling). These goods and services are essential to people's well-being, as well as to future economic and social development. The Guiana Shield forest, for example, with an exceptional carbon stock estimated at 25 billion tons, plays a crucial role in mitigating local and global climate change.

2.1.2 A fragile ecosystem increasingly threatened

Difficult to access and sparsely populated, the region has been relatively spared so far by anthropogenic activities including industry and mass tourism. However, the population is growing rapidly and so are economic development needs. Biodiversity is not the only treasure of the Guiana Shield. Its subsoil is also home to reserves of gold, tungsten, coltan, aluminium and hydrocarbons. The legal and illegal extraction of these minerals, mostly gold, has a significant environmental impact (Boudou et al. 2006; Hammond et al. 2007; Dezécache et al, 2017).

Around 215 000 hectares of forests and riverbeds have been destroyed by legal and illegal gold miners over the past three decades, up to 2018, particularly in the decade 2008-2018 when the area affected tripled (Figure 2). However, the increase in deforestation followed quite different dynamics depending on the territory. Indeed, the 2008-2018 surge (+145,000 ha) is particularly worrying in the western part of the Guiana Shield, with 61% occurring in Guyana, 32% in Suriname, 5% in French Guiana and 2% in Amapá (Rahm et al, 2021, WWF ECOSEO project).

Mining activities reduce or destroy the capacity of ecosystems to provide their goods and services essential to the well-being of human life. Mining also affects the many populations living in the southern interior of the territory by damaging the natural resources and the habitats on which they depend, particularly with mercury contamination.

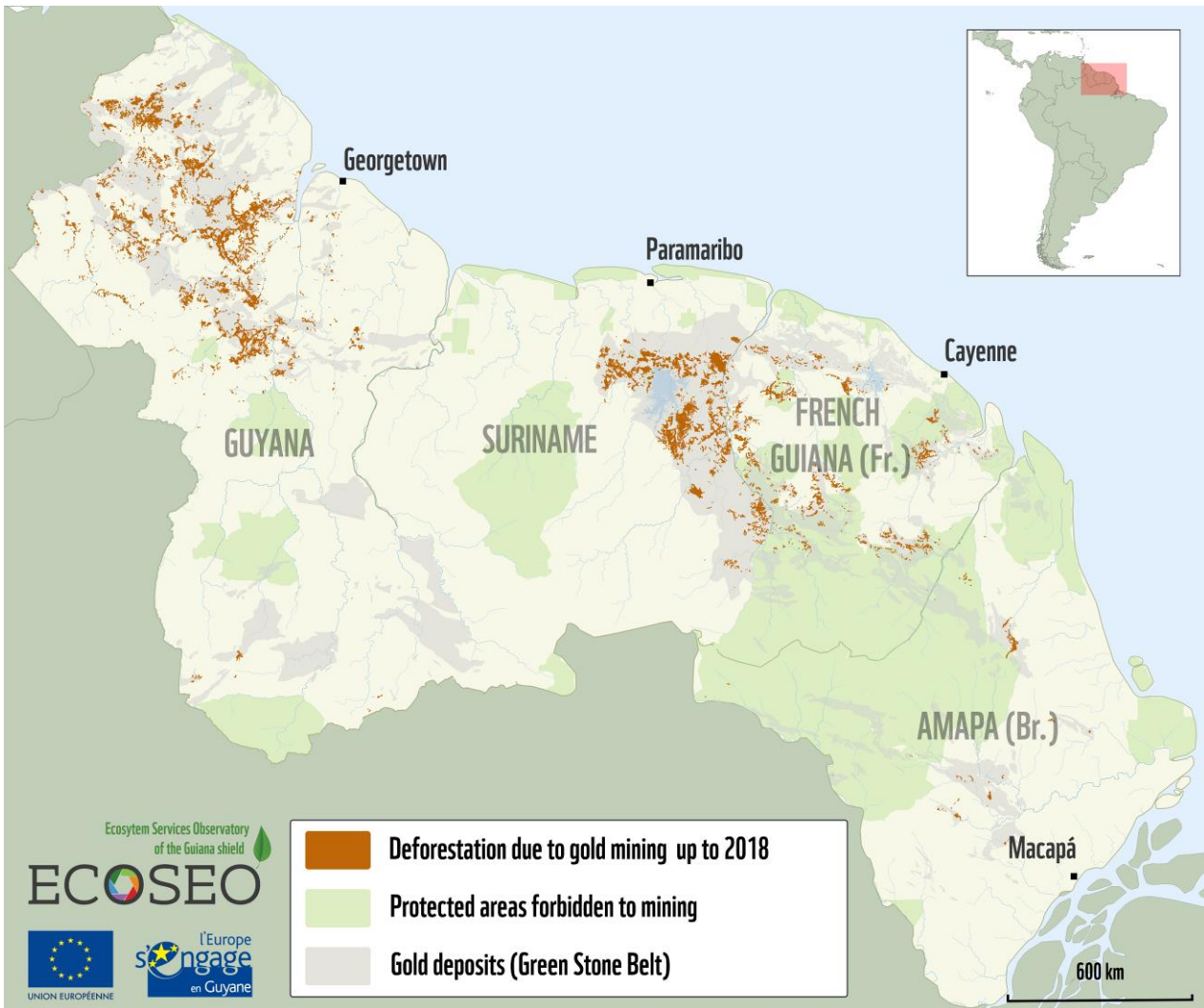


Figure 2. Gold mining deforestation up to 2018 in the Guiana shield

2.2 The French Guiana overseas region

French Guiana is an outermost region (OR) of France located on the northern coast of South America, in the Guianas. Bordered by Suriname to the west and Brazil to the east and south, French Guiana covers a land area of 83 534 km² and is inhabited by around 300 000 people. French Guiana is the second-largest region of France and the largest outermost region within the European Union. It is also the only continental OR. It has a very low population density, with only 3.6 inhabitants/km². Half of the population in 2023 lived in the metropolitan area of Cayenne, its capital (Figure 3).



Figure 3. Map of the French Guiana outermost region (OR)

2.2.1 Land occupation and Biological richness

Located at the biogeographical crossroads of the Guiana plateau and the Amazon basin, French Guiana has a very high specific, ecosystemic, biocenotic and landscape diversity. Around 98% of the territory can be considered as sheltering natural areas, mostly primary forests, but also mangroves and herbaceous marshes (Figure 4). Covering about 1.4% of the Amazon biome, it is home to the only large tropical forest whose management depends directly on a European country.

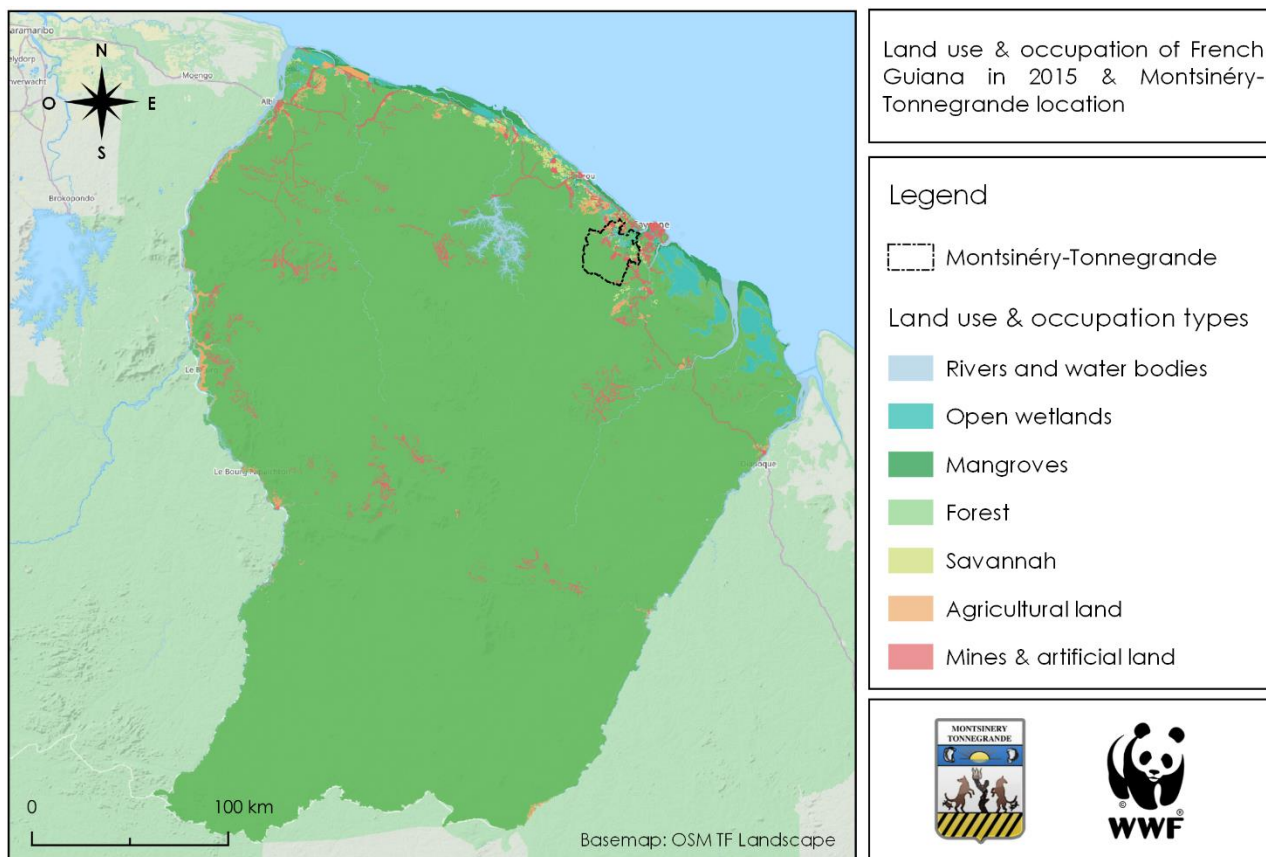


Figure 4. Land use & occupation of French Guiana & Montsinéry-Tonnegrande location

This preserved nature, combined with a great diversity of environments, ecosystems and habitats, endows French Guiana with a heritage of international scope, with the presence of emblematic species: jaguars, leatherback turtles, and insects among the largest in the world such as the titan beetle. Knowledge of this biodiversity is very heterogeneous among the major groups of species and unevenly distributed over the territory. The ecosystems located on the coastal belt, most subject to anthropogenic pressures are particularly unique. The interior is sparsely populated and forest ecosystems hold a high biodiversity.

These ecosystems provide a large number of services, on which many inhabitants depend more or less directly, for their subsistence (hunting, fishing, agriculture), transport (river) and more broadly their well-being (leisure, etc.), including its cultural and spiritual dimensions, particularly important for the Amerindian and black Maroon communities.

2.2.2 Environmental pressures

An aerial flight over the immense Amazon rainforest of French Guiana shows the vegetation as far as the eye can see, the canopy seems to cover almost all of the greenest territory in Europe. However, some major issues are already disturbing the fragile natural balance. Gold mining in the interior, rapid urban development on

the coast, and poorly controlled exploitation of marine resources require special attention.

For nearly 30 years, French Guiana has been experiencing a new **gold rush**. It is largely linked to poor populations in Brazil, who are led by mafia networks to exploit gold illegally. Nearly 10,000 *garimpeiros* stay in the Guianese forest and use mercury to amalgamate the precious ore. Contamination related to this toxic product remains a serious concern, both for the health of communities and ecosystems (Dezécache et al. 2017). At least 13 tons of mercury are discharged into the Guianese environment each year. Legal gold mining, although it does not use mercury, nevertheless generates significant impacts on aquatic environments, particularly through pollution with suspended solids, which is punctual but recurrent.

Even if the **deforestation** rate in French Guiana (about 3,000 ha/year, less than 0,04% of the territory) is much lower than in the countries of the region (Suriname and Guyana) its concentration in specific areas or environments (e.g. rivers), constitutes a threat to the ecosystems. The very strong demographic growth will amplify the trend in the years to come. Regarding the deforestation due to gold mining (approximately 1000 ha/year), approximately half is due to legal activity and the other half to illegal activity.

In connection with the strong demographic pressure, some decision-makers are prone to the **development of large extractive industries** in French Guiana (gold mining on an industrial scale, oil exploitation). However, these development options, unsustainable, could only represent economic mirages in the face of the real needs of the territory (Deloitte, 2018).

2.2.3 Protected areas

The protected areas (PA) of French Guiana represents more than half of the territory (Figure 5). The restrictions and management rules differ according to their protection status. The biggest and most important of all is the *Parc amazonien de Guyane*, a national park that represents around 3,4 million ha in total (40% of the territory), 2 millions of them being protected under the strongest status (Cambou & Dewynter, 2014, DEAL Guyane). It covers the southern half of the territory, including local and indigenous communities.

Then, six natural reserves (*Nouragues*, *Trinité*, *Amana*, *Kaw*, *Mont Grand Matoury*, *Lucifer Dékou-dékou*) also under the highest protection status existing in France, play a significant role in the conservation of the ecosystems of French Guiana. Local protected sites (e.g. *Abattis Cotica*) or larger areas but under a lower protection status such as the natural regional park, complete the PA's network of French Guiana.

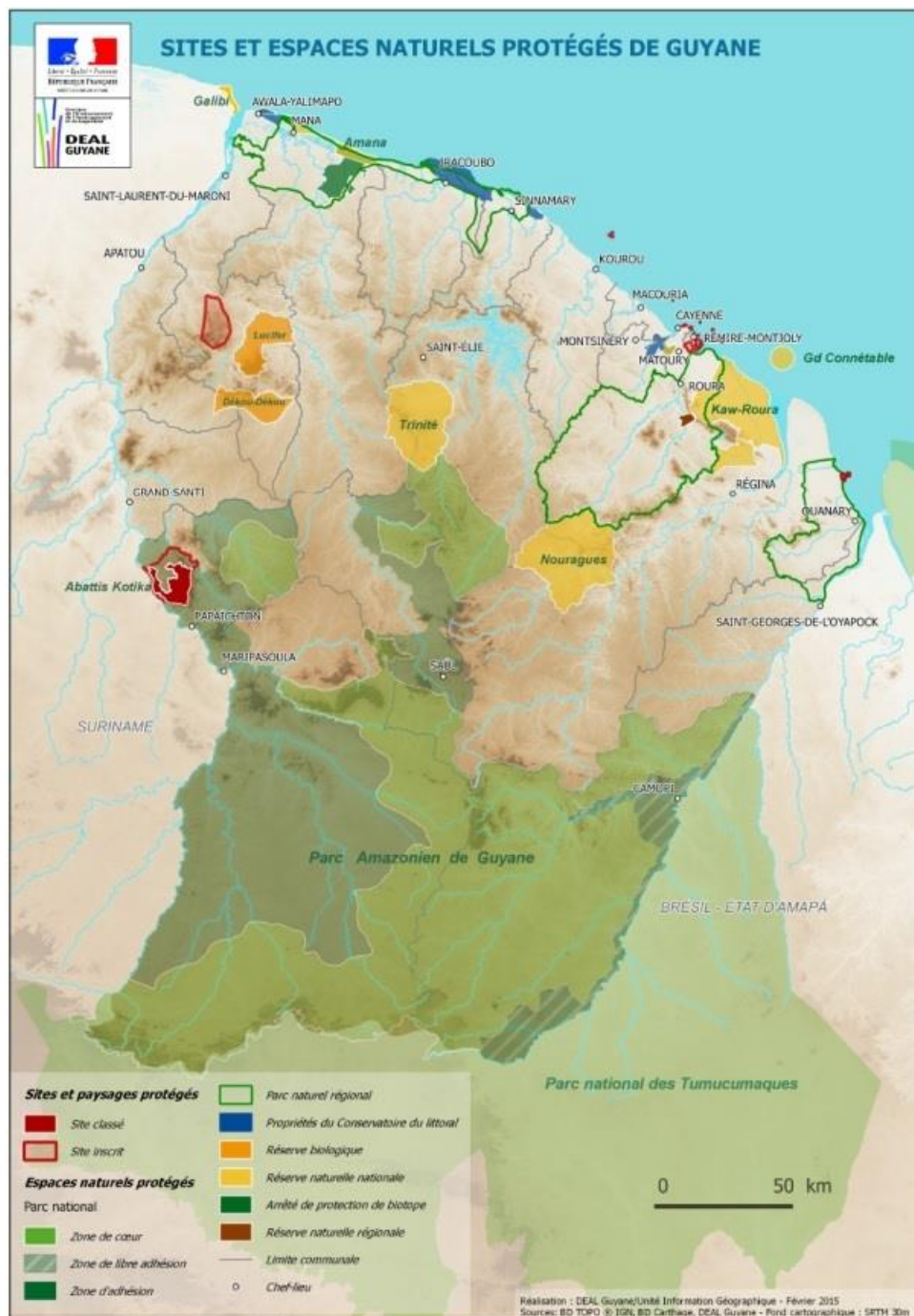


Figure 5. Protected areas in French Guiana

2.3 The Montsinéry-Tonnegrande municipality

MT is a rural municipality of French Guiana, one amongst the 22 of the territory (Figure 6). It is located on the coastal fringe, near the capital city, Cayenne.



Figure 6. Location of Montsinéry-Tonnegrande in French Guiana

It has around 3 000 inhabitants spread over its large territory of 627 km² (six times the size of Paris) and has hence a very low density of population of 5,2 inhabitants/km². The municipality contains two towns (Montsinéry and Tonnegrande), separated by around 20 kilometers (Figure 7). Numerous rivers and creeks, offering opportunities for recreational activity and tourism, surround the urban areas. Due to its proximity to the metropolitan area of Cayenne and as it offers a good quality of life, it could attract new population in the future (CACL 2022).

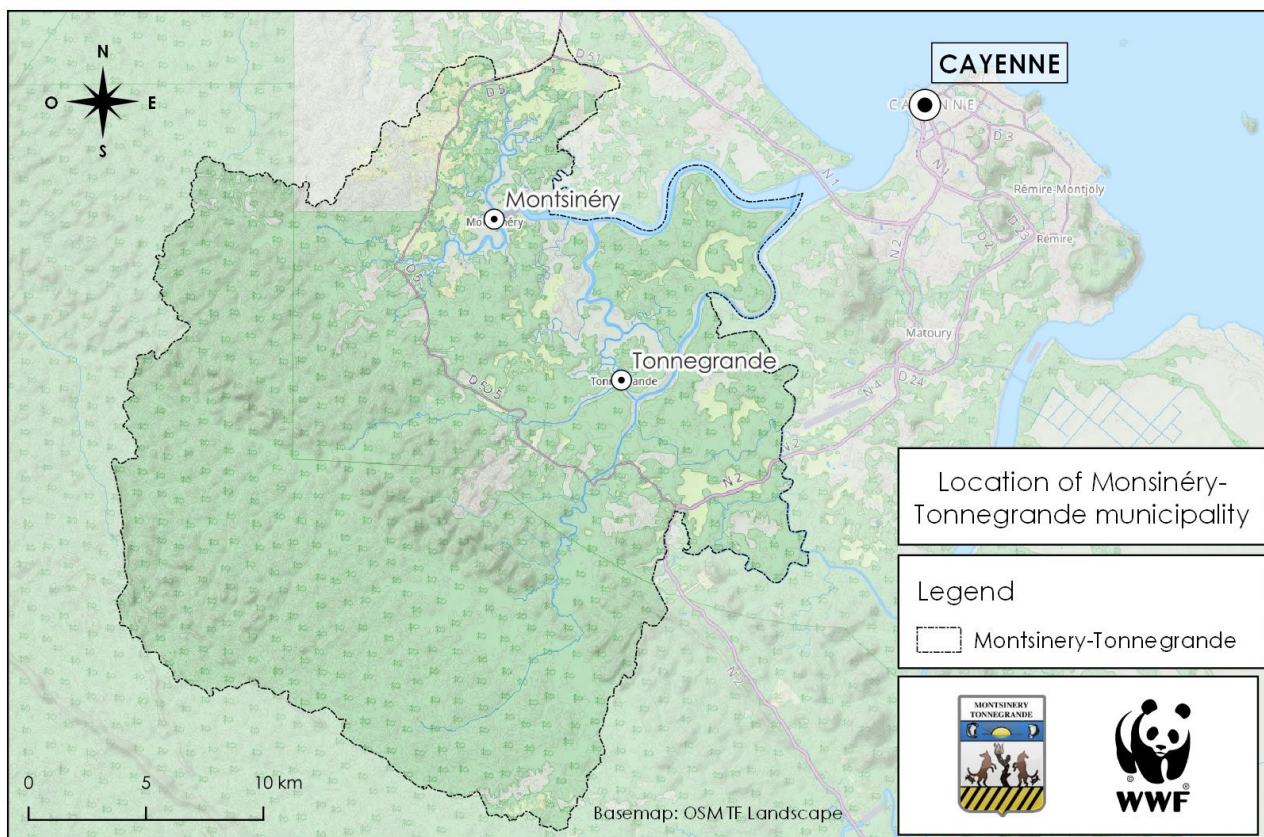


Figure 7. Montsinéry-Tonnegrande and the nearby city of Cayenne

2.3.1 Predominance of natural habitats and diversity of ecosystems

The land use and occupation of Montsinéry-Tonnegrande (Figure 8, adapted from Sieber 2020, ECOSEO/MOVE) shows that the vast majority (91%) of the municipality is occupied by natural habitats. Forest is by far the most predominant (79%) followed by open wetlands and water bodies (7%), Savannahs (3%) and Mangroves (2%). Artificial land like urban areas (7%) and agriculture (2%) occupy the rest of the territory.

The geographical distribution of those land occupations is not homogenous, and allow to distinguish three main areas:

- The lowlands, North-East of the territory, composed by open wetlands, savannahs and mangroves embraced by a maze of rivers and creeks that forms the mouth of the *Rivière de Cayenne*. Here stands the historical towns of Montsinéry and Tonnegrande, on the banks of the two rivers of the same names. They were the only way to connect the towns to Cayenne and the rest of Guiana by boat before the road existed.
- The highlands on the two third South west of the municipality, composed almost exclusively by ancient tropical rainforest not easily accessible excepted through forestry roads at the western and southern border of the municipality.

- In between the lands on both sides of the main road going through the municipality, that forms a land strip a few kilometers wide oriented NW-SE. Most of the urban and agricultural land of the municipality, mixed with natural habitats, is here. This is the main area for future development of the municipality as it is the most accessible and connects lowlands and highlands.

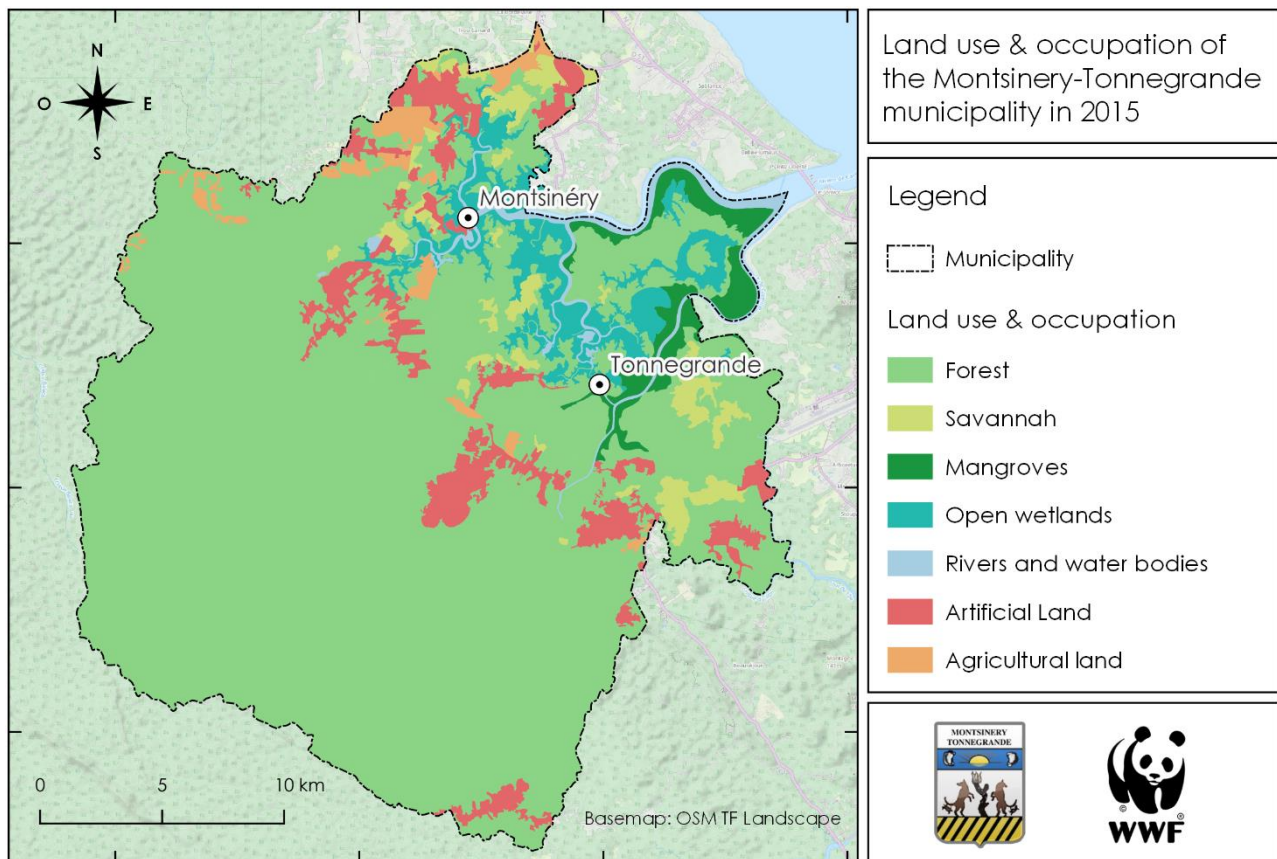


Figure 8. Land use & Occupation of Montsinéry-Tonnegrande

2.3.2 Biological Richness of the territory

MT municipality possess a large diversity of ecosystem types and a high biological richness. The areas of ecological interest (“ZNIEFF” in French) within the municipality give an indication of this richness. As shown in the (Figure 9), we find several of major ecological interest within the MT territory. The coastal conservatory, jointly with the local authorities is responsible for the protection and management of two significant sites: mangroves and open wetland at the mouth of the *Rivière de Cayenne*; and the forest around a heritage site called “*Bagne des annamites*”.

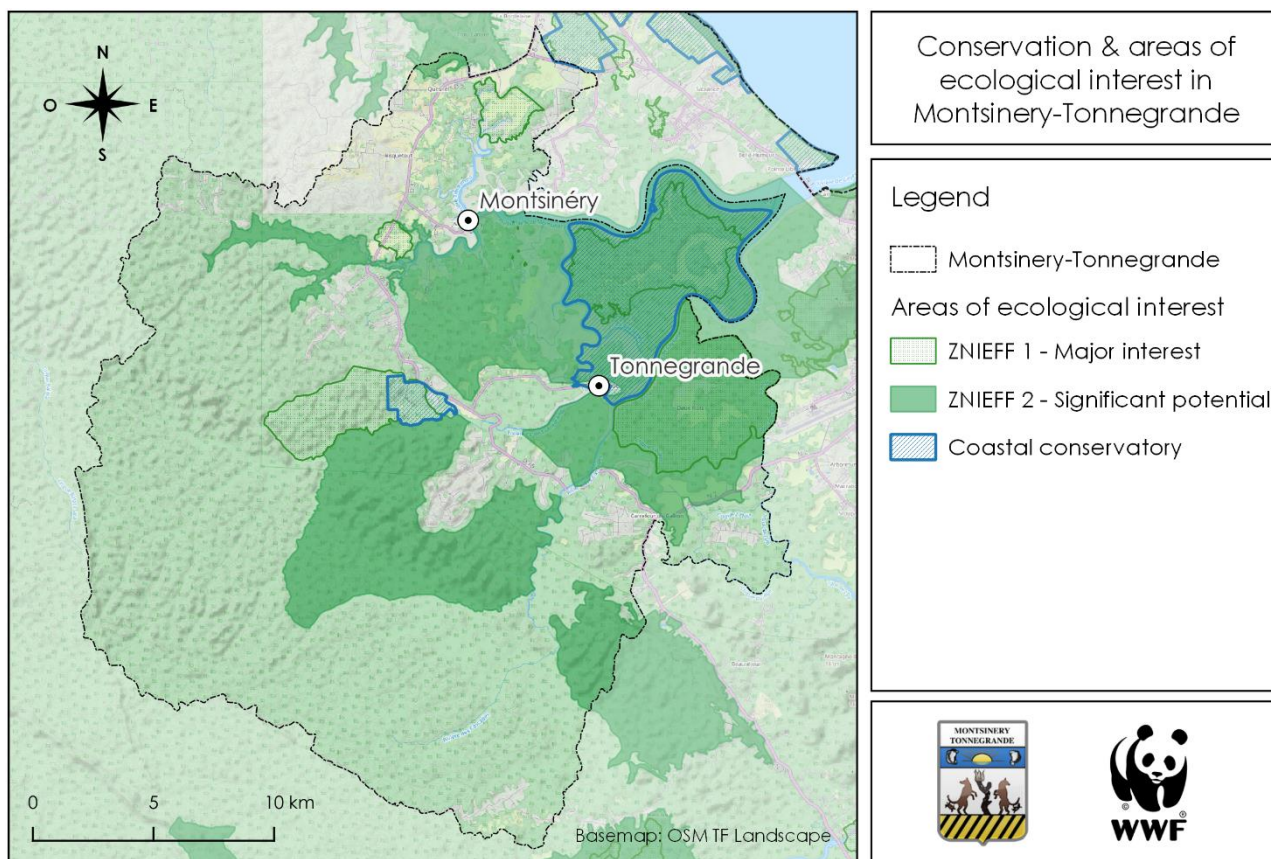


Figure 9. Areas of ecological interest in (ZNIEFF) Montsinéry-Tonnegrande

3 ANCHOR PROJECT OBJECTIVES & RESEARCH QUESTIONS

3.1 Context & studies on ecosystem services in French Guiana

The broad picture of ecosystem services in French Guiana has already been assessed at the level of the whole territory and beyond (the Guiana shield) through a regional project called ECOSEO (Ecosystem services observatory of the Guiana Shield). This project, led by WWF French Guiana in cooperation with several regional and international partners, including the Leibniz University Hannover (LUH), aimed at mapping the ecosystem services and assessing natural capital values for the whole Guiana Shield, including French Guiana. It started March 2019 and ended in September 2022.

The task on ecosystem services within this project involved mapping and assessment through the capacity matrix method, implemented at the scale of the whole French Guiana and Suriname, jointly by LUH and WWF France (Sieber 2020). It provided an interesting overview of the main ecosystem services of the territory and their location through a mapping process based on land use and land cover types (Sieber et al, 2021).

This work played an important role to communicate about the critical importance of Ecosystem services and was very useful to support advocacy to better integrate their value into political decision-making.

However, to go more in depth and include detailed information, we needed to implement complementary approaches. Therefore, we choose to focus on participatory approaches, to capture better the local issues, the forces at stakes around ecosystem services use and conservation at the level of management units, the municipality level in this case.

Furthermore, a municipal approach allows for the participation of inhabitants and the involvement of decision makers in the project. Then it gives an opportunity to test the integration of MAES methodologies into political decision and economic development planning, consistently with objective 2 of the MOVE-ON proposal.

The municipality of Montsinéry-Tonnegrande appeared has a very good place to implement this case study. Firstly, its territory includes vast, diversified ecosystems of high biological richness. Secondly, the vicinity of metropolitan area of the capital city Cayenne makes it a privileged and accessible place for nature based recreational activities. It also makes it an attractive place to settle for new inhabitants or investors. Thirdly, the municipality staff and their mayor, supports a sustainable development agenda for French Guiana (Lecante, 2018) since a long time. The involvement of the mayor was key in improving the knowledge of ecosystem services, and potentially in integrating them into development or management plans of the municipality.

3.2 Research questions and objectives

3.2.1 Main Goal

As exposed previously, the main overall threat on terrestrial ecosystems beyond gold mining is the development of non-sustainable projects to address the lack of economic activities that causes high rates of poverty and unemployment on the territory. To avoid this unsustainable path, there is a crucial need to enhance the development of sustainable sectors showing a way that conciliates nature conservation and economy (Deloitte, 2018). Highlighting the importance of ecosystem services and their potential use for the development of sustainable activities is one option.

In this context, as we need to convince policy and decision makers and the public, the main goal of this Anchor Project is to:

“Demonstrate the feasibility of a territorial management plan preserving and promoting ecosystem services”.

3.2.2 Research questions

Thus, the following research questions are driving the Anchor Project.

Policy question: “How can we find a trade-off, or even better, synergies between environment preservation and economic development, in a territory with an extraordinary ecological richness as well as high unemployment rate and inequities?”

How to address this question: through a participatory approach, local stakeholders' involvement in order to integrate ecosystem services into the territorial planning of a municipality.

Business question: “How can we create added value for the territory, while preserving the ecosystems?”

How to address this question: through the development of sustainable economic sectors, such as green tourism, bio-economic sector, etc.

Societal question: “How can we improve the acceptability and the credibility of economic solutions based on nature?”

How to address this question: with the demonstration of its feasibility, through one or two local and concrete examples.

3.3 Objectives and subtasks

The French Guiana Anchor Project rely on the case study of the municipality of Montsinéry-Tonnegrade. Its objectives are to:

- Identify and map the main ecosystem services provided to the population;
- Consult the inhabitants about relevance and use of ecosystem services;
- Involve local authorities and stakeholders to build integrated town development plans taking into account the conservation of biodiversity and ecosystem services.

The town council of MT is on board of the Anchor Project since its inception. The council is already involved in sustainable development planning and the mayor of the municipality is also the president of the local Committee for water and biodiversity. Then there was a significant interest in implementing this case study to catch this opportunity to build a locally integrated strategy of ecosystem services management. Then, this could be used as an example for sustainable development and conservation of ecosystem services planning in French Guiana.

To reach these objectives we defined three subtasks:

Subtask 3.2.1: Defining ecosystem types and mapping ecosystem services on the municipality territory, mainly regarding water and coastal ecosystem services;

Subtask 3.2.2: Making an inventory of the use of ecosystem services by the local population and their expectations regarding their preservation;

Subtask 3.2.3: Building a local development plan taking into account the preservation of the ecosystem services, along with local authorities (town council).

4 METHODS AND MATERIALS FOR ES MAPPING AND ASSESSMENT

The implementation of the Anchor Project focused exclusively on the case study of Montsinéry-Tonnegrande even if we also considered some other case studies initially. In the end, the MT municipality was the most reliable partner. WWF France carried out the whole case study together with the help of the municipality staff of MT. We associated a local conservation association called “Trésor” to our work, for technical assistance but without a formal partnership. The central events of the case study were the participatory mapping sessions, held in November & December 2022 although a strong preliminary and preparatory work took place before, such as literature review, data inventory and stakeholders interviews. We also carried out a small study on a participatory fauna observation database called “Faune-Guyane”, that allow to assess the importance of nature tourism linked to wildlife watching, in the municipality.

4.1 Literature review

4.1.1 Main previous ES studies covering French Guiana

Firstly, we looked for the previous studies, projects or research on ecosystem services carried out in French Guiana.

ECOSEO – Ecosystem observatory of the Guiana Shield

The ECOSEO project coordinated by WWF France with its partners in Guyana, Suriname, French Guiana and Amapá state in Brazil was implemented from 2019 to 2022 with the objective of “Preserving the ecosystem services of the region”. We produced critical knowledge for the region, such as a mapping and assessment of the ecosystem services in French Guiana and Suriname, carried out by the Leibniz University of Hanover (LUH). The results of this work were particularly useful for our AP as it offered an interesting entry to start the discussion with our partners and the public (e.g. the conceptual model of the local ecosystem services, Figure 10)

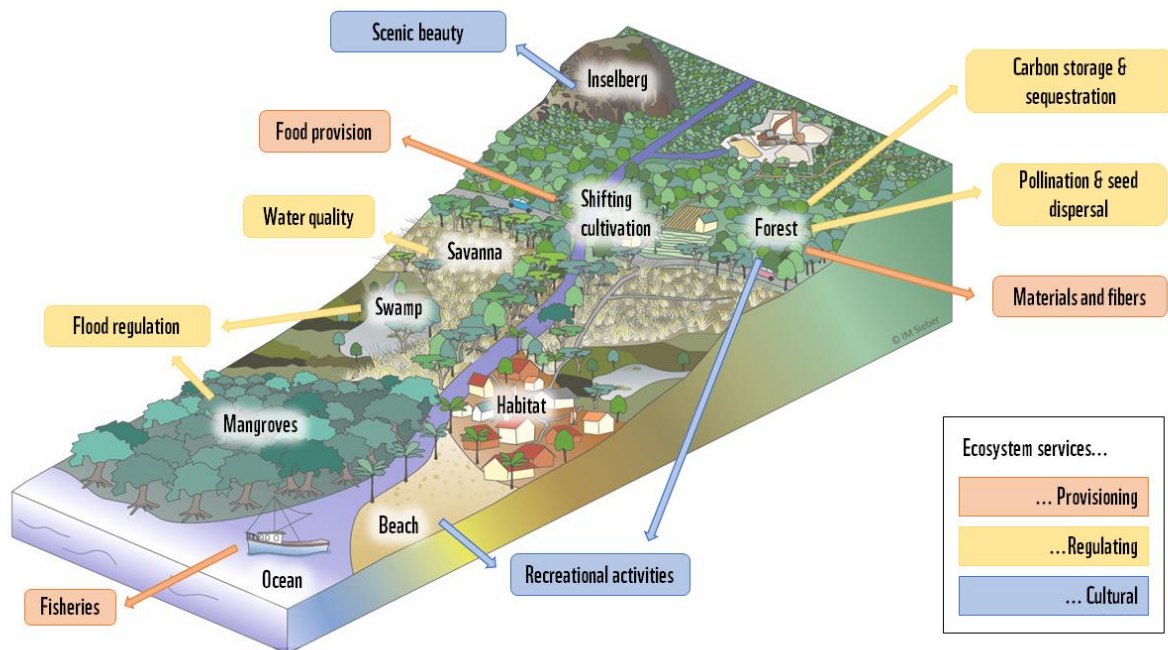


Figure 10. Ecosystem services in French Guiana (adapted from Sieber et al., 2020)

Within this work, we established a list of local ecosystem services in order to implement the capacity matrix mapping and assessment method (Sieber et al. 2021). We also used this list within this Anchor Project (see 4.4 Participatory mapping workshop).

MOVE – Mapping and assessing the state of ecosystems and their services in the Outermost Regions and Overseas Countries and Territories

The previous phase of the MOVE-ON project also helped with providing a first list of stakeholders and initiatives inventoried in French Guiana (Sieber et al, 2018). The results of the case study on French Guiana, jointly implemented with the ECOSEO project, provided with some useful data on land use & land cover (Sieber et al. 2020).

BEST – Amazonian ecosystems profile

The Best Initiative (Voluntary scheme for Biodiversity and Ecosystem Services in Territories of European Overseas) in which WWF France coordinated the case study for French Guiana, led to a very comprehensive study on biodiversity and ecosystems of the territory that is still a reference today (Roger et al., 2016). It allowed the identification of Key Biodiversity Areas (KBAs) but also try to define some Key areas for Ecosystems services. By the time, this was one of the few initiative to do so. It paved the way for the following ones.

4.1.2 Studies available on the Montsinéry-Tonnegrande municipality

For more locally sound information, we looked at the studies held at the scale of MT. As expected the scientific literature related to the municipality is not abundant. But some technical & legal reports related to the management and land planning of the municipality exist and provide useful information. Among them, we find:

- *Schéma de cohérence territoriale (SCoT)* a document that set the frame for development and land management at the level of a group of municipalities (CACL);
- *Plan Local d'Urbanisme (PLU)* a legal document that defines the areas and the rules for each type of use in the municipality.

As explained earlier, the MT mayor is a promoter of a sustainable development of its municipality but also of the whole French Guiana. He published a report in 2018 that draw the main orientations he foresees to follow this path (Lecante, 2018).

4.1.3 Methodologies for ES mapping and assessment

During our preparatory work of the AP, we tried to identify the most suitable methods for our case study. With the help of the others MOVE-ON partners and particularly the organization of an individual advice meeting | November 2021 by UH, URJC, & UNITIN, we focused our efforts on three methods:

- Deliberative assessment, with the example of Palomo I. et al. , 2014;
- Participatory mapping, with the example of Palomo-Campesino S. et al., 2018;
- Scenario planning.

4.2 Data inventory

To complete the literature review and as the case study focus mainly on mapping we made an inventory of the existing data, mainly GIS, available at the scale of the MT municipality.

Beyond our own data, produced in previous projects, we made our research mainly on a public platform called "Geoguyane" that gather most of the GIS data available for French Guiana. We find below the list of the data used in our AP :

- Land cover and Land-use;
- Urban planning;
- Environment and protected areas;
- Tourism;

- Forest management.

To complete this inventory the question of recreational activities, we also requested and used the following data.

- Fauna Participatory observatory *Faune-Guyane*;
- Photos Users days Flickr – InVEST.

With the help of available data and the literature review, we made a first overview of the potential ES in MT municipality (See part 5.1).

4.3 Stakeholders interviews

Before and during the implementation of the Anchor Project we had several encounters with the main stakeholders of the study area. We find below the list of the interviewees:

- The Mayor of Montsinéry-Tonnegrande;
- The Conservation Association *Trésor* director;
- The Mayor's chief of staff;
- A municipal councilor in charge of environment & farmer;
- A municipal councilor & teacher ;
- The President of the Montsinéry Canoe Club;
- A resident of MT and expert of the town history;
- The owner of a botanical garden.

Those interviews helped to set the frame of the case study, select the methodologies and the services to assess, identify a relevant group of experts and inhabitants to implement the participatory mapping sessions.

4.4 Participatory mapping workshop

The main tool chosen to implement the MT case study was participatory mapping. As implemented in Palomo-Campesino S. et al, 2018, it followed three steps: 1. Selection of the ecosystem services; 2. Participatory mapping sessions; 3. GIS conversion and analyses of the results.

4.4.1 Selection of the most relevant ecosystem services

We implemented this step jointly with the municipality staff. We choose to select a small number of ecosystem services in order to facilitate the implementation of the workshop and to obtain more in-depth results rather than a broad overview.

We proposed a list of 22 ES to the staff, adapted from the ECOSEO /MOVE case study (see table below).

	Division	Group	Name	Code	
Provisioning Services	Nutrition	Biomass for food consumption	Cultivated crops / food	SA1	
			Reared animals and their outputs	SA2	
		Biomass	Wild plants, algae and their outputs	SA3	
			Wild animals and their outputs	SA4	
		Water	Freshwater supply for drinking purposes	SA5	
	Materials	Raw materials	Materials and fibres	SA6	
			Plants and resources for medical use	SA7	
Regulating Services	Maintaining biological, physical and chemical conditions		Carbon Sequestration	SR1	
			Global and local climate regulation	SR2	
			Disease control	SR3	
			Pest control	SR4	
		Maintaining nursery populations and habitats	Maintaining nursery populations and habitats	SR5	
			Pollination and seed dispersal	SR6	
		Mediation of mass flows - risk reduction		Hydrological cycle and water quality and flow maintenance	SR7
				Maintaining soil quality	SR8
	Mass stabilisation and control of erosion rates			SR9	
			Storm protection	SR10	
			Flood protection	SR11	
Cultural Services	REPRESENTATIONS-subjective		Emblematic or symbolic	SC1	
			Heritage (past and future) and existence	SC2	
			Aesthetic	SC3	
	USE-objective		Recreational activities including (eco-) tourism	SC4	

Figure 11. List of potential ecosystem services in French Guiana

MT staff suggested at first the three following ES:

- Carbon sequestration ;
- Reared animal and their outputs ;
- Emblematic or symbolic cultural service.

Carbon sequestration represents a critical ES for MT as forest, mangroves, and open wetlands, well known for their capacity to store carbon, represents more than 90% of the territory. However, the participatory mapping is not the most relevant to assess it. Therefore, we used the results of the ECOSEO/MOVE-ON case study to analyze it (See Figure 16).

Reared animal and their outputs has not the same territorial importance than Carbon sequestration, as agriculture occupy only 2% of the territory.

Nevertheless, it is an important sector for the local economy and has a significant potential for the future. However, as for SR 1, the participatory mapping is not the most relevant to assess it.

In the end, after discussion with MT staff, we agreed to map the three following ES:

- **Recreational activities including eco-tourism**, mainly nautical activities in the case of MT;
- **Wild animals and their outputs**, mainly through fishing, collecting (oysters) and hunting;
- **Emblematic or symbolic value & Heritage and existence**, including abandoned sites linked to the slavery and penal colony periods.

4.4.2 Participatory mapping sessions

We organized two participatory mapping sessions in 2022, November 30th and December 7th (see invitation in annex). We invited the group of experts and inhabitants identified during the interviews, ten people participated (see table above). The participants represented a diversity of professions: farmer, fisherman, professor, touristic guide, etc. A municipal councilor and the person in charge of the urban planning of the municipality also contributed.



Figure 12. Picture of an ongoing participatory mapping session

After a general introduction explaining the objectives of the project and the method of participatory mapping, we dedicated around four hours (during the two sessions) to discuss and point out the main sites for each selected ES and a few additional ones (see Figure 12). We let the participants explore the A0 printed map of the municipality and share their knowledge as we marked the sites mentioned with one color per ES, adding also a short description (see Figure 13 below and in annex).

4.4.3 GIS conversion and analyses of the results

Once the participatory mapping sessions were completed, we converted the annotated printed map into a GIS version. We could precise and verify the location of the sites and clarify or complete their description. Figure 21 shows the results. Then, it was circulated among the participants for information and verification.



Figure 13. Participants to the first participatory mapping session and preliminary results

5 RESULTS

5.1 ES potential overview in Montsinéry-Tonnegrande

In the following part, we used the data inventory and the literature review to establish a first overview of the potential ES in the MT municipality and produced informative maps. We present the ES by type: provisioning, regulating, cultural. This does not pretend to be comprehensive but shows some interesting examples, based on the available data.

5.1.1 Provisioning services

Among the provisioning services stands the production of the agriculture sector. As a rural town, MT includes agricultural land. In 2021, it represents a small part of the territory, around 3 000 ha, 5% of the territory. Half of it is actually cultivated according to the national data. Most of the agricultural lands are pastures, around 1200 ha, to rear cattle. Due to the location of the municipality, close to the capital city and its consumers there is a potential for agriculture development in the future in MT, as the land management planning of 2016 and 2020 show (Figure 14).

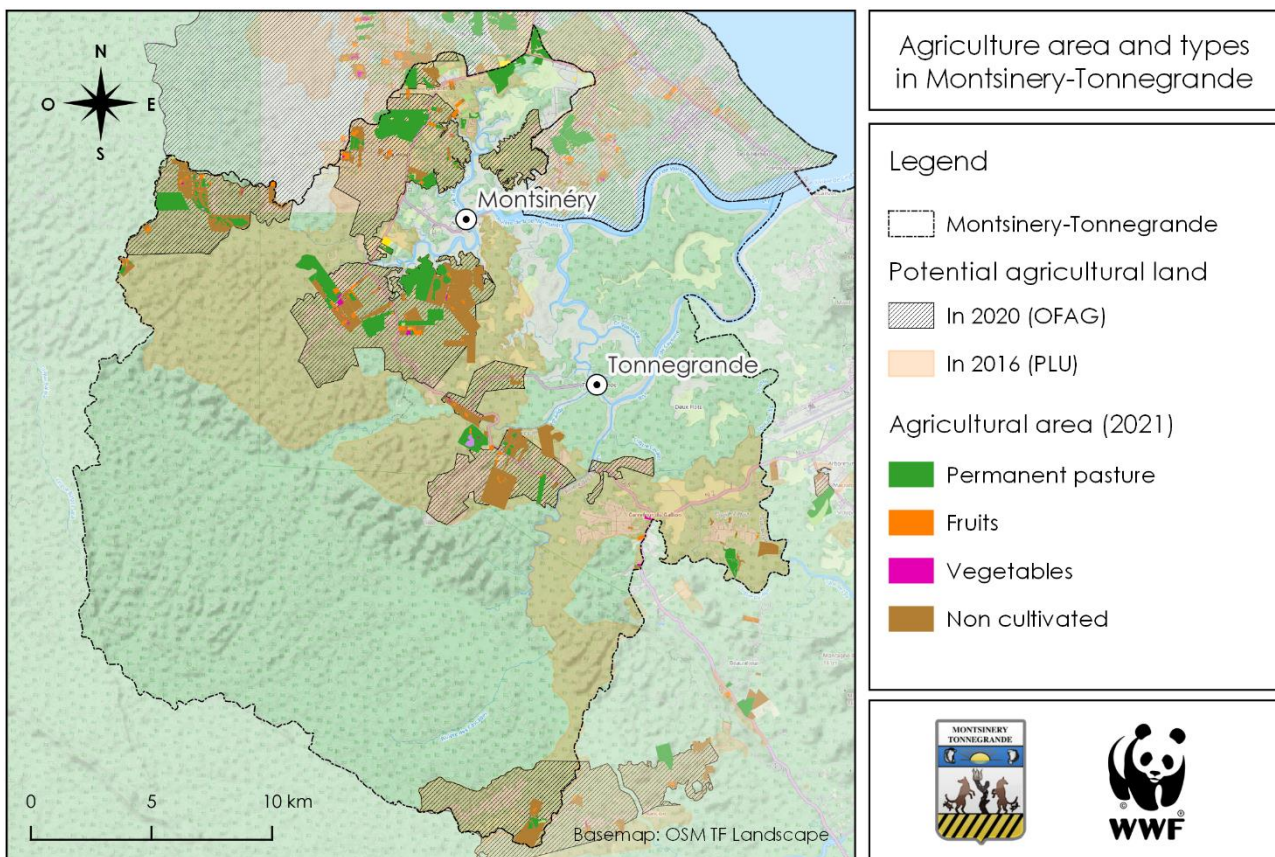


Figure 14. Agricultural land in Montsinéry-Tonnegrande

Tropical rainforest represents by far the largest land occupation type of MT, covering 80% of its territory. It is a source of numerous provisioning services including timber, which is the main commercial product. The National Forest office (ONF) is in charge of the forest management, within the permanent forestry domain (DFP). Within this area, it classifies the plots into different categories of use (Figure 15), and builds forestry roads. One of them gives access to the *Nancibo* forest in the southern part of the MT municipality. The forestry exploitation follows strict rules, to minimize the impact on the forest: five trees per ha are harvested every 60 years.

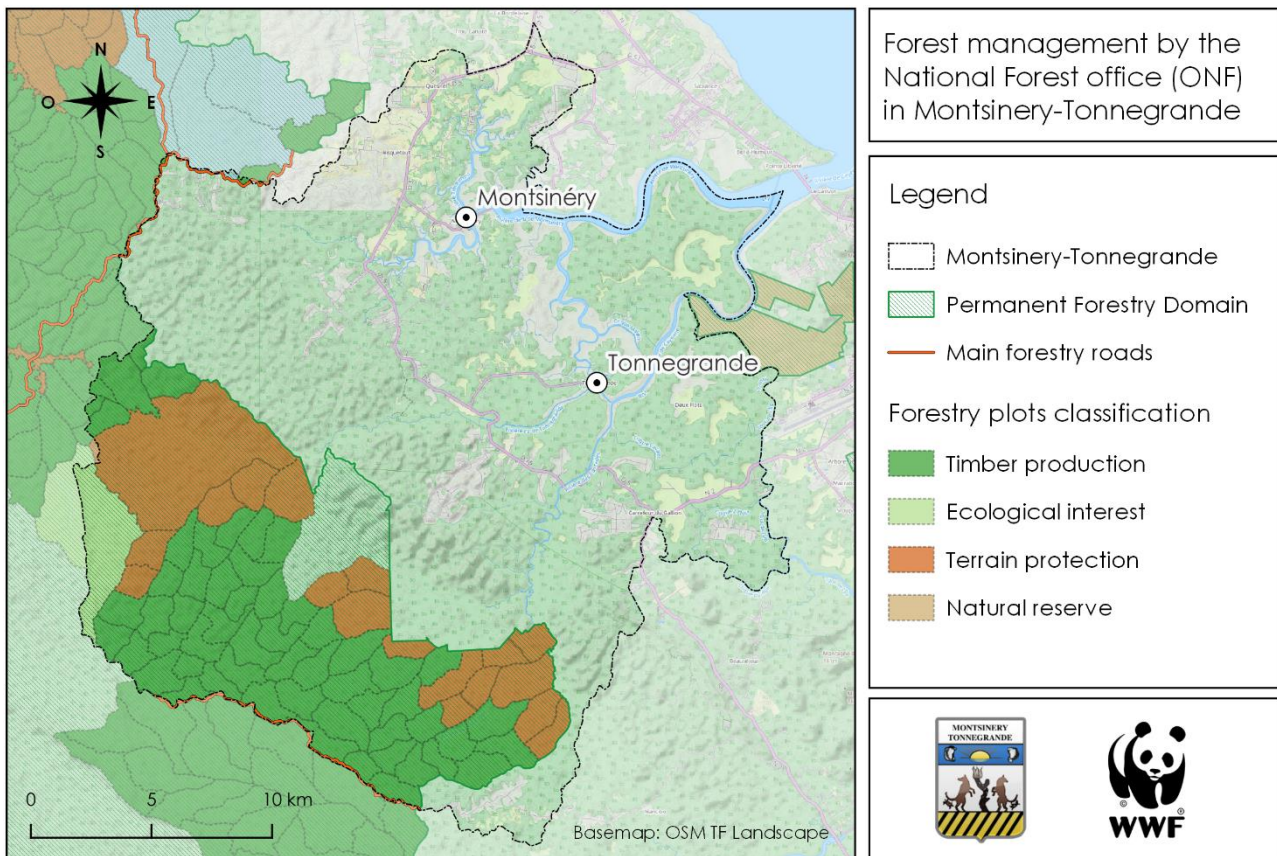


Figure 15. Forest management in Montsinéry-Tonnegrande

5.1.2 Regulating services

Among the regulating services provided by the ecosystems of MT, Carbon sequestration might be one of the most significant. Rain forest, Mangroves, open wetlands are well known to store high quantities of carbon and represents together around 90% of the MT territory. The capacity matrix method implement within the ECOSEO and MOVE case study ranked this service as very high (see Figure 16).

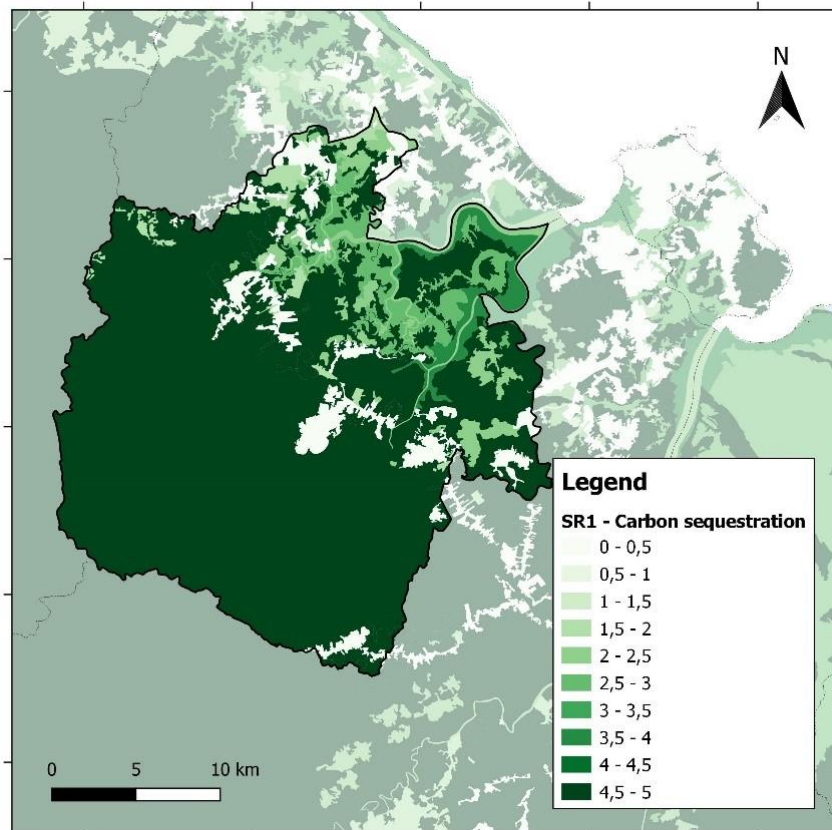


Figure 16. Capacity (0 = None ; 5 = High) of ecosystems to supply carbon sequestration service in Montsinéry-Tonnegrande (Sieber et al. 2021)

5.1.3 Cultural services

Located near the capital city of Cayenne where the majority of French Guiana population lives, and being easily accessible, tourism, especially nautical activities, is significant in MT municipality. It also includes touristic sites related to nature recreation and/or heritage sites. The map below (Figure 17) represents some of them as, inventoried by the CACL, but the list is not comprehensive and the participatory mapping below also intends to complete it.

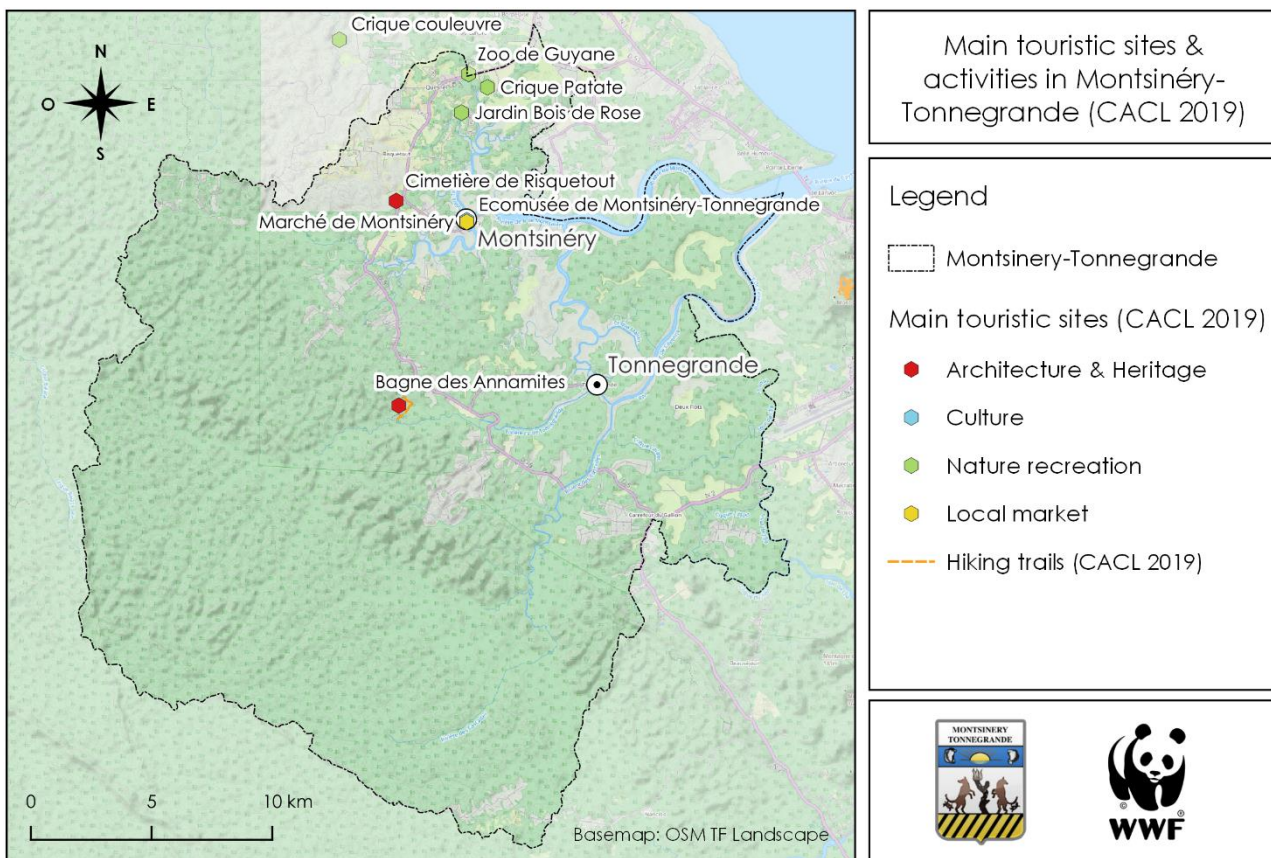


Figure 17. Touristic sites in Montsinéry-Tonnégrande

5.2 Focus on the participative fauna monitoring

Natural habitats represent the vast majority of the MT territory. It hosts the whole richness of amazon species. Being easily accessible, it is a privileged territory for naturalists to observe fauna. One participatory database in French Guiana allows the public to register their own observations. Beyond the scientific values of this data, it also indicates the attractiveness of the territory for this type of eco-tourism. We analyzed the data collected within the MT municipality from 1992 to 2022. Approximately 46 000 observations were recorded in total during this period. The graph in the Figure 18 shows an exponential increase from the beginning of 2010's until today, with a peak of 7000 observations in 2019 and almost 100 observers in 2022. The decrease in 2020 and 2021 is probably due to the restrictions of movements during the Covid crisis.

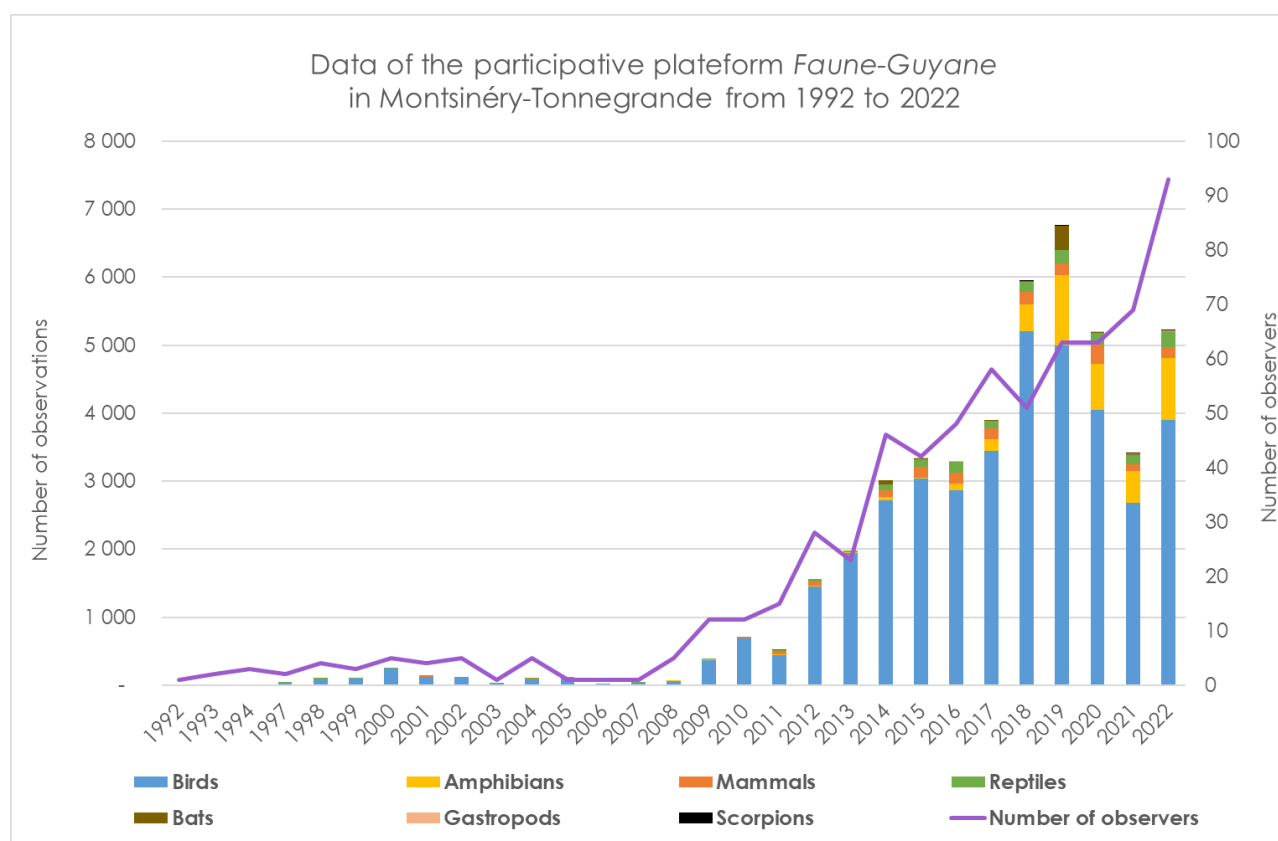


Figure 18. Observation data of the *Faune-Guyane* participatory platform from 1992 to 2022 in MT

A look to the spatial distribution of the data will give an assessment of the most frequented and attractive areas for fauna watching. As expected, Figure 19 shows that the observations are located along the roads and other tracks. The accessibility is the probably the most significant determinant.

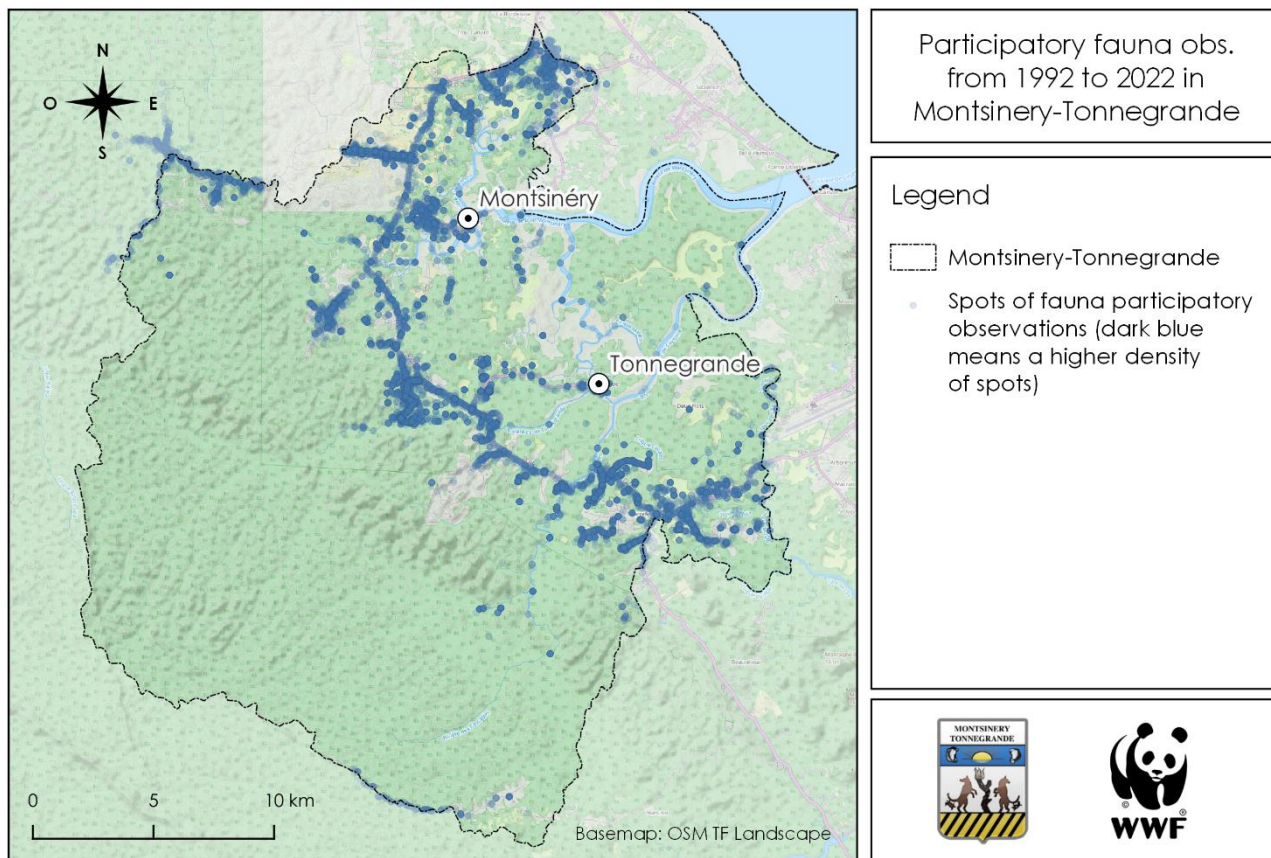


Figure 19. Location of observation data from *Faune-Guyane* platform

The heat map we made in Figure 20 shows more precisely, where the concentrations of observations are the highest. It confirms the very high attractiveness of the natural and heritage site *Bagne des Annamites*. Some dirt roads such as *Piste Risquetout* also gather significant numbers of observations as they give an easy access to the interior of the forest

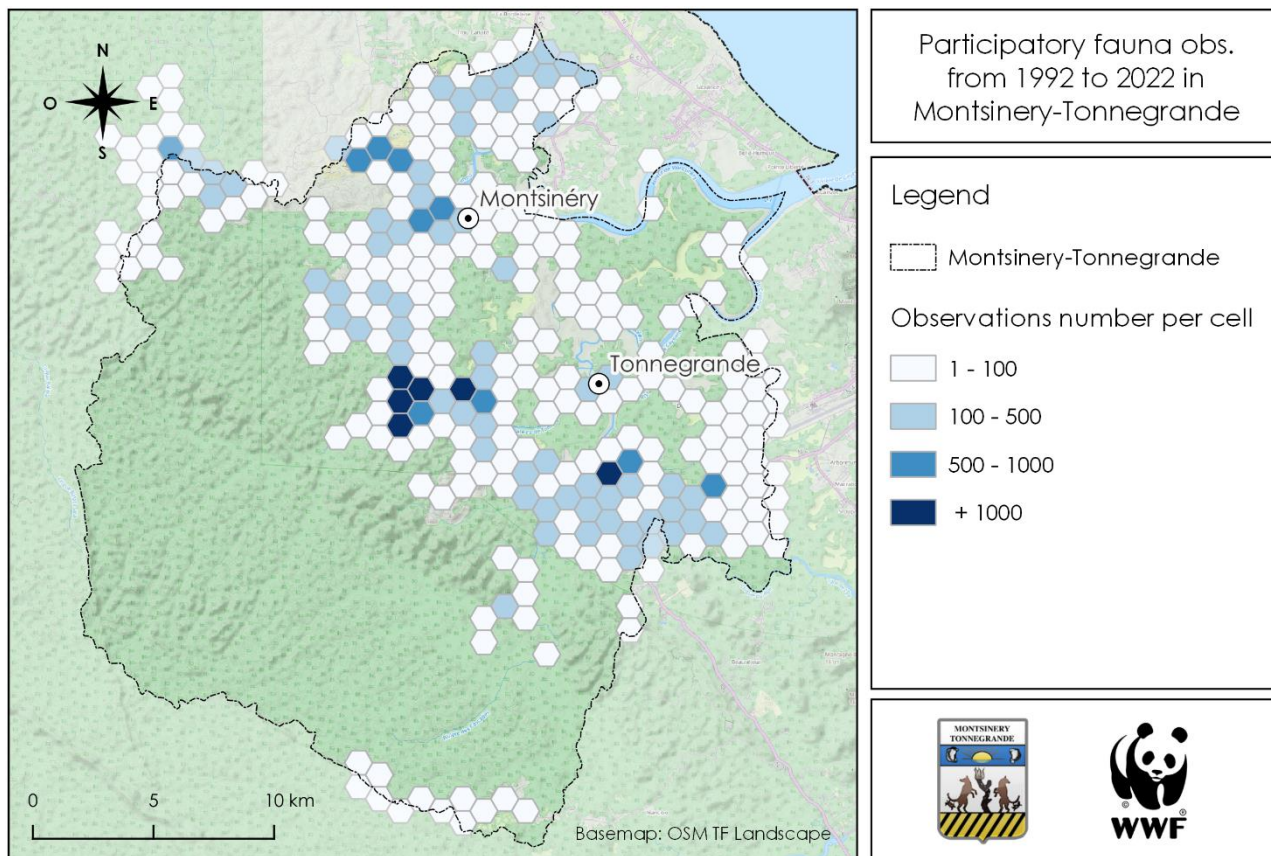


Figure 20. Density of observations from the *Faune-Guyane* platform

5.3 Local Ecosystem services mapping in Montsinéry-Tonnegrande

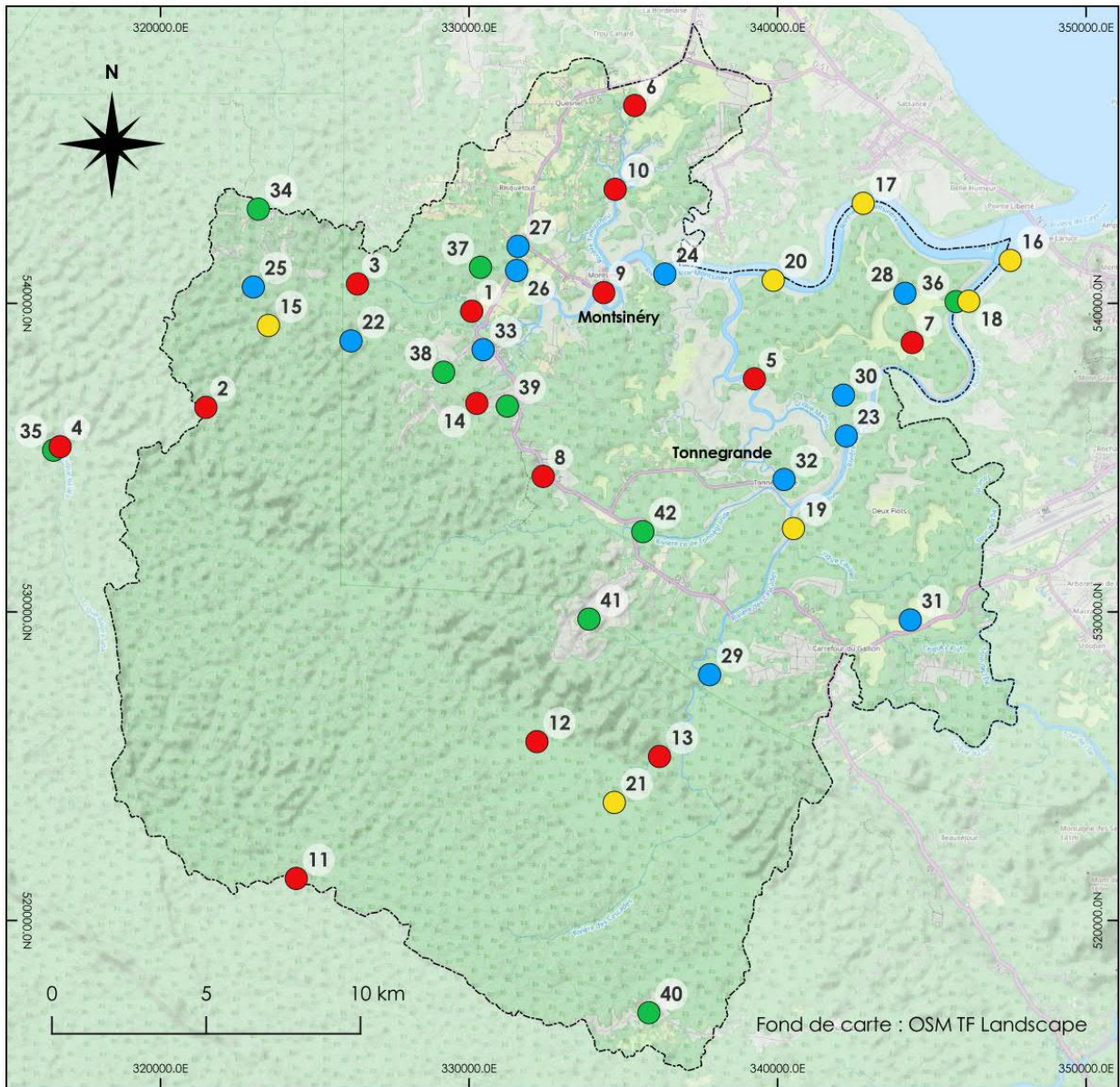
We explained above the methodology of the workshops and the way we implemented it in MT. We obtained some interesting results as 42 spots of ecosystems services were identified in the territory, with the following numbers per ES type:

- 14 for tourism and recreational activities;
- 12 for heritage and/or emblematic sites;
- 7 for wild animal products;
- 9 others.


Most of the recreational activities are linked with nautical activities (Canoe, etc.) and/or with aquatic ecosystems, like swimming for instance. It shows the development potential for water related activities. The participants mentioned particularly an area, upstream of the *Montsinéry* river.

The number of heritage sites listed shows also the importance of the landmarks left by the history of the town, linked with the period of slavery or the penal colony. Known by the old villagers, those sites are not all inventoried and not always clearly identified as most of them are now part of wild and natural habitats.





The smaller number of wild animals' ES can rely on the fact that this ES and the related activities (fishing and hunting) extends more than the previous ones and cover in fact a large area rather than a single spot. Another explanation can also rely on the fact that participants might be less keen on sharing this kind of knowledge. Nevertheless, this ES includes some important traditional activities of such as oysters or crabs harvesting in the mangroves.



Légende

 Commune de Montsinéry-Tonnegrande

Principaux services écosystémiques

-  Tourisme et activités nautiques
-  Prélèvements d'aminiaux ou de végétaux
-  Patrimoine naturel et culturel
-  Autres




Cartographie et évaluation des services écosystémiques des outremer européens

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Figure 21. ES participatory mapping results (Red: Tourism; Yellow: fishing and hunting; Blue: Heritage or emblematic value; Green: others)

5.4 Spatial analysis of the participatory mapping results

To go further into the explanation of the results, we analyzed the listed ES spots with other data.

First, we examined spot distribution within the land use and land occupation types (Figure 4). The results (below) showed the highest number of spots in the forest habitat, which is consistent with the fact that it represents the most important land occupation of the territory. Nevertheless, some other occupations have a higher share in the results than their real weight in the territory. Together, mangroves, rivers, and open wetlands hosts more than a quarter of the listed spots, demonstrating the importance of these habitats for tourism for instance.

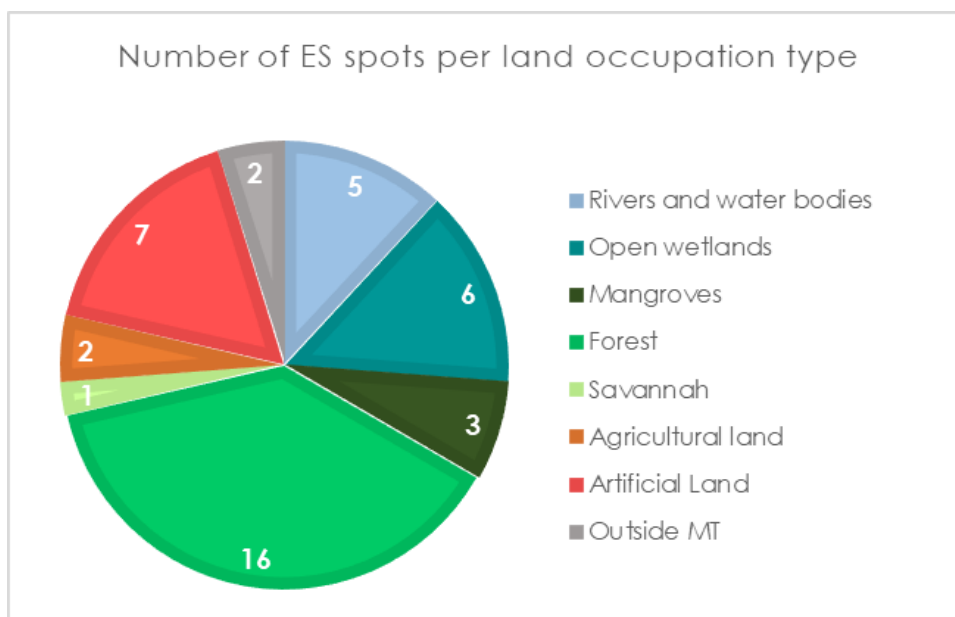


Figure 22. Cross analysis of ES GIS participatory results and LULC types

Secondly, we analyzed our results with the current local urbanism plan from 2011 (Figure 23). This plan identifies four types of areas:

- Urban area (current);
- Urban development area;
- Agricultural area (current and development);
- Natural areas for conservation.

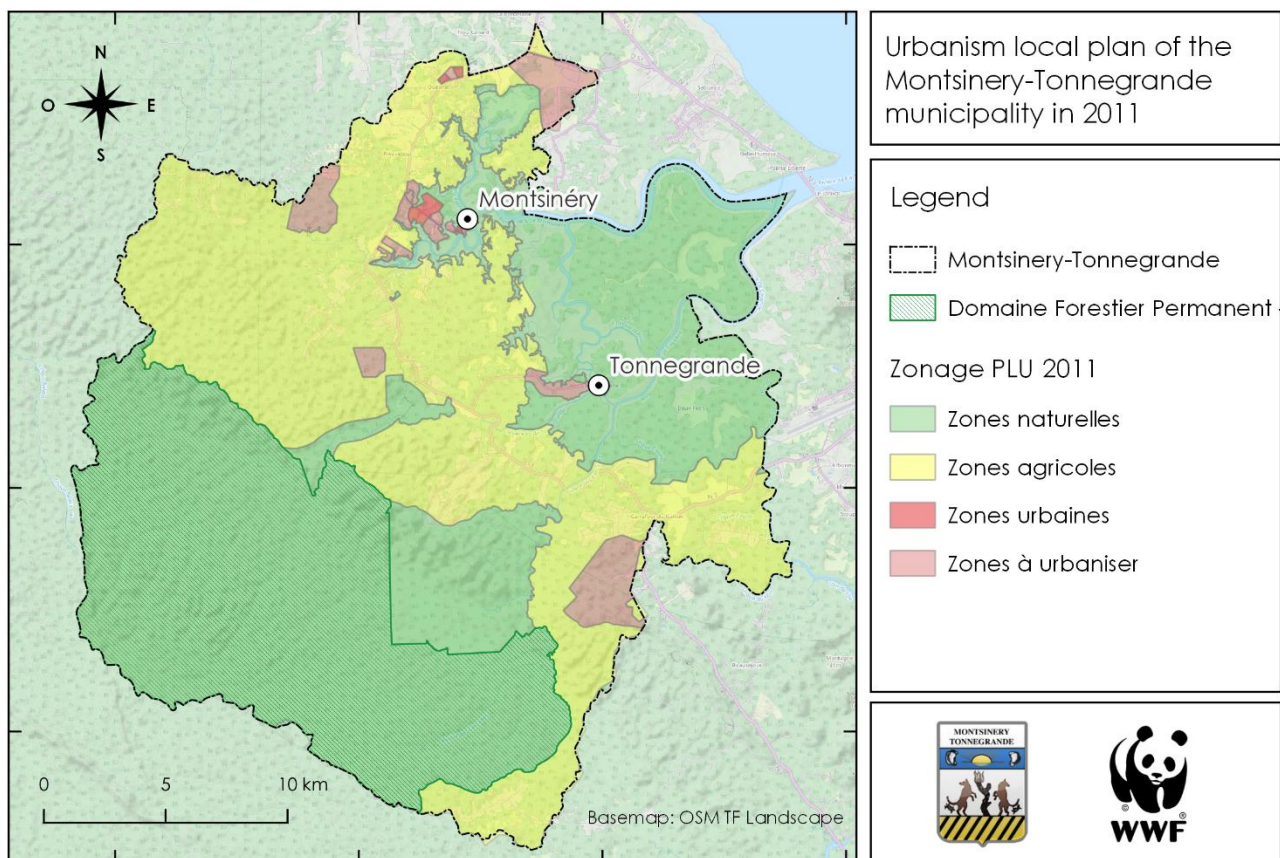


Figure 23. Land management plan of Montsinéry-Tonnegrande (2011)

Crossing our results with the data gave an indication to which extent the existence of ecosystem services is integrated (or not) in to the land management plan (below). The result showed that almost half of the ES spots (19) are located in nature areas and almost the other half (18) is located in agricultural development area. Only a few of them are located in urban areas (current or development), mostly because they represent the smallest development category in size, but also because they are not the most suitable areas to provide ES.

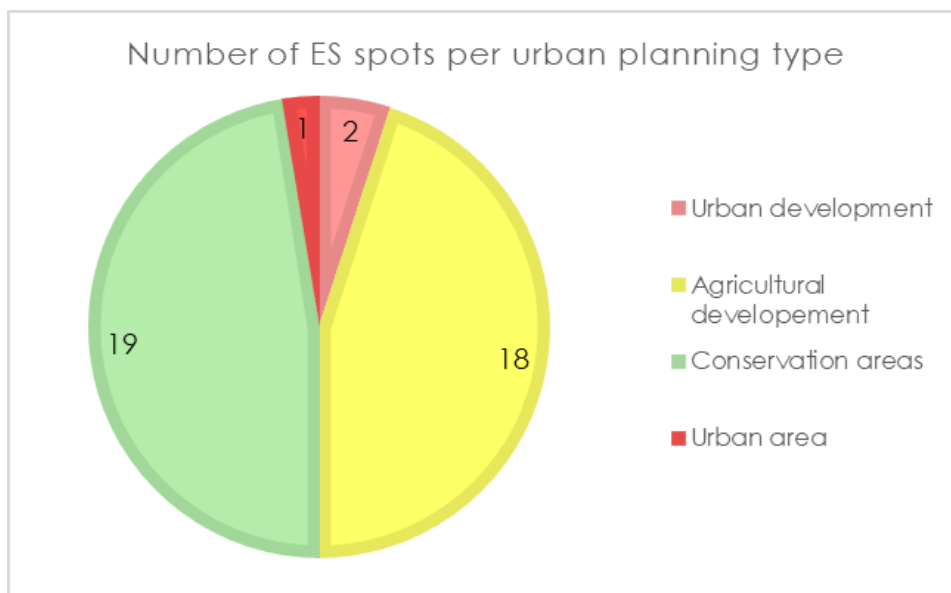


Figure 24. Cross analysis of ES GIS participatory results and MT Land management plan

In the end, the results might indicate some discrepancy between the type of development plan in the area and the services provided by the ecosystems. This could help raising crucial question for the revision of the PLU, which is currently ongoing. Will the agriculture land development maintain the ES provided in specific areas? How can we find synergies with the development of eco-tourism in some areas? etc.

To go further in the use of the results we split the ES accounts between ES types into each PLU category (Figure 25). Regarding Tourism and Heritage services, we do not see any difference with the global distribution: half of each es type is in either nature areas or agricultural development areas. Nevertheless, it is interesting to show that the ES spots related to “wild animal and their products” are exclusively located in nature areas, which might guarantee their preservation. This could give an opportunity to the local authorities to include them better into the development plans of the municipality.

Development areas (PLU)	Tourism	Heritage	Wild animal	Others	Total
Urban	1	1	0	0	2
Agriculture	5	5	1	7	18
Nature	7	5	6	1	19
Urban (current)	0	1	0	0	1
Total	13	12	7	8	40

Figure 25. Number spots per ES types and development area types of the PLU

6 DISCUSSION

This Anchor Project focused explicitly on a local geographical area to capture better the territorial reality of the ecosystem services, their perceptions by the local stakeholders and their use by the population. In that sense, this AP was very successful and the results achieved are very complementary with the previous ones realized in the ECOSEO / MOVE case study at the level of the whole French Guiana. It opens the possibility to replicate the same participatory approach in other chosen areas of the territory and to better understand the supply of ES at a local scale.

This AP also allowed to interact directly with the ES users and to gather local experts' knowledge that is not compiled elsewhere and that is often underestimated. A clear example is the obvious lack of data regarding tourism in the municipality, as it was previously inventoried by metropolitan administration (CACL), shown in Figure 17. Our two participatory mapping sessions allow completing this inventory (Figure 21). At the same time, the project increased the awareness of the workshops' participants about the omnipresence of ecosystem services and their importance.

Indeed, the case study of Montsinéry-Tonnegrande gave an illustrative example of how much ecosystems and people are linked in French Guiana "rural" land. In our specific case, the results allowed to identify areas of the municipality where Ecosystem services are more important than elsewhere. Some sections of the *Montsinéry* rivers, for instance, offers good condition to establish recreational equipment for nautical activities. Other areas and Heritage ES spots could be integrated into touristic tours. The conclusion meeting of the AP held with the municipality staff pointed out his possibility. Thus, it opens the way to better integrate them into decisions on land management plans such as the "PLU". This ongoing process will be pursued further.

In the end, this case study also demonstrated the feasibility of such participatory work where local authorities and elected representatives support a positive and sustainable agenda for their territory. The potential for the development of sustainable activities based on ES is confirmed then.

Of course, such case study could have covered a wider scope. We studied a limited number of ecosystem services with only one group of people. One way to improve the results would be to extend the approach to other ES or to other parts of the MT territory and touch more inhabitants.

Unfortunately, the Covid crisis and its consequence did not facilitate the exchanges and the inclusion of a large number of participants to the study during the first half of the implementation of the project. However, our combined efforts in the second half allowed us to reach successfully our objectives.

7 CONCLUSIONS

Finally, as the main goal of our Anchor Project was to “**Demonstrate the feasibility of a territorial management plan preserving and promoting ecosystem services**”, we can consider that we paved the way to achieve this result. The work done closely with the MT municipality will be integrated into development plans and projects.

Indeed, the results of the mapping and assessment of the ecosystem services in MT were greatly appreciated by the municipality staff, its mayor and by the inhabitants, participants of the workshops. It highlighted the importance of some ecosystem services such as ecotourism and motivated the stakeholders to promote them better, by the sustainable development of “green” economic activities around.

This kind of Anchor Project was a premiere with the MT municipality and a premiere in French Guiana. As the MT Mayor and its staff showed great interest in this work, we will explore jointly the ways to go further, either in terms of knowledge or in terms of concrete outputs. Indeed, beyond the possible inclusion of some ES results into the revision of the urbanism plan (PLU), we will also analyze and discuss together the possibility of adapting a scheme of Payment for environmental services (PES) that is being tested currently in France mainland. The initiative called “Nature impact” can give financial support to private or public landowners to reward commitments in the preservation or the restoration of Ecosystem services. Knowing the importance of the latest in French Guiana combined with a context where there is a critical lack of economic activities and employment, this could bring a new interesting light on the conservation approaches in this territory.

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9 ANNEX

9.1.1 Annex 1 – Invitation to the first participatory mapping session

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Evaluation et cartographie des services écosystémiques des outremer européens

Atelier de cartographie participative des services écosystémiques de la commune de Montsinéry-Tonnegrande



Mercredi 30 Novembre 2022 à 9h30

Mairie de Montsinéry-Tonnegrande



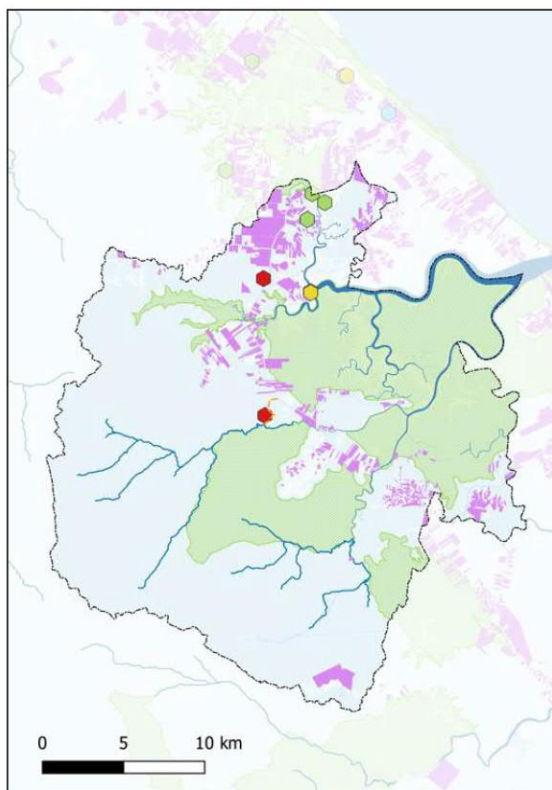
Tourisme, activités nautiques



Sites naturels et patrimoine culturel



Collecte de produits de la mangrove et de la forêt



9.1.2 Annex 2 – Raw results of the participatory mapping sessions

