SUMMARY FOR POLICYMAKERS

March 2023

4 POUR 1000

LES SOLS POUR LA SÉCURITÉ ALIMENTAIRE ET LE CLIMAT

SOIL CARBON STORAGE IN CROPLANDS, GRASSLANDS, FORESTS AND WETLANDS OF FRENCH OVERSEAS TERRITORIES

State of knowledge and levers for action

ADEME AGENCE DE LA TRANSITION ÉCOLOGIQUE | cirad LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT | INRAE | IRD Institut de Recherche pour le Développement FRANCE | MINISTÈRE DE L'INTÉRIEUR ET DES OUTRE-MER Liberté Égalité Fraternité | MINISTÈRE DE L'AGRICULTURE ET DE LA SOUVERAINETÉ ALIMENTAIRE Liberté Égalité Fraternité | OUTRE MER 5.0

1 Project context, challenges and objectives

Soils are at the heart of global challenges and organic carbon is a vital part of them. They help to mitigate climate change by absorbing atmospheric CO_2. They are a reservoir of biodiversity. They also play a key role in food security, since 95% of our food depends directly on soils. Storage of organic carbon in soils contributes to their fertility, to limiting their erosion and to their water retention capacity.

Maintaining or increasing soil organic carbon stocks is one of the few options identified by **the Intergovernmental Panel on Climate Change** (IPCC) to contribute to these global challenges. The recent launch by the European Union of the mission on *"Soil health and food"* serves to confirm this growing interest in soils and soil organic carbon. Their sustainable management can contribute to several of the **United Nations Sustainable Development Goals,** including SDG 2 on zero hunger, SDG 13 on action to combat climate change, and SDG 15 on the protection and restoration of land.

In the French overseas territories, soils are also central to local challenges: resilience to climate change, food autonomy, sustainable food, employment, and waste management. These challenges structure the 2030 objectives of the French Overseas **Trajectory 5.0: zero exclusion, zero carbon, zero waste, zero agricultural pollutants, and zero vulnerability.**

Overseas agricultural and forest soils can play an important part in achieving these objectives. This is the ambition of the international initiative **"4 per 1000: soils for food security and climate"** (https://4p1000.org). The initiative invites all stakeholders involved to implement specific actions to foster soil carbon storage by promoting a range of practices. Its goal is to encourage stakeholders to engage in a transition to productive, highly resilient agricultural and forestry systems that are based on appropriate land and soil management, create jobs and income, and thus drive sustainable development.
A first 4 per 1000 France study entitled "Storing 4 per 1000 carbon in soils: the potential in France", the results of which were published in 2019, focused on different agricultural and forestry practices enabling additional carbon to be stored in metropolitan French soils.

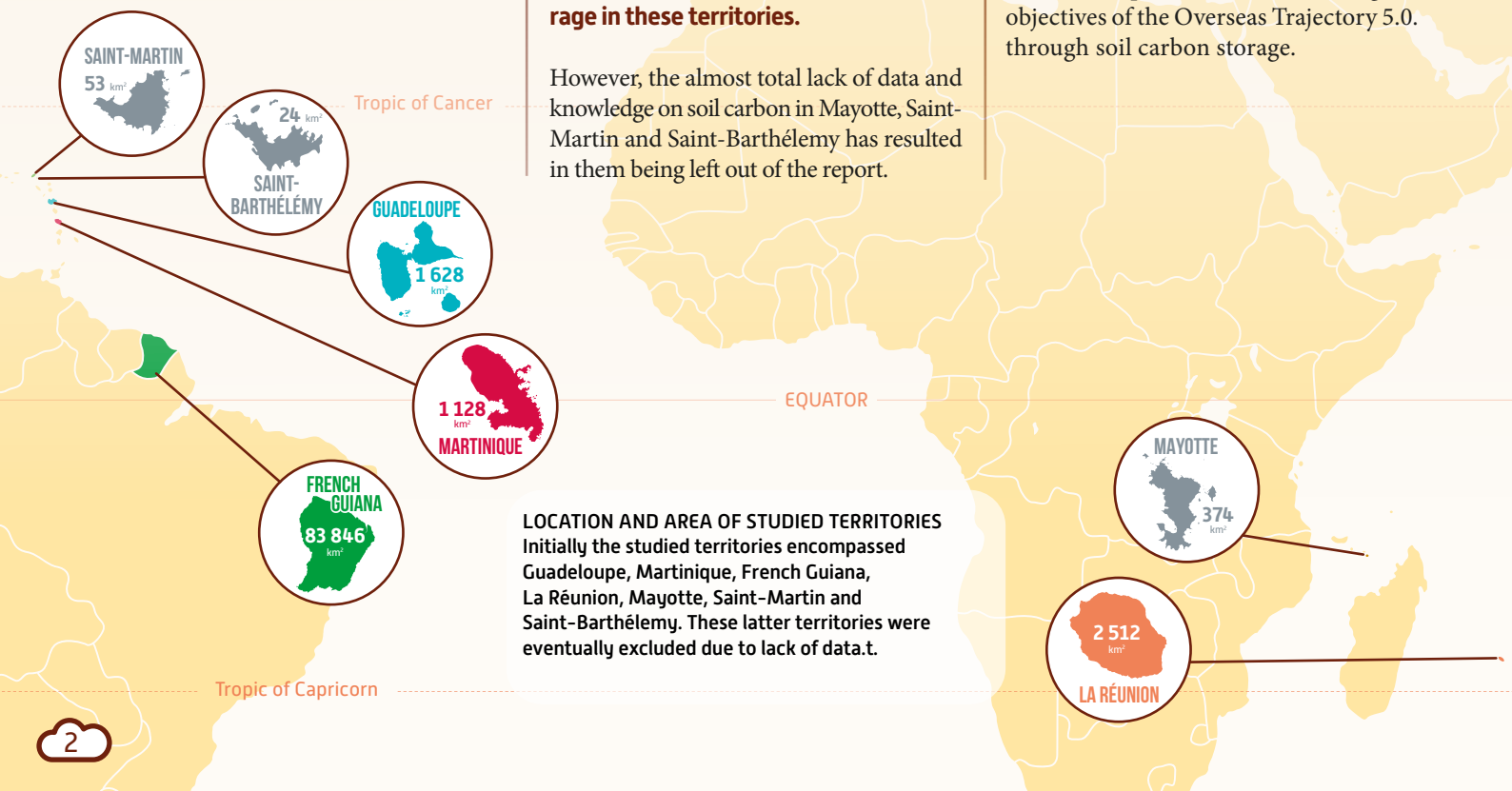
The objective of this study is to review knowledge on soil carbon stocks and fluxes in the French overseas departments and regions (DROM), territories that represent more than 15% of the total area of metropolitan France. It has thus identified tools to be mobilised in order to foster the preservation of stocks and to improve soil carbon storage in these territories.

However, the almost total lack of data and knowledge on soil carbon in Mayotte, Saint-Martin and Saint-Barthélemy has resulted in them being left out of the report.

This first study has answered the following questions:

- What are the soil carbon stocks and how do they evolve at the territorial level?
- What are the effects of land use change on these soil carbon stocks?
- What are the effects of agricultural and forestry practices on soil carbon stocks?
- What are the socio-economic and political drivers of uses and practices that foster soil carbon storage?
- What are the tools to be mobilised to foster soil carbon storage?
- How can the agricultural methodologies of the French Low-carbon label (Label bas carbone) be transposed to the overseas territories?

Another goal of the study was to identify the knowledge gaps to be filled in order to develop public policies that preserve soil carbon stocks in the overseas territories.
Finally, our recommendations are aimed at contributing to the implementation, by agricultural and forestry stakeholders in the overseas territories, of practices that contribute to climate change mitigation and adaptation, and to achieving the objectives of the Overseas Trajectory 5.0. through soil carbon storage.



LOCATION AND AREA OF STUDIED TERRITORIES
Initially the studied territories encompassed Guadeloupe, Martinique, French Guiana, La Réunion, Mayotte, Saint-Martin and Saint-Barthélemy. These latter territories were eventually excluded due to lack of data.t.

Photo by JM Blazy

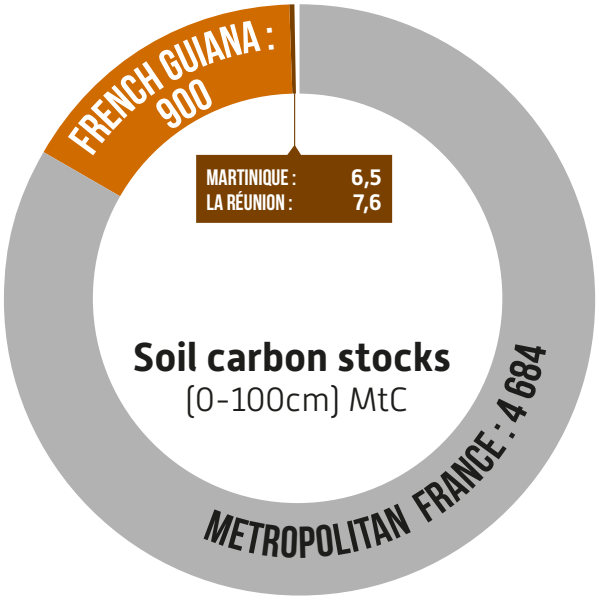
Associated crops in an experimental agro-ecological banana plantation at the INRAE site in Guadeloupe (French West Indies)

2 Main findings of the study

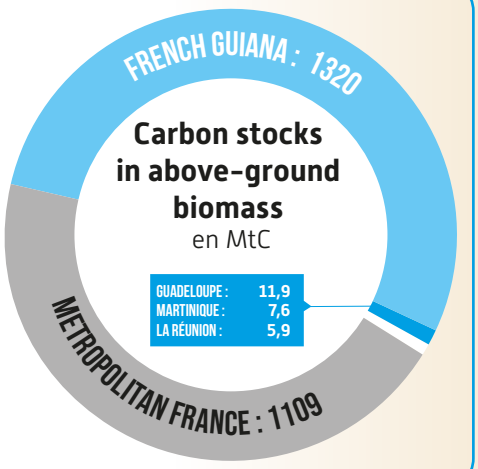
Soil carbon stocks in the French overseas territories are generally high, but tend to be declining because of land use change and current agricultural dynamics..

2.1 What are the soil carbon stocks in the overseas territories?

These stocks represent approximately 20% of the soil carbon stocks in metropolitan France. They have been calculated based on information available in Martinique, La Réunion and French Guiana. In Guadeloupe, on the other hand, data exists, but the corresponding stocks have not been calculated.



In addition, aboveground carbon stocks in French Guiana represent 120 % of the carbon in aboveground biomass in metropolitan French forests, at approximately 1 320 MtC, whereas the forest area in French Guiana represents 46 % of the metropolitan forest area.



2.2 What are the drivers of soil carbon stocks in the French overseas territories?

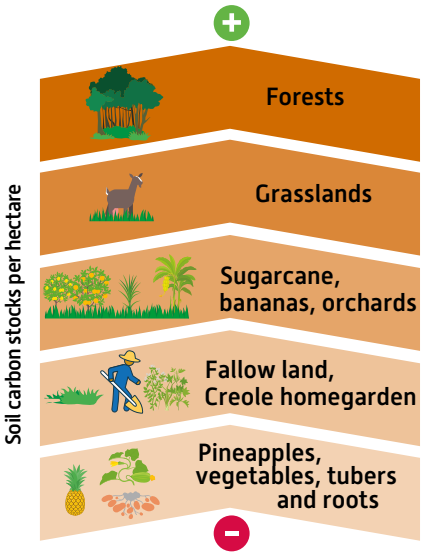
Whatever the territories concerned, the drivers of soil carbon stocks are multi-factorial. The soil type, and especially its composition in terms of clays, oxides and allophanes, is one of the main determinants, along with other key factors, such as land use or agricultural and forestry practices.

2.3 What are the soil carbon stocks according to soil types?

In the volcanic island territories, Andosols (young volcanic soils) have higher carbon stocks than other soils, with values that can exceed **200 tC/ha in the 0-30 cm soil depth layer**.
In French Guiana, Ferralsols (red soils) have higher carbon stocks than other soils, with values of approximately **130 tC/ha in the 0-100 cm soil depth layer.**
These high values in overseas soils are very different to those typically measured in metropolitan France (35 to 80 tC/ha on average).

Photo by V Blanfort

Soil samples from French Guiana



2.4 What are the soil carbon socks according to land use?

For a given territory and for identical soil and climate conditions, the soil carbon stocks per hectare increase according to the following sequence: Pineapples, vegetables tubers and roots < Fallow land, Creole homegarden < Sugarcane, bananas, orchards < Grasslands < Forests.

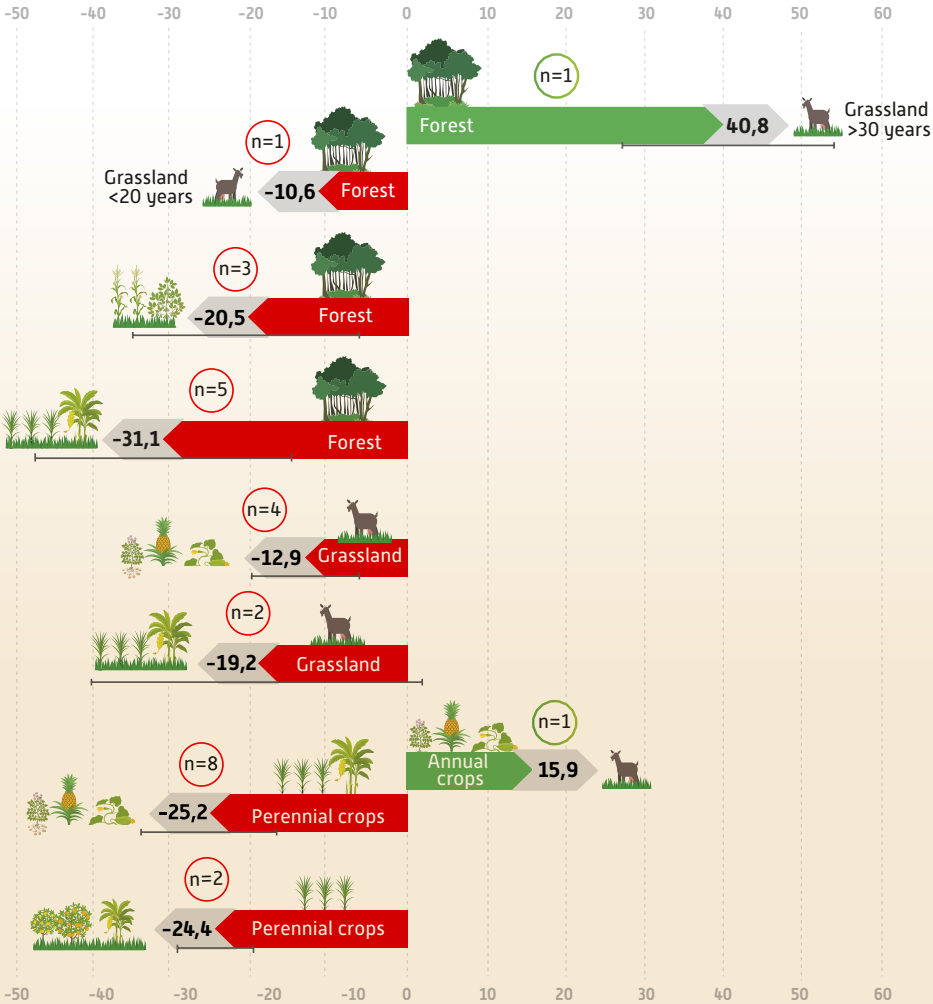
According to the land use, soil carbon stocks per hectare can reach values that are two to three times higher than in metropolitan France, and for half of all uses, soil carbon stocks exceed 100 tC/ha in the first 30 cm of soil. Furthermore, for forests, there is little data on these soil carbon stocks, except for those in French Guiana. The high variability of soil carbon stocks for a given use is explained by the effect of the soil type and by differences in the agricultural practices implemented.

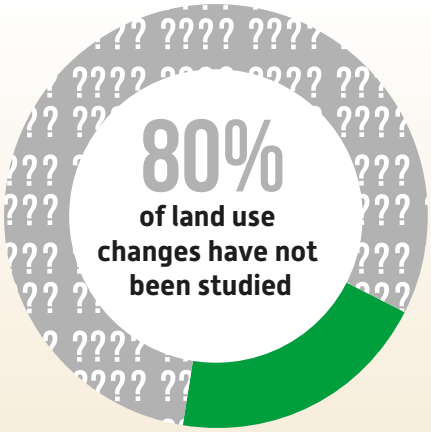
2.5 What is the effect of land use change on soil carbon stocks in the French overseas territories?

Eight types of transitions are documented in the overseas territories (see figure 2).

For these transitions, the ranges of variations in soil carbon stocks are high (> 10%), with higher variations in La Réunion.
The conversion of forests to annual crops (maize-soybean, vegetables) or perennial crops (bananas, sugarcane, orchards) results in a decrease in soil carbon stocks. The conversion of perennial crops to vegetables and tubers, or pineapples, also results in a decrease in soil carbon stocks. Only the conversion of annual crops to grasslands can result in an increase in soil carbon stocks.

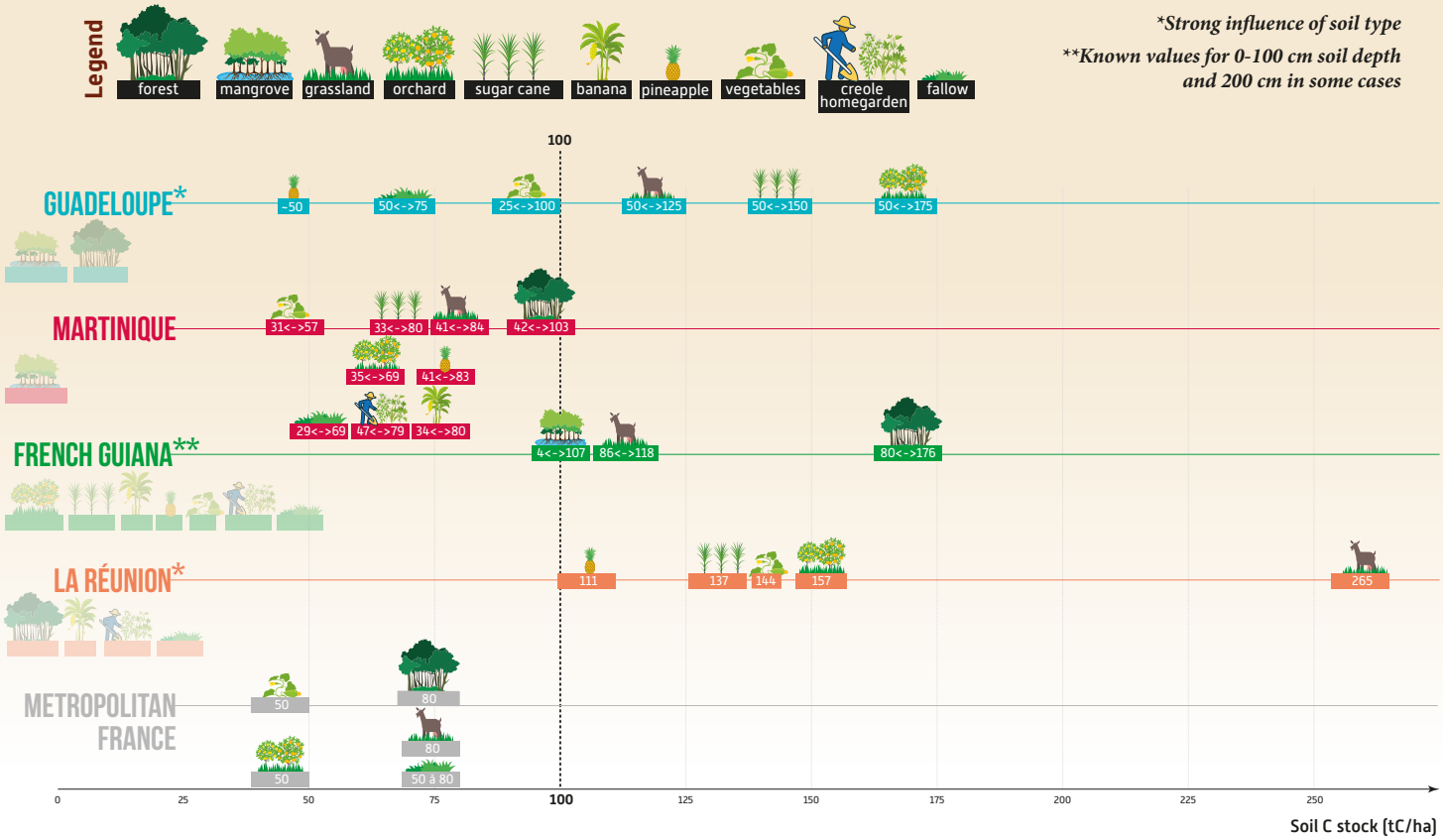
In total, 80% of land use changes have not been studied. In territories undergoing rapid change in terms of land use (forest conversion in French Guiana, urbanisation in the West Indies), this constitutes an obstacle to assessing the impact of these planning choices on soil carbon stocks at this scale.





Legend

Variation in soil carbon stock as a percentage of the initial situation according to the type of change in land use in the overseas territories. The number of studies available is shown in a circle (n=). The standard deviation is represented by the black line.



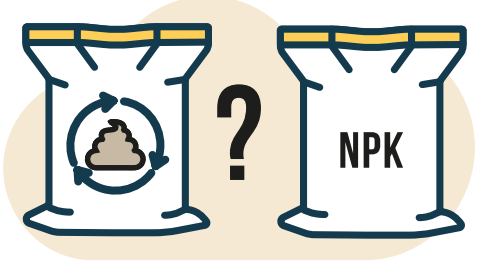
Soil carbon stocks per hectare by land use in the French overseas territories. Land uses for which soil carbon stocks per hectare are known are shown in colour. Watermarked land uses are those for which these stocks are not known. The values for metropolitan France are given for comparison and are taken from ADEME (2014).

2.6 What is the effect of changes in practices on soil carbon stocks in the French overseas territories?

Nine different agricultural practices were studied over several years to assess the effect (+, =, −) of changes in agricultural practices on soil carbon tocks in the overseas territories:

- +++ Replacing mineral fertilisation of **bananas** by organic fertilisation
- = Incorporating vegetable crop rotation or grazed fallow into **sugarcane** or **banana** plantations, with or without organic fertilisation
- + Proscribing burning of **sugarcane** residues
- = Replacing shallow tillage by no tillage for **maize** and **soybean** crops
- ++ Replacing deep tillage by shallow tillage for **vegetable crops**
- + Replacing mineral fertilisation of **vegetable crops** by organic fertilisation
- + Replacing mineral fertilisation of **grasslands** by organic fertilisation
- + Incorporating trees into **grasslands** (agroforestry)
- + Regreening **mining sites**

For the practices documented over several years, the ranges of annual variations in soil carbon stocks are typically greater than 1 tC/ha/year. Soil carbon losses can be rapid, whereas increases take several years.



Replacing mineral fertilisation by organic fertilisation results in an increase in soil carbon stocks, whatever the type of crop. However, this practice raises the question of the availability and origin of this raw material.

For vegetable and tuber crops, **limiting tillage also helps to limit soil carbon losses,** in comparison with deep tillage.

In grasslands and mining sites, **incorporating woody plants,** whether in agroforestry (silvopastoral systems) or for regreening, also results in an increase in soil carbon stocks.

No forest management practices (harvesting intensity, slash management) have been studied in terms of their impact on soil carbon stocks.

3 Main recommendations and perspectives of the study

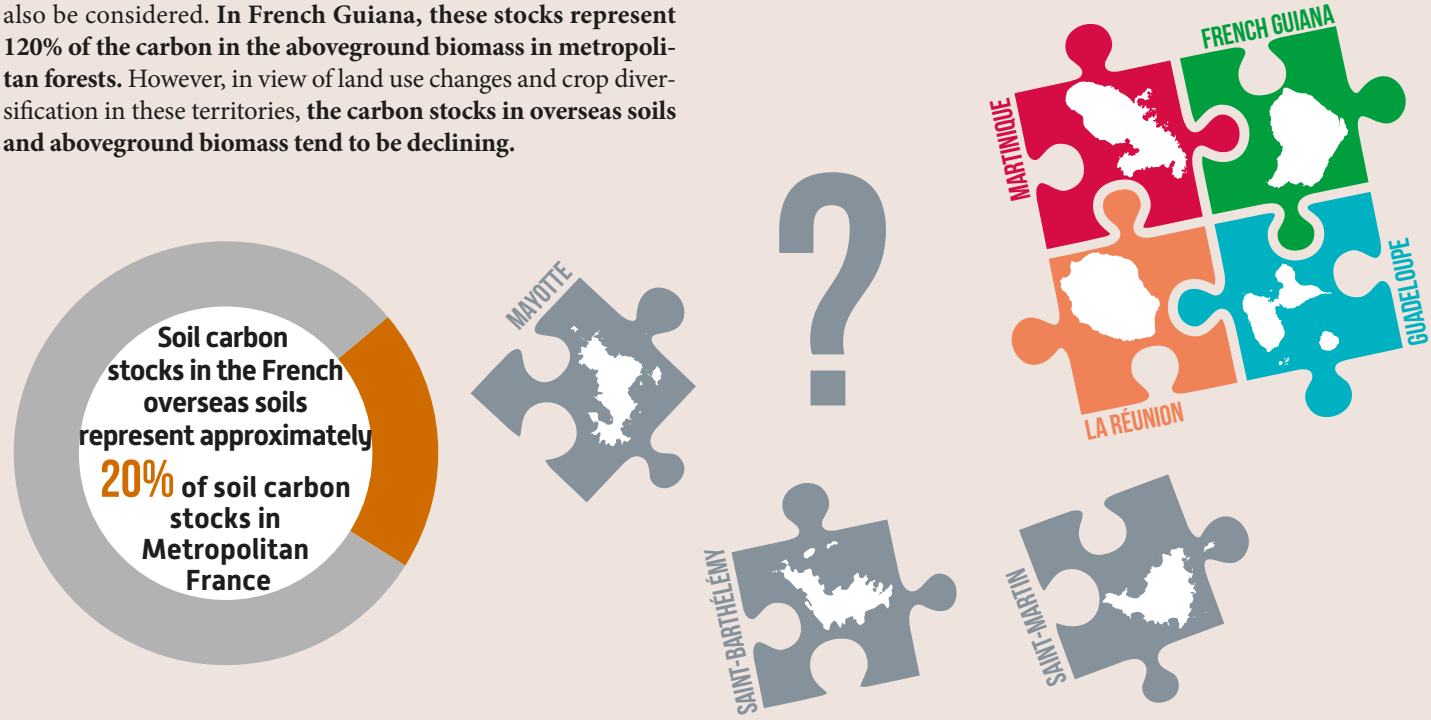
For the first time for the French overseas territories, this study has assessed the state of knowledge on soil carbon, taking a cross-cutting, multidisciplinary approach.

3.1 Findings

Two key lessons have emerged:

1 Soil carbon stocks in the French overseas soils represent approximately 20% of the soil carbon stocks in Metropolitan France.
According to land use, soil carbon stocks per hectare can reach values that are **two to three times higher than in metropolitan France**. To understand the weight of these territories in France's carbon balance, the carbon stocks in aboveground biomass must also be considered. **In French Guiana, these stocks represent 120% of the carbon in the aboveground biomass in metropolitan forests.** However, in view of land use changes and crop diversification in these territories, **the carbon stocks in overseas soils and aboveground biomass tend to be declining.**

2 Information is still fragmented and needs to be consolidated in Guadeloupe, Martinique, French Guiana and La Réunion to ensure they become references for tropical and subtropical zones in general.
On the contrary, no information has been identified concerning soil carbon stocks in Mayotte, Saint-Barthélémy and Saint-Martin. Consequently, this knowledge gap is currently an obstacle to the extension of the 4 per 1000 France study to these territories.



3.2 Recommendations

Our general recommendation is to preserve the high soil carbon stocks that exist and to minimise their decline in the French overseas territories.

We propose an operational application of our recommendations, simultaneously addressing the political, organisational, social, economic, technical and scientific dimensions, being convinced of their interdependencies and of the need to address this challenge in a systemic manner.
Beyond the benefits of preserving soil carbon stocks, these recommendations also help to address other global issues, including biodiversity loss, climate change and food security.

1 Ensuring that tools for planning and implementation of the Common Agricultural Policy (CAP) incorporate payments for ecosystem services associated with agricultural and forestry practices that maintain or limit the decline in soil carbon stocks. The portfolio of practices should be established territory by territory. However, our study shows that **organic fertilisation**, better **management of nitrogen inputs** for sugarcane, **no burning of sugarcane residues, agroforestry** the inclusion of **cover crops** in banana plantations, **limited depth and frequency of tillage** or the inclusion of **temporary fallow** in vegetable and tuber crops, and the **regreening** of mining sites all meet this objective. The same applies to **rotational grazing** or the long-term **maintenance of productive forage cover** for pasture management.

Support for the structuring of sectors involved in agricultural diversification will be important in this context, since they have a key part to play in meeting this objective of preserving soil carbon stocks.

In general, it will be important to determine the surface areas in which these stocking practices could still be implemented in order to assess the expected impact in terms of carbon storage.

Moreover, for organic fertilisation, it must be ensured that this is not simply a transfer of organic matter (for example, straw) from one agricultural plot to another. Support for organisational innovations both within and between sectors (livestock farming and crop production in particular), to foster the circular economy in the management of organic inputs, would be necessary.

2 Efforts to combat farmland speculation and retention. Switching to agricultural practices that are less intensive in terms of synthetic inputs could require the expansion of agricultural areas. This is the case, for example, of the inclusion of temporary fallow in vegetable and tuber crops. Such changes in crop management practices are only feasible if access to additional farmland is possible, in terms of both its availability and its cost. The preservation of carbon stocks, in soils or aboveground biomass, therefore requires dedicated spatial planning choices and policies.
Our study has shown that land use change has a significant impact on soil carbon stocks, even if there is still a great deal to study. **The integration of carbon accounting, through the Plans Climat Air Energie Territoriaux (PCAET - Climate, air, energy territorial plans), for example, and of tools such as ADEME's ALDO, could help to guide these spatial planning choices while taking account of carbon in soils and vegetation.** This integration is particularly important for territories such as French Guiana, where the land use change dynamics are largely detrimental to forests, or in the West Indies and La Réunion, where urban pressure is growing.

3 Developing incentive measures, encouraging the deployment of the France Relance plan (hedge planting programme, for example), and communicating on agroecological practices in general will all contribute to implementing the stocking practices identified in this study. These actions nevertheless need to be supported, and this is the purpose of the two following recommendations..

4 Facilitating access to investment, to farm machinery cooperatives (CUMA) for equipment and to training. The implementation of certain practices will require specific equipment (shallow tillage), new knowledge (management of cover crops) or financial resources (agroforestry).

5 Transposing the French low carbon standard (Label bas carbone) to contribute to the adoption of stocking practices through economic incentives, to transition to the agri-environmental measures of the CAP.

It is clear that these actions and recommendations are closely linked to one another. We nevertheless believe that public policy is the most powerful tool to contribute to achieving the general recommendation of preserving existing soil carbon stocks and limiting their decline in the French overseas territories.

3.3 The need for knowledge and research actions

These recommendations must also be accompanied by action in terms of research. Five research actions have been identified to contribute to the previous recommendations:

1 Increasing knowledge of soil carbon stocks and greenhouse gas balances in the French overseas territories in order to measure the impact of public policies intended to contribute to climate change mitigation. In particular, our study has highlighted the knowledge gaps concerning carbon stocks in overseas forest soils, and more generally across almost 4 200 km^2.
The Réseau de Mesures de la Qualité des Sols (RMQS - Soil quality measurement network), for example, needs to be strengthened in the French overseas territories, especially in French Guiana, a vast and diversified territory. These DROMs need to be equipped with tools to measure and monitor soil carbon stocks at the appropriate scale to guide spatial planning choices and to assess the impact of policies to foster the implementation of stocking practices in agriculture and forestry.

2 Adapting methods to quantify soil storage capacities in order to transpose the French low carbon standard to tropical conditions and crops. While this study has facilitated the launch of this process for agricultural soils, efforts need continue in La Réunion, Martinique and French Guiana. Moreover, no information exists on models for forestry and agroforestry soils.
Beyond the Low-carbon standard, such tools will be used in the ex ante assessment of the impact of agricultural and forestry practices on soil carbon.

3 Stepping up research on the social dimensions to foster innovation. It is nevertheless clear that this field of investigation has been explored very little so far, despite being essential to understand the motivations and obstacles of the different stakeholders and to design public policies or incentive tools.

4 Developing systemic approaches for the evaluation of agroecological scenarios that are co-developed on the scale of each overseas territory, in view of the close interdependencies of the political, social, economic, technical and environmental dimensions of the issue of carbon storage. Taking account of the territorial scales seems essential to understand these interactions. The development of such approaches depends on research and raises numerous methodological questions.

5 Creating interfaces for territorial and inter-territorial dialogue between science, policy and agricultural and forestry stakeholders, for the design of public policies or political decision making.
The highly integrative nature of soils requires such interactions. To our knowledge, there are no existing bodies that facilitate these interactions, which is an obstacle to the preservation of soil carbon stocks in the French overseas territories.

This summary was done by

Authors:
Julien DEMENOIS (Cirad), Ellie DAGUET (Cirad), Jean-Marc BLAZY (INRAE), Alain ALBRECHT (IRD), Vincent BLANFORT (Cirad), Vincent FREYCON (Cirad), Antoine VERSINI (Cirad), Jorge SIERRA (INRAE), Jean-Christophe ROGGY (INRAE)

Design:
Atelier Aymara (www.une-saison-en-guyane.fr)

English translation:
Anna Kiff, Julien Demenois

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Find out more

The final report, annexes and this summary are available online at : https://www.etude-4p1000-outre-mer.fr