



Identification of key MAES potential contribution to the achievement of the set of EU directives and international commitments

Deliverable n° D.5.2

April 2022

Citation: MOVE-ON project (2022), European Commission Directorate General Environment Grant Agreement no. 07.027735/2019/808239/SUB/ENV.D2. *Deliverable D.5.2 - Identification of key MAES potential contribution to the achievement of the set of EU directives and international commitments.*

Coordinated by:



Partners:



Supported by:



This project has received funding from the European Union represented by European Commission Directorate General Environment under grant agreement N° 07.027735/2019/SI2.808239/SUB/ENV.D2. This document only reflects the views of its authors. The Commission is not responsible for any use that may be made of the information it contains.

Project Acronym	MOVE-ON
Project Title	From case studies to anchor projects - setting the ground to advance MAES in Europe's overseas.
Grant Agreement n°	07.027735/2019/808239/SUB/ENV.D2
Start of the project	May 2020
Duration	36 months
Project coordinator	FRCT - Regional Fund for Science and Technology, Regional Government of the Azores (Portugal)
Website	www.moveon-project.eu

Deliverable title	Report on key assets of EU ORs for an effective policy for ecosystem protection in the wider context of global changes.
Deliverable n°	D.5.2
Activity title	Activity 5 – Developing and Disseminating Good Practice Guidelines and Policy Recommendations
Task title	Task 5.2 – Identification of key MAES potential contribution to the achievement of the set of EU directives and international commitments
Task Leader(s)	<i>Institut de Recherche pour le Développement (IRD)</i>
Lead authors	<i>Rachel Bitoun</i>
Contributing authors	<i>Rodolphe Devillers Ewan Trégarot Gianluca Ferraro</i>
Due date of deliverable	April 2022
Actual submission date	01/04/2022
Dissemination Level:	Public

Version	Status	Date	Author(s)
1.0	1 st Draft	07/03/2022	Rachel Bitoun (IRD)
1.1	2 nd Draft	25/03/2022	Gianluca Ferraro (UoP) Artur Gil (IVAR) Carolina Parelho (FRCT) Paula Rendon (LUH) Ewan Trégarot (UoP)
1.2	Final Draft	29/03/2022	Rachel Bitoun (IRD)

Summary

Following MOVE-ON Task 5.1, this report explores the gaps that separate science from practice in the adoption of Ecosystem Services (ES) approaches in the European Union overseas, proposing pathways that could encourage their implementation. Here, we identify key challenges and obstacles for achieving sustainability goals and provide strategies for the implementation of ES-based management.

The report draws conclusions from stakeholders' interviews conducted in three MOVE-ON anchor projects - the Canary Islands, French Guiana, and Reunion Island - based on an extended SWOT analysis that identifies local strengths, weaknesses, opportunities, and threats to the achievement of sustainable development. The MAES barometer informed the selection of case studies. MAES barometer is a monitoring tool assessing the state of Mapping and Assessment of Ecosystems and their Services (MAES) in anchor project regions (the Azores, the Canary Islands, French Guiana, Reunion Island, and Saint Helena). The analysis provides seven strategies for future implementation of ESs approaches in adaptation to local contexts. On average, the strategies proposed are expected to affect the delivery of 6 ESs. Our results show strong interlinkages and effects of the strategies to achieve Sustainable Development Goals (SDGs) 15 (Life on land), 2 (Zero hunger), 14 (Life below water), and 11 (Sustainable cities and communities). These results demonstrate the ability of ES assessments to tackle the three sustainability pillars (social, economic, and environmental), and the potential of EU outermost regions to achieve international commitments such as SDGs.

Table of Contents

INTRODUCTION	7
METHOD	9
1. Site description	10
a. Case study 1: The Canary Islands	10
b. Case study 2: French Guiana	11
c. Case study 3: Reunion Island	12
2. Conceptualization and interview structuring	12
3. Data collection	13
4. Data exploration	14
a. Sentiment analysis	14
b. Coding process: PESTEL themes and SWOT matrix	15
5. Data analysis	17
a. Strategies for ecosystem services implementation	17
b. Ecosystem services contribution to the achievement of EU policy targets	17
RESULTS	19
1. Interviewee characteristics	19
2. Sentiment analysis	20
3. PESTEL factors	22
a. Canary Islands key factors	23
b. French Guiana key factors	32
c. Reunion Island key factors	39
4. Ecosystem services contribution to Sustainable Development Goals (SDGs)	45
DISCUSSION AND CONCLUSION	48
REFERENCES	54

List of Figures

Figure 1 - Workflow display for the proposal of strategies for the achievement of Sustainable Development Goals (SDGs) and EU policy targets using Ecosystem Services (ES) approaches. These proposals are based on the Political, Economic, Socio-cultural, Technological, Environmental, and Legal (PESTEL) strengths, weaknesses, opportunities, and threats (SWOT) analyzed in three EU outermost regions (the Canary Islands, French Guiana, and Reunion Island).	9
Figure 2 - Deductive conceptual web based on the literature review (n = 11) of key features to take into account for the proposal of pathways for ES implementation. These key features are the strengths, weaknesses, opportunities, and threats, affecting ecosystem resilience and perception of ESs.	13
Figure 3 - Distribution of interviewees for the research project per organization type.	19
Figure 4 - Chart of weighted sentiment value (dark gray), respondent's attitude score (light gray), and average value (red), per respondent (n = 38) and per case study (Canary Islands, French Guiana, Reunion Island).	20
Figure 5 - Distribution of the PESTEL factors per case study (Canary Islands, French Guiana, Reunion Island).	23
Figure 6 - PESTEL factors and subfactors most representative of the Canary Islands (in bold level 2 factors, in italics level 3 factors).	24
Figure 7 - PESTEL factors and subfactors most representative of French Guiana (in bold level 2 factors, in italics level 3 factors).	32
Figure 8 - PESTEL factors and subfactors most representative of Reunion Island (in bold level 2 factors, in italics level 3 factors).	39
Figure 9 - Contributions of strategies for ecosystem services (ES) implementation (on the left) in the Canary Islands (CI), French Guiana (GF), and Reunion Island (RE), to the United Nations Sustainable Development Goals (SDG, on the right). Links between ES and SDGs are adapted from Wood et al. (2018). The size of the icons is proportional to the strength of ESs contribution to a given SDG.	47
Figure 10 - Example of how strategies for ES implementation in three outermost regions contribute to achieving the Sustainable Development Goal 15 (SDG 15), and how it is translated into European actions supporting this goal, modified and adapted from EC (2016).	51

List of Tables

Table 1- Main level 2 PESTEL categories used for interview coding.	15
Table 2- ESMERALDA Database criteria used for method selection.	17
Table 3- Distribution of interviewees per region.	19
Table 4- Distribution of quotes per region per sentiment type.	21
Table 5- Canary Islands SWOT matrix.	25
Table 6- Ecosystem services assessment methodology per strategic orientations for the Canary Islands, based on the ESMERALDA database.	31
Table 7- French Guiana SWOT matrix.	33
Table 8- Ecosystem services assessment methodology per strategic orientations for French Guiana, based on the ESMERALDA database.	38
Table 9- Reunion Island SWOT matrix.	40
Table 10- Ecosystem services assessment methodology per strategic orientations for Reunion Island, based on the ESMERALDA database.	45
Table 11- Contribution of the strategies for sustainability to ESs, based on the CICES v5.1 classification system of ESs.	46

Abbreviations

CI	Canary Islands
CICES	Common International Classification of Ecosystem Services
ES	Ecosystem Service
EU	European Union
GF	French Guiana
IAS	Invasive Alien Species
MAES	Mapping and Assessment of Ecosystem Services
NGO	Non-Governmental Organization
NP	National Park
PESTEL	Political, Economic, Socio-cultural, Technological, Environmental, and Legal and Regulatory
RE	Reunion Island
SDG	Sustainable Development Goal
SWOT	Strength, Weakness, Opportunity, and Threat

INTRODUCTION

The European Commission is committed to monitoring the implementation of Agenda 2030 and the related Sustainable Development Goals (SDGs) through Eurostats' yearly tracking of European Union (EU) progress (Kluza et al., 2021). In the past couple of years, important EU policy changes tackled social, economic, and environmental sustainability with comprehensive frameworks, consistently with the SDGs. For example, with the adoption of the European Green Deal (EC, 2019), the EU is addressing 12 out of 17 SDGs. The Green Deal addresses issues such as greenhouse emissions, climate change adaptation, air pollution and health protection, and the impacts of our ways of producing and consuming. In addition, the EU has adopted a new comprehensive Climate Law (European Parliament and European Council 2021), the 2030 Climate Target Plan (EC, 2020a), and two strategies, the Farm to Fork Strategy (EC, 2020b) and the EU Biodiversity Strategy to 2030 (EC, 2020c).

Targets for the protection, restoration, and promotion of the sustainable use of ecosystems and their services are embedded in the SDGs (UN, 2015). Inversely, 12 out of the 17 SDGs are strongly supported by the supply of ES. ESs contribute to achieve sustainable relationships between human society and ecosystems (Bull et al., 2016). Wood et al., (2018) found that the SDGs relying most on ESs are SDG15 (Life on Land), 14 (Life Below Water), 1 (No poverty), 11 (Sustainable Cities and Communities), and 3 (Good health and well-being). However, co-benefits generated from ES-based management for SDGs implementation are often overlooked and underexploited (Yang et al., 2020). We found challenges disconnecting science, policy, and practice in ESs approaches (Bitoun et al., 2021) due to disconnections between ESs assessments and real-world problem solving (Nahuelhual et al., 2020). The usefulness and importance of ES assessments for decision-making have been widely discussed in the literature. However, evidence of its practical implementation in support of policy and decision-making remains scarce (Longato et al., 2021). The challenge for the uptake of ESs approaches is to develop ES-based strategies grounded in local issues.

ES-based management can contribute to mitigating environmental pressures and weaknesses by informing the design of environmental management alternatives and for strategic planning (Berte & Panagopoulos 2014). The SWOT (Strength, Weakness, Opportunity, and Threat) analysis is widely applied in business management as a tool to support strategic decision making, but it also has been used for environmental management and for ES approach implementation. Previous studies used SWOT analysis to assess the ES framework in the four SWOT quadrants (Bull et al., 2016) or to assess the opportunities for integrating ESs into existing policy documents (Autmane & Cabral 2021; Inkoom et al., 2017). However, one of the shortcomings of SWOT analysis is its subjectivity, which can lead to inconsistencies and omissions (Panagiotou & van Wijnen 2005). To overcome this limitation, we used an extended SWOT analysis, the PESTEL (Political, Economic, Social, Technological, Environmental, and Legal and regulatory) analysis. PESTEL

analysis is a strategic framework used to analyze and monitor a system in its macro-environment (Øivind Madsen & Ove Grønseth 2022). Combining SWOT and PESTEL is useful for a systematic and comprehensive reporting of key factors for sustainability. In this study, PESTEL analysis is used to identify key factors that may affect directly or indirectly the achievement of sustainability goals in selected case studies. The selection of the case studies was informed by the MAES barometer. This monitoring tool assesses the state of Mapping and Assessment of Ecosystems and their Services (MAES) in anchor project regions (the Azores, the Canary Islands, French Guiana, Reunion Island, and Saint Helena). We selected the regions with the highest and lowest score (French Guiana, 16 points and Reunion Island, 6, respectively) to explore contrasting case studies. The Azores (12 points) and Saint Helena (11 points) were considered intermediate case studies. At the time of the study, delays in background project deliverable necessary to achieve this task and travel restrictions, both due to covid-19, lead to the selection of the most contrasting case studies (low and high scores).

This study aims to provide a view of the key challenges and obstacles to achieving sustainability goals and provide strategies to implement ES-based management in three outermost regions of the EU. We determined what ES-based strategies are strategic to address the main PESTEL challenges and opportunities of the Canary Islands, French Guiana, and Reunion Island. We assessed this research question by reviewing context-specific factors such as, but not limited to, management practices, cooperation among stakeholders, environmental threats, and economic development. This question was investigated with semi-structured interviews carried out in the three selected case studies to collect evidence of the main Strengths, Weaknesses, Opportunities, and Threats, challenging or facilitating the achievement of sustainability goals. Based on this evidence, we propose seven strategies for implementing ES-based management to overcome local challenges while seizing opportunities. ESs are identified following the Common International Classification of Ecosystem Services (CICES v5.1). Finally, we demonstrate how the implementation of ES-based strategies can affect multiple ESs delivery and simultaneously advance the achievement of SDGs. This report demonstrates synergies between SDGs and EU policy targets, thus highlighting the cumulative benefits of assessing and mapping ESs in the selected case studies.

We selected three EU outermost regions anchor projects of the MOVE-ON project following consultations with other project team members to assess local opportunities for ES implementation: the Canary Islands, French Guiana, and Reunion Island. The barometer is based on 25 indicators covering seven categories to monitor the MAES implementation level per region. We selected the region with the highest and lowest scores (French Guiana, 16 points, Reunion Island with 6 and the Canary Islands with 7) to explore contrasting case studies.

METHOD

This study analyzes the challenges and opportunities for sustainable development in three EU outermost regions and proposes strategies to make use of ESs assessments as a means to address these challenges. To do so, we used an extended model of the SWOT analysis (PESTEL analysis), a tool used in business management for strategic planning. We performed an analysis of the literature on SWOT applications to ESs based management to frame the study (Interview structuring, Fig. 1).

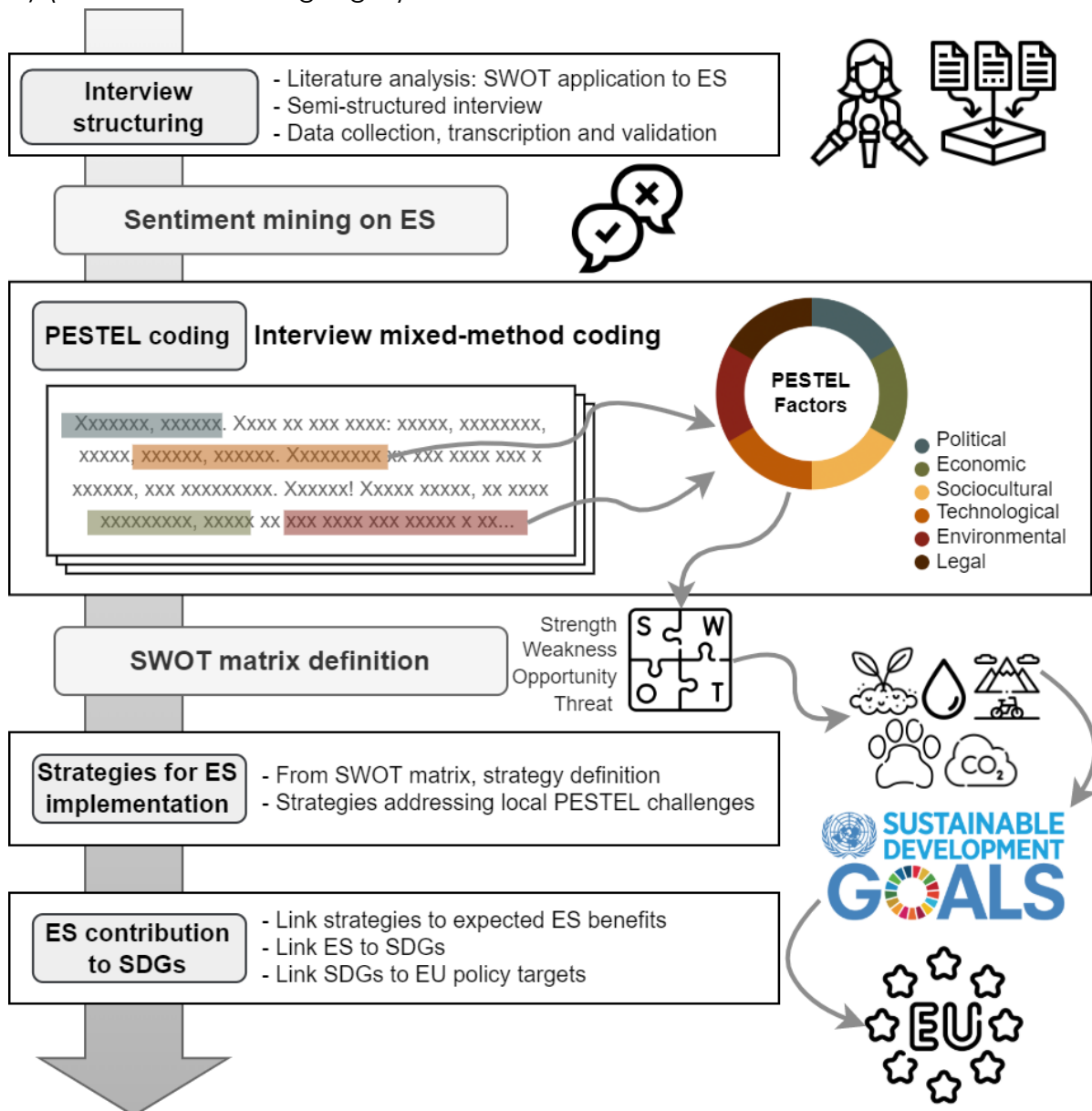


Figure 1 - Workflow display for the proposal of strategies for the achievement of Sustainable Development Goals (SDGs) and EU policy targets using Ecosystem Services (ES) approaches. These proposals are based on the Political, Economic, Socio-cultural, Technological, Environmental, and Legal (PESTEL) strengths, weaknesses, opportunities, and threats (SWOT) analyzed in three EU outermost regions (the Canary Islands, French Guiana, and Reunion Island).

Then, we carried out interviews to identify the main PESTEL factors facilitating or impeding sustainable development in the selected case studies (data collection). Interviews were coded into PESTEL factors, then synthesized and reported in SWOT matrices to propose ESs implementation strategies addressing the identified challenges. Finally, we highlighted the contribution of our proposals to achieve multiple SDGs and EU policy targets.

This study follows the framework presented in Fig. 1 and is presented in this report as follows: (i) site description, (ii) conceptualization and interview structuring, (iii) data collection, (iv) data exploration, and (v) data analysis.

1. Site description

Three EU outermost regions anchor projects of the MOVE-ON project were selected following consultations with other project team members to carry out an assessment of local opportunities for ES implementation: the Canary Islands, French Guiana, and Reunion Island. To help select a range of representative case study sites, the selection was informed by the MAES barometer. The barometer is based on 25 indicators covering seven categories for the assessment of MAES implementation level per region. We selected the region with the highest score (French Guiana, 16 points) and the one with the lowest scores (Reunion Island, 6, and the Canary Islands, 7) to explore contrasting case studies. Saint Helena and the Azores scored 11 and 12, respectively. Additional case studies were considered but covid-19 travel restrictions at the date of study limited the travel to a number of other locations (Saint Helena and the Azores).

a. Case study 1: The Canary Islands

The Canary Islands are a North Atlantic volcanic archipelago located off the southwest of Morocco consisting of eight islands. These islands are the most remote autonomous region of Spain, and an outermost region of the EU. The archipelago had a population of 2.24 million inhabitants in 2020, with a density of approximately 300 inhab./km². The archipelago is divided into two provinces, each having their respective capitals and governments on the most populated islands, *Santa Cruz de Tenerife* and *Las Palmas de Gran Canaria*. The Canary Islands politics are embedded in a complex multilayered system, comprising the Spanish national level, the Autonomous region level (archipelago government), two provincial governments, and an elected Island Council (*Cabildo Insular*) on each island. The administrative and policy organization is based on the Island Councils, leading to important competencies managed at the island level (Hernández-Martín et al., 2021).

The Canary Islands' economy is highly driven by tourism, which contributes to 76% of its annual economic growth. The economy faces a trade imbalance, with almost all goods being imported to the islands, and only some low-value agricultural products exported. Tourism has experienced rapid growth from the early 1960s under the influence of foreign investments on the island. This has contributed to the improvement of local economic

conditions (Hernández-Martín et al., 2021) but has caused considerable environmental impacts.

With more than 4000 endemic species, the Canary Islands are an internationally recognized biodiversity hotspot. A Mediterranean climate dominates the region, with low seasonal variations in temperatures, low annual rainfalls, and generally dry conditions. Agriculture development and especially the introduction of grazing animals have caused historical damages to the islands' ecosystems. Furthermore, vegetation clearing and utilization of groundwater resources accelerated the desertification processes in the archipelago.

b. Case study 2: French Guiana

French Guiana is a French overseas territory (*Département-Région d'Outre-Mer*), located in the northeastern part of South America, bordering Brazil to the south and Suriname to the west. The Amazon forest covers 96% of its territory (86,504km²). French Guiana hosts great biodiversity, with seven to ten thousand plant species, but with low endemic rates (De Geyer et al., 2020). French Guiana ecosystems provide high levels of ES, especially mangroves, rivers, and forests (Sieber et al., 2021). For example, mangroves are a critical blue carbon stock (Walcker et al., 2018). Whereas, small-scale gold mining and urbanization are the two main drivers of change. The gold mining industry, both legal and illegal, causes deforestation and alters water quality (Hammond et al., 2007). There is a public demand for infrastructures, which causes inevitable deforestation. Indeed, due to the large extent of forest cover, urban development occurs at the expense of forests and savannas, the latter being more exposed to urban pressure. Urbanization is expected to increase further as projections estimate a doubling of the population by 2050 (Demougeot & Baert 2019).

French Guiana is a multi-ethnic territory where Creoles, Brazilians, Bushinengué, Chinese, French, Hmong and Indigenous, coexist among other ethnic groups. It is one of the most linguistically diverse territories in the world with five types of European languages, indigenous languages, English and French creoles) comprising numerous dialects (Léglise 2017). Although large stretches of the territory are currently unoccupied (3.4 inhab./km²), the population growth rate has increased nearly tenfold in sixty years (32,000 inhabitants in 1960 against 294,000 inhabitants in 2021). Most of the population occupies 10% of the territory, along the coastal areas, and a minor share of the population is settled along the two main waterways, *Maroni* and *Oyapock* Rivers.

The French Guianese economy is highly driven by its space center (*Centre Spatial Guyanais*, CSG) and associated research (*Centre National d'Etudes Spatiales*, CNES). Secondary economic sectors include timber production, fishing, and construction, while agriculture is underdeveloped due to unproductive soils. Social challenges impede the economic development of the territory, such as high unemployment rates, poor levels of

literacy and school enrolment, and a lack of public infrastructures (housing, schools, hospitals, road networks), especially considering the population increase.

c. Case study 3: Reunion Island

Reunion Island, like French Guiana, is a French overseas territory located East of Madagascar in the Indian Ocean. It is a tropical volcanic island, part of the Mascarene archipelago, which also includes the islands of Mauritius and Rodrigues. Reunion Island and Madagascar region is an internationally recognized biodiversity hotspot due to important endemic species rates. Indeed, 28% of species are endemic to the island (871 species) and 45% are endemic to the Mascarene archipelago (Saliman et al., 2017). Reunion Island has been listed as a UNESCO World Heritage since 2010. However, Invasive Alien Species (IAS) threaten the island's biodiversity. Indeed, all habitat types except subalpine shrubland and wetlands have been affected by invasion or transformation (Strasberg et al., 2005). Important surfaces of the island are under a protection regime, with 40% of the island covered by the Reunion National Park (NP) and 42km of the coastline protected within a Marine Reserve.

The Canary Islands and Reunion share a similar economic dependency on tourism. In addition, Reunion Island economy is also driven by sugarcane production. The territory complex topography constrains growth and expansion, leading to dense anthropized areas along the coastal areas associated with high demographic pressures (Ribalaygua et al., 2019). The island has a population of 866,000 inhabitants (2019), with a density of 345 inhab./km². The island is affected by high unemployment rates, exceeding threefold that of the EU average, exacerbated locally by low levels of qualification.

2. Conceptualization and interview structuring

SWOT analysis is a widely used decision-making and planning tool used to identify challenges and opportunities (Lozano and Vallés 2007, Sevkli et al., 2012), here in the achievement of sustainable development.. We followed SWOT factor definitions of Jetoo & Lahtinen (2021). A *Strength* is considered as the territory's features facilitating the achievement of sustainability goals. *Weaknesses* are the features that impede the attainment of these goals. Strengths and weaknesses are internal attributes of the territory, considered as a system. For example, political interest and biodiversity are internal features, while climate change and EU regulations are external features. *Opportunities* and *Threats* are external features that affect the territory and the achievement of sustainability goals.

A review of the literature was performed on the application of SWOT analysis to ES study. Nine papers studying ES using SWOT analysis were identified (see Supplementary Materials A). SWOT factors extracted from the literature were organized into a deductive conceptual web, which helped better understand interlinkages amongst factors (Fig. 2). This conceptual web served as a theoretical basis for the elaboration of the semi-structured

interviews. Topics of the interviews covered all the above factors, identified in the literature as obstacles or hindrances for the achievement of sustainability goals. For example, management practices were found to stem from socio-cultural aspects, such as environmental awareness and the socio-economic status of the territory. These socio-cultural aspects affect political interest for environmental management, and in turn affect the perception of ecosystems and their services. We posit such features are should be taken into account to propose strategies based on ES assessment fit to local needs and perceptions.

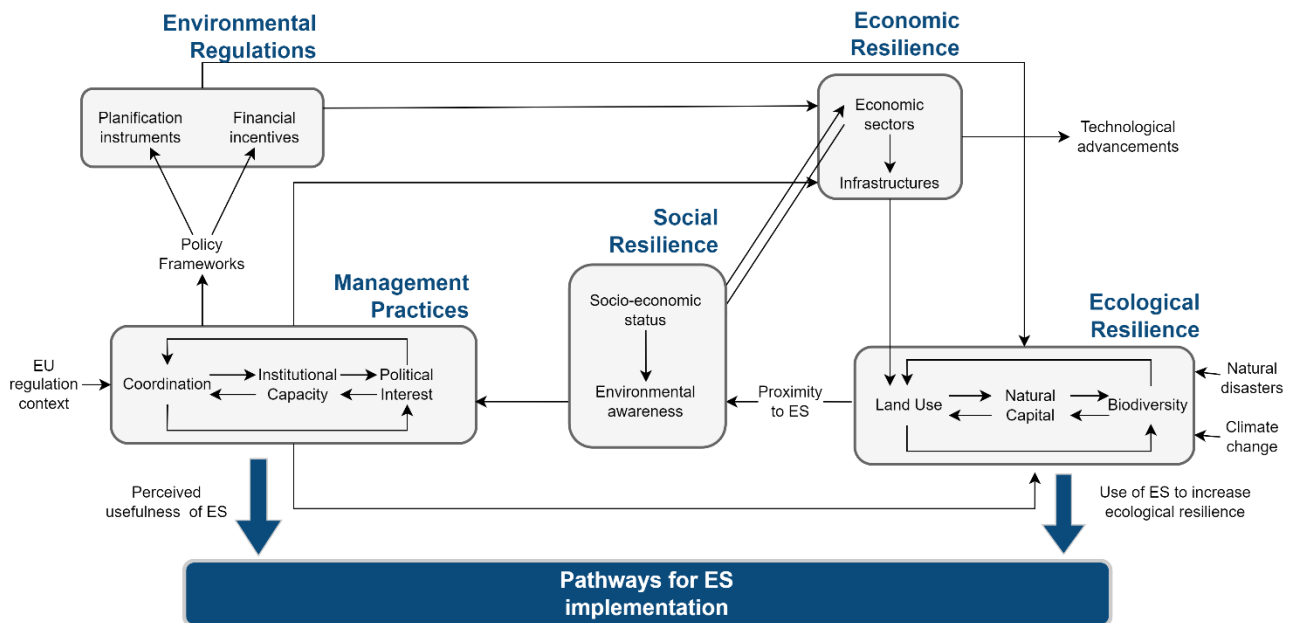


Figure 2 - Deductive conceptual web based on the literature review (n = 11) of key features to take into account for the proposal of pathways for ES implementation. These key features are the strengths, weaknesses, opportunities, and threats, affecting ecosystem resilience and perception of ESs.

3. Data collection

Purposeful sampling (Miles et al., 2019) was used to select individuals knowledgeable with our topics of interest, available and willing to participate. The participants to the interviews were selected for each case study from three sources. First, from the stakeholder databases developed in MOVE¹ and MOVE-ON² European projects under which this research was carried out. The stakeholder backgrounds aimed in this study were those working on topics related to ESs (e.g., natural sciences, spatial planning, ecological economics), following Bull et al. (2016). Second, a complementary web search was used to complement the database to ensure the best representativeness of the sample (e.g., number of

1 MOVE project (2019), European Commission Directorate General Environment Grant Agreement no. 07.027735/2018/776517/SUB/ENV.D2. Deliverable D.2.1. List of institutional and individual stakeholders placed on the MAES landscape.

2 MOVE-ON project (2021), European Commission Directorate General Environment Grant Agreement no. 07.027735/2019/808239/SUB/ENV.D2. Deliverable D.4.1. Report on external stakeholder's analysis.

participants, type of organizations). Then, snowball sampling was used while on the field to reach out to additional individuals. Each participant in the study was asked to provide contact information of individuals they believed to have influence in local environmental management or knowledgeable on our topics of interest (Fig. 2). The target groups consisted of local and regional administrations, private organizations, non-governmental organizations, local representatives, nature protection associations, and experts from universities. Our goal was to reach information saturation, as recommended in Miles et al. (2019), defined as the obtaining of a comprehensive understanding of a topic until no new substantive information is acquired.

To conduct this research, permission was given by participants to write transcriptions of the interviews for further analysis of their content. Full transcriptions were sent back to participants for content approval and the signature of consent forms. To preserve participant confidentiality, participants' names were anonymized.

The semi-structured interviews covered questions regarding knowledge and application of ESs, networks, and strategic development (see Supplementary Materials B). The interview was used as a guideline for face-to-face meetings with selected stakeholders. All questions did not apply to participants (e.g., some had no experience in assessing or mapping ESs), and were therefore modulated based on the stakeholder being interviewed. Moreover, additional questions were asked during interviews to explore further with participants key features that were not anticipated. When confronted with contradictory statements between participants, we asked for further information to better comprehend events. Therefore, some context-dependent questions emerged to address previous statements with additional participants to increase the reliability of one's statement.

4. Data exploration

a. Sentiment analysis

A sentiment analysis was performed for opinion mining. Sentiment analysis is a method used to extract sentiments and opinions from texts (Birjali et al., 2021). Sentiment analysis is increasingly used for social media opinion mining (Reyes-Menendez et al., 2018). In this study, we used sentence-level sentiment analysis to determine whether a sentence from the interview transcriptions expressed positive or negative opinions (Birjali et al., 2021) on ES. Sentiment analysis is usually performed on large data samples (e.g., social media comments) and analyzed using statistical methods (e.g., Bayesian networks, neural networks, machine learning (Chen et al., 2014). Given the small size of our sample ($n = 48$), we ran a manual sentence-level sentiment analysis with NVivo 1.6.1. QSR International, a Computer-Assisted Qualitative Data Analysis Software (CAQDAS).

Relevant sentences were assigned a value based on opinion words (e.g., "great" is very positive, "poor" is very negative) and the context of the sentence. Only sections dealing

with participants' opinions of ES were analyzed. The section usually corresponds to the answer to the following question: "Do you know the concept of ecosystem services? Was the concept applied in your organization? If yes, in what context? If not, why so?". However, such opinions could also be located elsewhere in the transcription, depending on the respondent. Sentences were allocated scores that range from [-2 to +2], from very negative to very positive, based on the prior identification of opinion words, then on the analysis of the content of the sentence. A weighted sentiment score was calculated per respondent, following Equation 1,

$$W_{S_{i=n}} = \frac{(R_{S1}V_{S1}) + \dots + (R_{S4}V_{S4})}{\sum R_S} \quad (1)$$

Where, W_s refers to the sentiment weighted score; i refers to the interviewee; R_s to the number of references per coded sentiment; and V_s to the value per sentiment type.

Respondent attitudes towards a survey or interview were found to be an important determinant for cooperative behaviors and can affect the quality of the data collected (Stocké & Langfeldt 2004). In addition, respondents with cooperative attitudes were found to be more likely to take part again in a research project (Liu 2018). To evaluate quality data and estimate the willingness to support the initiative, the analyst scored the "attitude" of the respondent towards the aim of the project and his willingness to support the initiative subjectively during the interview to capture non-linguistic elements (e.g., pauses, hesitations, and facial expression) as well as the narrative of the interviews. Liu (2018) scored respondent attitudes on a three-point scale (friendly, cooperative, and hostile). We added a fourth point to the scale for comparison purposes between attitude and sentiment. Therefore, attitude scores ranged from -2 (hostile, the respondent could block the initiative), to +2 (enthusiastic support, the respondent could support the initiative).

b. Coding process: PESTEL themes and SWOT matrix

For systematic reporting of SWOT factors, we used the PESTEL analysis. Primary sources of qualitative data used for the analysis include field notes, documents specific to the case study sites provided by participants (e.g., brochures and reports), scientific papers, and the interview transcriptions, corrected and commented on by the participants. Consistently with Miles et al. (2019), data were condensed in case summaries and coded into themes.

Interviews' coding was initiated from a first codebook generated by an automatic theme coding of all interviews. Qualitative data were explored and analyzed with NVivo. Automatic codes were then condensed and organized into PESTEL categories and sub-categories, following the deductive conceptual web built from the literature analysis (first coding cycle, Table 1).

Table 1 - Main level 2 PESTEL categories used for interview coding.

PESTEL Category	Level 2 categories
Political	Coordination Global vision Human and financial means Political will
Economic	Agriculture Economic development Employment Tourism
Socio-cultural	Environmental awareness Socio-economic status
Technological	Data Knowledge
Environmental	Biodiversity Climate Landscape – Spatial planning
Legal and Regulatory	Law application Policy framework

This first codebook was used as a common basis for the separate analysis of each case study. Successive iterations through the content of the interviews allowed for the extension and the adaptation of the initial codebook to each case study (second coding cycle). Mixed-method coding was used based on three types of coding methods: descriptive coding, In Vivo coding³ (Saldaña, 2016), and theme coding (Miles et al., 2019). A third coding cycle aimed at verifying codes had been consistently attributed within the dataset.

The distribution of PESTEL factors and subfactors identified using the coding process were presented as sunburst charts for each case study. Charts are structured in three rings, concerning the structure of the codebooks used for analysis (e.g., environmental factors (level 1) > biodiversity (level 2) > fauna (level 3)). A threshold was applied to only visualize codes of at least 2% of coded references per case study for an optimized visualization of results and avoid graphical overload. A coded reference corresponds to a sentence or a paragraph of the interview to which a code is attributed based on the theme covered by the sentence of the paragraph.

Challenges and opportunities for the implementation of ES were assessed using a thematic analysis. From the coding process, we determined themes and topics that we organized in PESTEL categories to help understand participants' opinions of a given topic. PESTEL categories were separated into the four SWOT categories (Strengths, Weaknesses, Opportunities, and Threats) and synthesized into matrices (see Fig. 4, 6, and 8). The categories were ranked based on the number of factors included. Finally, a SWOT analysis per case study was performed to identify which ES-based management strategies are strategic to address local challenges and opportunities for sustainable development.

³ Also referred to as verbatim coding, literal coding, and natural coding (Saldaña 2016).

5. Data analysis

a. Strategies for ecosystem services implementation

Based on the SWOT matrix results, strategies for ES implementation are proposed for each case study. These strategies aim to optimize strengths, seize opportunities, overcome weaknesses and threats, when making use of ES methodologies addressing local challenges. These strategies build on local opportunities and challenges for the implementation of the MAES framework. Each strategy is then linked to an ES assessment and/or mapping methodology to achieve each strategy. The ESMERALDA project database⁴ (Santos-Martin et al., 2018) was used to identify adequate methodologies based on selected criteria. Table 2 summarizes the criteria used in this report for the identification of relevant methods for assessment and/or mapping of ES.

Table 2 - ESMERALDA Database criteria used for method selection.

Criteria	Dimension	Domain	Objective	Method name	Method purpose
	Biophysical Economic Sociocultural	Agriculture policy Biodiversity policy Climate policy Risk management Economic policy Health policy Spatial planning Water policy	Accounting Awareness raising Financing Instrument design Legal and regulatory issues Litigation Operational management Policy evaluation Preference assessment Priority setting Project evaluation Reputational and marketing Site management Societal	Name, as stated	Purpose, as stated

b. Ecosystem services contribution to the achievement of EU policy targets

The contributions of the pathways for ES implementation (ES strategies resulting from Section a.) to specific ESs were assessed against the standards of The Common International Classification of Ecosystem Services (CICES, v5.1⁵). The ES strategies were considered as contributing to an ES if a positive impact on the supply of a given ES was expected from the strategy's implementation. For example, the protection of a river catchment is likely to preserve ESs related to water resources.

To link ESs to SDGs we used the survey results from Wood et al., (2018) who analyzed the perceived level of ES contribution to SDGs using expert opinion. The SDGs selected in their study were those having an impact on human well-being or those having an environmental outcome. Therefore, SDGs dealing exclusively with policy outcomes were excluded by Wood et al. (2018), as their connections to ESs are uncertain. They defined the strength of

⁴ ESMERALDA (n.d.), Esmeralda Database, URL: <http://database.esmeralda-project.eu/>

⁵ CICES (2022), Resources, URL: <https://cices.eu/resources/>

the contribution as 'weak' or 'strong' depending on the degree of confidence of the results and the number of responses.

To link the contribution of MAES to the achievement of SDGs, a Sankey diagram was produced using the Plotly open-source graphing library⁶ for Python⁷. The links between ESs and SDGs were adapted from Wood et al. (2018) and combined into the three ESs categories, following the CICES v5.1 classification system (provision, regulation, and cultural ESs). The contributions of SDGs to EU policy targets are discussed in the Discussion section.

⁶ Inc., P. T. (2015). Collaborative data science. Montreal, QC: Plotly Technologies Inc. Retrieved from <https://plot.ly>

⁷ Plotted with the Pycharm C.E 2021.3.2 integrated development environment <https://blog.jetbrains.com/pycharm/>

RESULTS

1. Interviewee characteristics

Thirty-eight (38) participants were interviewed between June and December 2021, with 10 interviews conducted in the Canary Islands, 19 in French Guiana, and 10 in Reunion Island (Table 3).

Table 3 - Distribution of interviewees per region.

	Canary Islands	French Guiana	Reunion Island
Number of people contacted	58	46	28
Number of interviews	10	18	10
Positive response rate	17.5%	41.9%	35.7%
Dates of interview	Oct. 11 - Nov. 5, 2021	Nov. 23 - Dec. 8, 2021	Jul. 7 - Aug. 19, 2021

Interviewees represent all types of stakeholders (Fig. 3). The sample is dominated by 'Academic' stakeholders (25%), followed by 'NGOs' and nature protection associations (22%), 'Public agencies' (21%), 'Private organizations' (17%), and 'Administrations' (15%). However, there is variability amongst study sites.

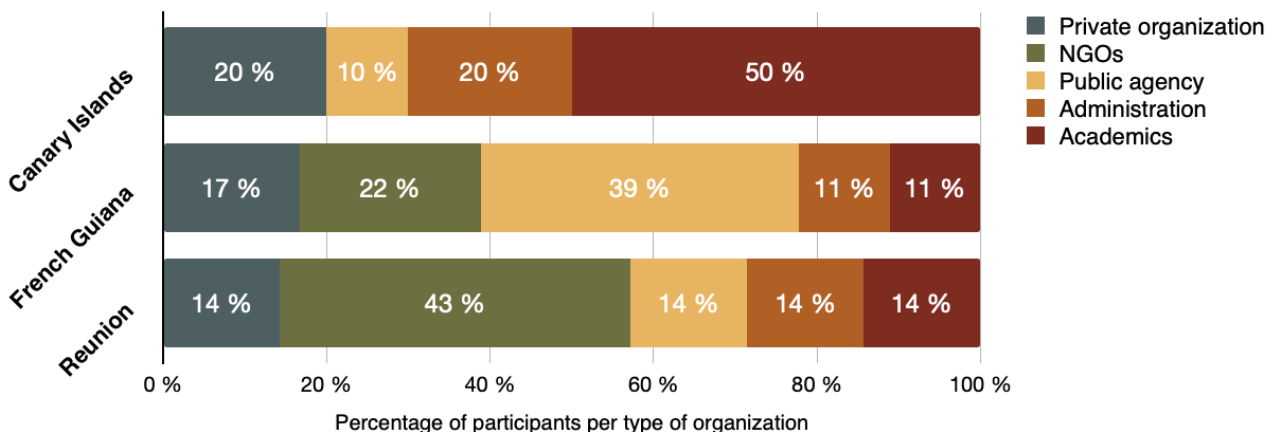


Figure 3 - Distribution of interviewees for the research project per organization type.

First, NGOs and nature protection associations were not represented in the Canary Islands due to few existing organizations within the archipelago since the 2008 economic crisis. Nevertheless, we contacted three nature protection associations, but very low response rates (17.5%, Table 3) affected the possibility for a more diverse range of stakeholders interviewed. Moreover, academics are more represented in the Canary Islands (50%) than in French Guiana or Reunion Island, which could bias the results. However, thanks to the

help provided by local project partners, contacts with other stakeholders were facilitated. Despite the low representativeness of the sample, data saturation was still reached.

Second, French Guiana's sample represents all types of stakeholders, with a dominance of public agencies (39%). Obtaining contacts in French Guiana was greatly facilitated by a strong interest in the research project and by the participants arranging direct contact with other stakeholders they believed influential in local environmental management, for instance, public agencies.

Third, Reunion Island sample has evenly distributed types of stakeholders except for NGOs, which cover 43% of the sample.

2. Sentiment analysis

The relationship between attitude assessment and sentiment analysis was moderate (Pearson's correlation $r = 0.59$). Both metrics follow a similar trend (Fig. 4). Respondents with attitudes ranging from neutral ('indifferent') to negative ('uncooperative' or 'hostile') tend to have a negative sentiment towards ES approaches. Inversely, respondents with positive attitudes ('compliant' or 'enthusiastic support') tend to have a positive sentiment towards ES approaches. The respondent '30' appears in this context as an outlier. This respondent was highly convinced of the necessity of using ESs to guide sustainable decision-making, but was also highly skeptical of the chances to reach out to decision-makers. Therefore, the score marks high in terms of attitude since the respondent would put some effort in promoting ESs but marked moderately negative in the sentiment analysis because of the respondents' pessimist views of current spatial planning practices and political views on sustainable development.

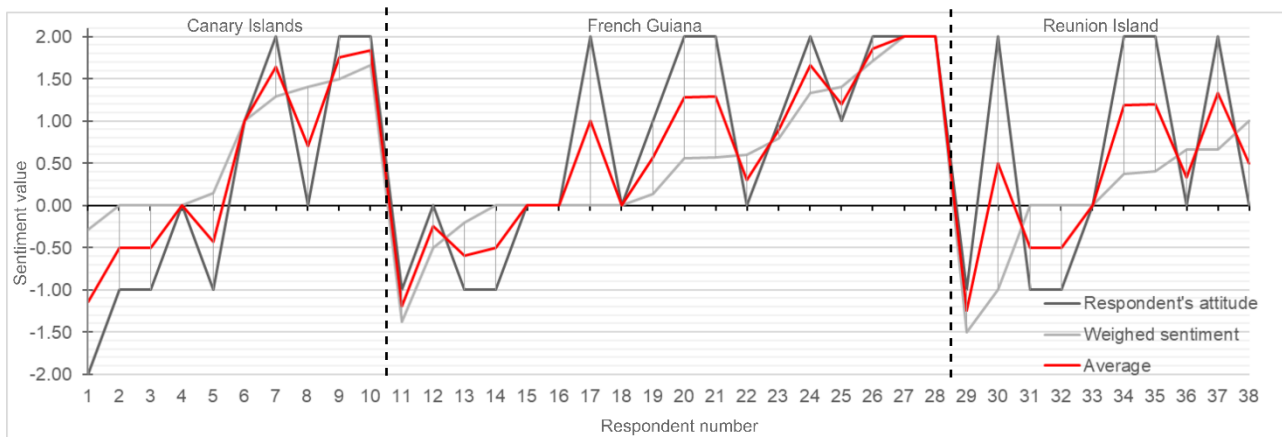


Figure 4 - Chart of weighted sentiment value (dark gray), respondent's attitude score (light gray), and average value (red), per respondent ($n = 38$) and per case study (Canary Islands, French Guiana, Reunion Island).

On average across the three study sites, 14.3% of respondents displayed 'very negative' sentiment on ESs, with slight variations amongst sites (Canary Island, 11.8%; Reunion Island, 13.3%; and French Guiana, 17.8%, Table 4). 'Moderately negative' sentiment marked an average of 22.9% with an important variation between Reunion Island (33.3%) and the other

case studies ($\approx 17\%$). For both 'very negative' and 'moderately negative', quotes covered various topics.

Table 4 - Distribution of quotes per region per sentiment type.

	Canary Islands	French Guiana	Reunion Island	Average
Very negative	11.8%	17.8%	13.3%	14.3%
Moderately negative	17.6%	17.8%	33.3%	22.9%
Moderately positive	35.3%	33.7%	23.3%	30.8%
Very positive	35.3%	30.7%	30.0%	32.0%

For example, ESs are perceived as 'not operational', 'too vast', 'time-costing', as a 'trendy concept', 'utilitarian and anthropocentric'. A group of respondents is not convinced that ESs can improve environmental management because it is a 'pure economic concept', or because it 'does not provide accurate results'. Indeed, respondents found methodologies unsuitable for some ecosystems (e.g., marine and tropical forests) and thus prefer other methods (e.g., ecological assessments, population monitoring). Respondents with a 'moderately negative' sentiment tend to be those who knew ESs but had no interest in applying them. Or, they were the respondents who did not see the usefulness in applying ESs because of a 'confusing language', the 'lack of systematic work', the 'difficulty to communicate on ESs', the 'low social awareness', and the 'low interest on the political agenda' where 'more pragmatic issues of higher priority' are preferred. Respondents could not see ESs being used without a top-down approach and legally binding documents.

Respondents had an average of 30.8% 'moderately positive' sentiment. Over a third of respondents from French Guiana and the Canary Islands (33.7% and 35.3% of quotes respectively) displayed moderately positive sentiments towards ES. Reunion Island appears as an outlier with only 23.3% marked as 'moderately positive'. These respondents were those who made implicit use of ESs without direct mention of the term ES or those who applied ESs concepts, but had difficulty doing so or did so because it was asked of them. Indeed, these approaches were found to be increasingly targeted by calls for project proposals (e.g., European projects). These respondents found ESs useful to create social awareness on the differences between perceived ESs and empirical supply of ESs.

Respondents had an average of 32% 'very positive' sentiment on ESs with moderate variation from one case study to another (Reunion Island and French Guiana, $\approx 30\%$; Canary Island, 35.3%). Respondents were those who have already applied the concept and are planning to carry out further studies. Very positive opinions related mainly to the perceived potential of ESs for improving the sustainability of land management. The

perceived potential of ESs included 'setting priorities', and allowing 'management plans to adapt to users'. Other opinions were diverse, saying ESs 'foster collaboration on transversal projects', 'provide a basis for incentive development', or 'create economic opportunities for nature-based products'.

Extreme sentiments (very positive and negative) present little variation between case studies while intermediary sentiments (moderately negative and positive) reveal the existence of two groups, one formed by French Guiana and the Canary Islands, and the other formed by Reunion Island. The first group has a dominant positive sentiment with 70.6% positive sentiment in the Canary Islands and 64.4% in French Guiana, whereas Reunion Island has shared sentiments on ESs with 53.3% positive and 46.6% negative sentiments.

Due to a limited number of participants ($n = 48$) and a low representativeness of the sample in terms of stakeholder types, we could not test the variability in sentiment on ESs per type of stakeholders (e.g., academics, public agencies).

3. PESTEL factors

In this section results are presented as follows: (i) visualization of the PESTEL factors, and then in sections a, b, and c, (ii) visualization of the sub factors per case study, (iii) presentation of the respective SWOT matrix, (iv) the strategy proposal per case study, and the methods most fit to assess relevant ESs per strategy (v).

PESTEL subfactors, identified in the coding process, are presented in sunburst charts in Fig. 6-8. Charts are structured in three rings, following the codebooks used for analysis (e.g., environmental factors (level 1) > biodiversity (level 2) > fauna (level 3)). Second, a SWOT matrix was developed for each case study based on the coded content of the interviews, presenting a synthesis of the characteristics of PESTEL factors, whether they were strengths, weaknesses, opportunities, or threats to the achievement of sustainable development goals. Third, based on the matrix, strategies for ES implementation are proposed to optimize strengths, seize opportunities, while overcoming weaknesses and threats per case study. These strategies were finally linked to the methods for ES assessment and mapping, as presented in the ESMERALDA project database.

The distribution of PESTEL factors, identified through the coding process, is presented in Fig. 5. Similarities and differences are observed from the analysis of the PESTEL factors distribution.

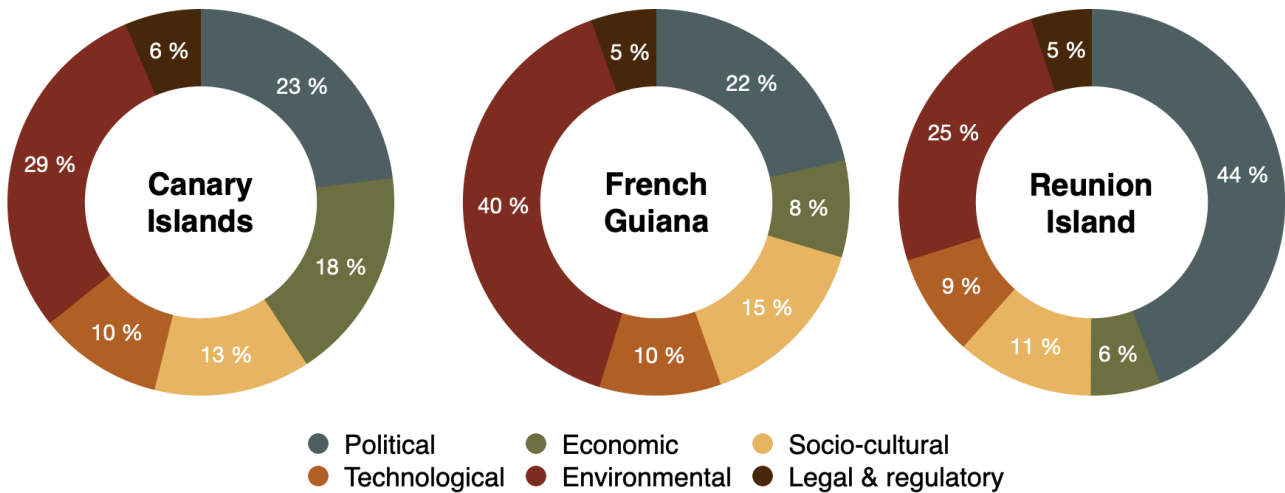


Figure 5 - Distribution of the PESTEL factors per case study (the Canary Islands, French Guiana, and Reunion Island).

The hierarchy of factors follows similar patterns, with a dominant group comprising 'Environmental' (average of 31.3%) and 'Political' (29.7%) factors, followed by a second group comprised of 'Socio-cultural' (11.3%), 'Economic' (10.7%), and 'Technological' (9.7%) factors. 'Legal and Regulatory' factors represent a minor share in all case studies with an average of 5.3%. The importance of environmental factors was to be expected in consideration of the scope of the study and participants' backgrounds. However, the importance of political factors was greater than expected. Differences were observed in the case studies. Environmental and political factors aside, the Canary Islands seems driven by economic factors, while French Guiana and Reunion Island seem driven by socio-cultural factors. These differences follow the same hierarchy as the case studies' economic health. For example, the case studies' Gross Domestic Product (GDP) reached 50.00 billion USD (2017) in the Canary Islands, 20.84 billion USD (2017) in Reunion Island, and 4.97 billion USD (2017) in French Guiana. Participants acknowledge the influence of socio-cultural factors on the perceptions of nature and social acceptability of projects aiming at the preservation of environmental features. When socio-economic development is favorable, economic factors are influential in the perception of natural assets. In Reunion Island and French Guiana to a lesser extent, participants found local political factors being essentially barriers to sustainable development.

a. Canary Islands key factors

Interviews were analyzed and coded for the Canary Islands and suggest the dominance from the environmental factors followed by political and economic factors. Natural resources, conservation, and IAS are important environmental subfactors. Political subfactors highlight the importance of political will, human and financial means, and island governance. Aquaculture, port activity, and tourism are important economic subfactors (Fig. 6).

Table 5 - Canary Islands SWOT matrix.

	Strengths	Weaknesses	Opportunities	Threats
Environmental	<p>Biodiversity: Many natural protected areas, such as areas of the Natura 2000 network.</p> <p>Conservation: Forest management on Tenerife and water resource management are accredited with the FSC certification for good forestry practices. Participants agree on the necessity to reconcile nature enjoyment with nature conservancy. Strong collaboration in the management of protected areas.</p> <p>IAS: Possesses one of Europe's largest seed banks and ensures a management of plant nurseries consistent with genetic variability.</p> <p>Spatial planning: The Canary Islands are pioneers in marine spatial planning.</p>	<p>Biodiversity: Canary Island forest covers have greatly suffered from intensive agricultural practices (e.g., crops, cattle raising) and intensive use of natural resources. The forest covers are now relictuel and scattered over the islands with little ecological connectivity.</p> <p>Conservation: Economic, political, and social dimensions conflict with one another and conflict with scientific environmental evidence.</p> <p>IAS: Although local representatives use endemic species for plantation in urban areas and parks, they have little consideration of the genetic origin of species despite the available information on genetic analysis.</p> <p>Spatial planning: Some construction projects are contradictory with the protection of nature (e.g., port construction in a marine protected area). Rising demographics cause further land artificialization, especially in the coastal area.</p>	<p>Conservation: Current discussions for the creation of a National Park in Gran Canaria. From the beginning, there has been a strong will to include local natural resource users in the creation of the park (preserve livelihoods). The project is likely to foster good social acceptance.</p> <p>IAS: The possibility to extract bioproducts from invasive species while contributing to the control of these plants is under exploration.</p>	<p>Biodiversity: Port infrastructures, offshore oil rigs, and climate changes (increase in water temperatures) are disturbing the trophic chain and the ecological stability of these ecosystems. This is likely to continue pressuring the marine mammal populations, relying on the fish stock of the Canary coastal waters.</p> <p>IAS: The islands are highly threatened by IAS (feral goats, Californian snake), overgrazing endemic species and hunting seed disseminators (geckos, birds).</p> <p>Natural resources: Water resources, although currently sufficient, remain scarce on these volcanic islands.</p>
Political	<p>Island governance: Diverse archipelago where islands have their own identity. The Canary government has been progressively delegating natural area competencies to the island level (<i>Cabildo</i>). There is a good collaboration in the management of protected areas. Island administrations join their teams to work together on programs.</p> <p>Political will: Strong influence of political will on</p>	<p>Coordination: Despite the good knowledge basis of ecosystems and the threats they undergo, channels of communication do not ensure the effective flow of information to decision-makers and the population.</p> <p>Political will: Lack of political will on fauna (e.g., light pollution for bird protection, controls at sea for whale protection) and flora management (e.g., IAS, little respect to plant genotypes), and waste management,</p>	<p>Political will: A change of political party in the last regional election led to a shift of focus of the regional representative, who is more sensitive to climate change mitigation, Blue Economy, and waste management.</p> <p>Financial: The creation of a financial environmental incentive, a tax for the use of fuel-based resources is under analysis. This tax is intended to finance</p>	

	Strengths	Weaknesses	Opportunities	Threats
	<p>certain topics (e.g., Blue Economy).</p> <p>Financial: Sufficient funding.</p> <p>Regional cooperation: Strong regional collaboration with states from the Macaronesian region (the Azores Islands, Cape Verde, Madeira, Mauritania, Morocco) and global export of their aquaculture practices. Cooperation is fostered through exchanges of skills and student training.</p>	<p>especially when there is a relation to tourism.</p> <p>Community network: Many NGOs collapsed during the 2008 economic crisis. Since then, only few NGOs dealing with natural resources from the remain. Participants find the work of forest associations sometimes harmful due to a lack of scientific basis of their practice (e.g., excessive tree plantation programs).</p> <p>Island governance: Variability in the institutional capacity of islands. The highly populated islands have more staff and financial resources than the least populated islands.</p> <p>Staff resources: Increasingly limited since the 2008 economic crisis, where the Spanish Government has cut down public expenditures. Retired workers are no longer replaced.</p>	<p>forest restoration.</p>	
Economic	<p>Tourism: Tourism aims for inclusiveness and benefits to the population. Ocean-related activities represent a large part of the tourist activities (i.e., diving, whale watching). Tourist development differs per island (e.g., Lanzarote on nature-based sustainable tourism)</p> <p>Economic development: With an optimized regulatory framework, the lowest levels of burdens, company investments are facilitated. The territory is highly attractive to investors, creating local employment opportunities.</p> <p>Aquaculture: International reference for good aquaculture. The sector is highly competitive.</p>	<p>Tourism: With mass tourism and speculation, radical and rapid changes (urbanization, road management and port infrastructure), especially in coastal conservation of natural assets.</p> <p>Port activity: Past and current projects for harbor creation have been highly criticized by scientists and the public for the importance of their impact or their negligible usefulness (e.g., Canary project within a marine reserve; harbor built in and unfavorable conditions for navigation). Intense ferry traffic on the Canary waters causes whale collisions and disturbance (mortality exceeds birth rates). For economic reasons, operators refuse to reduce their speed, one of</p>	<p>Tourism: Tourists create a lobby on decision-makers, they demand for system aiming at facilitating international investments can cause conservation of natural assets. Their unsustainable economic development message receives more attention than if not well managed. that of scientists wishing to provide</p>	<p>Economic development: Low taxation and international investments can cause unsustainable economic development message receives more attention than if not well managed.</p>

	Strengths	Weaknesses	Opportunities	Threats
	<p>Industrials have strong bonds with scientists the best-identified solutions to limit whale specialized in aquaculture. An effective collision. However, they demonstrate interest in dialogue between industrials and scientists exploring other solutions, such as route leads to the incorporation of the best scientific adaptation to avoid migratory routes. evidence in industrial practices. Industrials are engaged in research projects, to ensure the production of operational solutions that fit their needs. The aquaculture industry works closely with local ingredient producers (for fish operators, who regret the lack of controls at feeding), participating in a circular economy. sea.</p> <p>Whale watching: With abundant and permanent resident populations of whale species competitiveness between touristic operators is low. They are organized in professional end-user associations to regulate their activity and manage pressure on the populations. The 'Whale Heritage Site' recently accredited the archipelago. In addition, the islands learn from each other and cooperate. Indeed, El Hierro, the last to start whale watching, uses best practices for its development, based on neighboring island successes and failures.</p>	<p>Whale watching: Some (a minor share) boats illegally take tourists out at sea causing economic loss and frustration to legal needs. The aquaculture industry works closely with local ingredient producers (for fish operators, who regret the lack of controls at feeding), participating in a circular economy. sea.</p>		
Socio-cultural	<p>Environmental education: Many education programs, events (e.g., science fair, open doors), and areas of nature open for school activities (<i>Aulas de Naturaleza</i>) to build public capacity and raise awareness. Tenerife and Gran Canaria have university environmental programs.</p> <p>Public participation: Strong observation (nature enthusiasts, students, fishers) and bird safeguarding (<i>Calonectris borealis</i>). Local managers are convinced of the necessity for</p>	<p>Social acceptability: Low for some measures, such as the eradication actions necessary to control invasive feral goats (traditional use) and cats, or to lower the speed of the ferries to limit whale collision. This causes drawbacks to project accomplishment. Scientific evidence is usually taken into account with the exception of whale topics causing conflict with the population. Social media coverage is perceived a major mind-shaping process, usually delivering the wrong messages.</p>		

	Strengths	Weaknesses	Opportunities	Threats
	public participation and promote such approaches in their work, where possible. However, participants agree there are still improvements needed.			
Technological	<p>Knowledge: Important investments in sustainable aquaculture development. Strong collaboration between actors in the development of applied methodologies for aquaculture. Stakeholders share data, knowledge, and methods. Several networks of permanent plots are used to monitor long-term environmental changes (e.g., IAS). The Canary islands host one of Europe's largest seed banks for genetic conservation.</p>	<p>Knowledge: There are knowledge gaps for some marine ecosystems (e.g., rhodolith beds, deep-sea coral reefs). The knowledge produced by universities is too theoretical for real-life application (except aquaculture).</p>		
Legal and Regulatory	<p>Policy framework: Sufficient policy and regulatory frameworks to take action for the management of the environment and protection of flora and fauna.</p>	<p>Policy framework: Frameworks sometimes overlap (nation, autonomous region, island), leading to contradictory rules on a given area.</p> <p>Law application: Despite the frameworks, there is a lack of law enforcement (controls and sanctions).</p>	<p>Policy framework: Project for a new biodiversity law aiming to add consistently the environment in educational programs (<i>Ley de Biodiversidad</i>). A participant argued there is 'a new ecosystem of policies with a strategic approach to the sustainable development of the region'.</p>	

Based on the SWOT matrix, three strategies for ES implementation are proposed to optimize strengths, seize opportunities, while overcoming weaknesses and threats.

Strategy 1 (S1): ES assessment to inform ecotourism

Whale watching is a high-income activity in the Canary Islands. However, marine mammal populations are pressured by increased ferry traffic, which increases collision risks. These risks are both harmful to the sustainability of whale populations (some species faced with more mortality than birth rates) and could threaten the Canaries' Whale Heritage Site accreditation, which in turn would diminish the profitability of the whale watching tourism sector. One of the identified solutions to reduce collision risks is to limit the speed of ferries and adapt their routes to avoid areas key for species development (e.g., resting areas, feeding areas, reproduction areas). However, this solution is not acceptable to ferry operators, which are themselves in need of economic profitability, transportation duration having a major influence on customer choice. Exploring this issue through the lens of ES assessments could help reach an acceptable trade-off. Tourists' demands for well-managed ecosystems pressure decision-makers in their environmental planning. For instance, customer opinions and preferences are valued in the tourism development of the archipelago. Exploring tourist preferences for mammal conservation, by evaluating their willingness to pay for a ferry ticket with an increased price could compensate for the economic loss caused by speed reduction. In addition, a voluntary approach of ferry operators could in turn be publicized, which could have potential effects on the operators' market shares. With consumers demanding higher standards for products and services (i.e., environmentally friendly operators), other ferry operators will align to the market and adapt their strategy, following classic demand-offer economic curves.

Strategy 2 (S2): ES social assessment for National Park priority setting

Gran Canaria Island is committed to creating the island's first National Park (NP) in the upcoming years. Populations who sustain part of their livelihoods on natural resource utilization (land cultivation, fishing, and hunting) currently inhabit the anticipated area for the NP. The social acceptability of projects dealing with natural resources, especially terrestrial, is low. This was demonstrated by the strong social opposition to invasive grazing animal eradication programs, yet necessary for the preservation of endemic plant species. As a means to overcome this challenge, the Island government aimed, from the beginning of the discussions on the NPs creation, for social inclusion in the definition of the rules that could apply to the area. ES deliberative assessments can prove useful to carry out such work. By engaging stakeholders early in the design of the NP, they could share their opinions and concerns regarding the management of the natural resources in the area. This would allow the definition of protected area rules to fit local conditions, and the co-definition of areas of strict protection and areas where natural resource extraction is permitted. Such an

approach can prevent future conflicts and foster awareness and engagement for the pursuit of the project.

Strategy 3 (S3): Monitor changes in ES to predict aquaculture economic risks.

Aquaculture in the Canary Islands takes the form of mariculture, with areas exploited at sea (as opposed to freshwater aquaculture). Mariculture is highly interconnected with the ecosystem in which the activity takes place. If poorly managed, mariculture can have severe impacts on ecosystems. First, fish escapes can have genetic repercussions on local wild stocks of the same species, acting as an exotic species in the ecosystem (Hilborn and Hilborn, 2019). Second, because of high fish densities, mariculture sites are ideal for the breeding of diseases and parasites (ibid.), and nutrient enrichment can be harmful to seagrass meadows, essential ecosystems for the survival of juveniles. However, when good practices apply, mariculture can support a wide range of ESs (e.g., source of protein, medicinal resources). For example, oyster reefs are useful for the filtration, denitrification, stabilization of shorelines, and the creation of habitat for associated species (Alleway et al., 2018). The activity is also highly dependent on the ecological state of the ecosystem in which farms are located. For example, ocean water pollution may cause dramatic health hazards and important economic losses to fish farmers. ES assessments can be beneficial for the simultaneous monitoring of ecosystem changes effects on fish farms (e.g., temperatures, pollution, nutrient loading) and fish farm effects on ecosystems (e.g., disturbance of wild species, nutrient enrichment, trophic chain impact). This can help predict risks and adapt practices to overcome these risks. The strong collaborations between Canary Islands researchers and fish farmers in mariculture development can provide an advantage for the pursuit of innovative and sustainable practices.

According to the scope and the objectives of each strategy, Table 6 identifies an assessment and/or mapping methodology fit to achieve each strategy.

Table 6 - Ecosystem services assessment methodology per strategic orientations for the Canary Islands based on the ESMERALDA database.

	Dimension	Domain	Objective	Method name	Method purpose
S.1	Economic	Biodiversity policy	Reputational and Marketing	Contingent valuation	A "stated preference" ⁸ valuation that uses survey approaches to ask respondents how much they are willing to pay (or accept) for specified changes in the provision of ES.
S.2	Socio-cultural	Biodiversity policy	Priority setting	Deliberative assessment	Umbrella term for various tools and techniques engaging, and empowering non-scientist participants. These methods ask stakeholders and citizens to form their preferences to ES together in a transparent way through an open discussion.
S.3	Economic	Economic policy	Project evaluation	Corporate ES review	A structured methodology that helps private sector decision-makers to develop strategies to manage business risks and opportunities arising from their company's dependence and impact on ecosystems.

⁸ See Method factsheet: stated preference valuation, *in*. OpenNESS project (2017), European Commission FP7. Integrated valuation of ecosystem services. Guidelines and experiences. Deliverable 33-44, Barton, D.N. & Harrison, P.A. (Eds.). p.289-293. URL: <http://www.openness-project.eu/library>

b. French Guiana key factors

Interviews were analyzed and coded for French Guiana and suggest the dominance of the environmental factors followed by political and sociocultural factors. Forest conversion and mineral resources are important environmental subfactors, while partnership and political will are important political subfactors (Fig. 7).

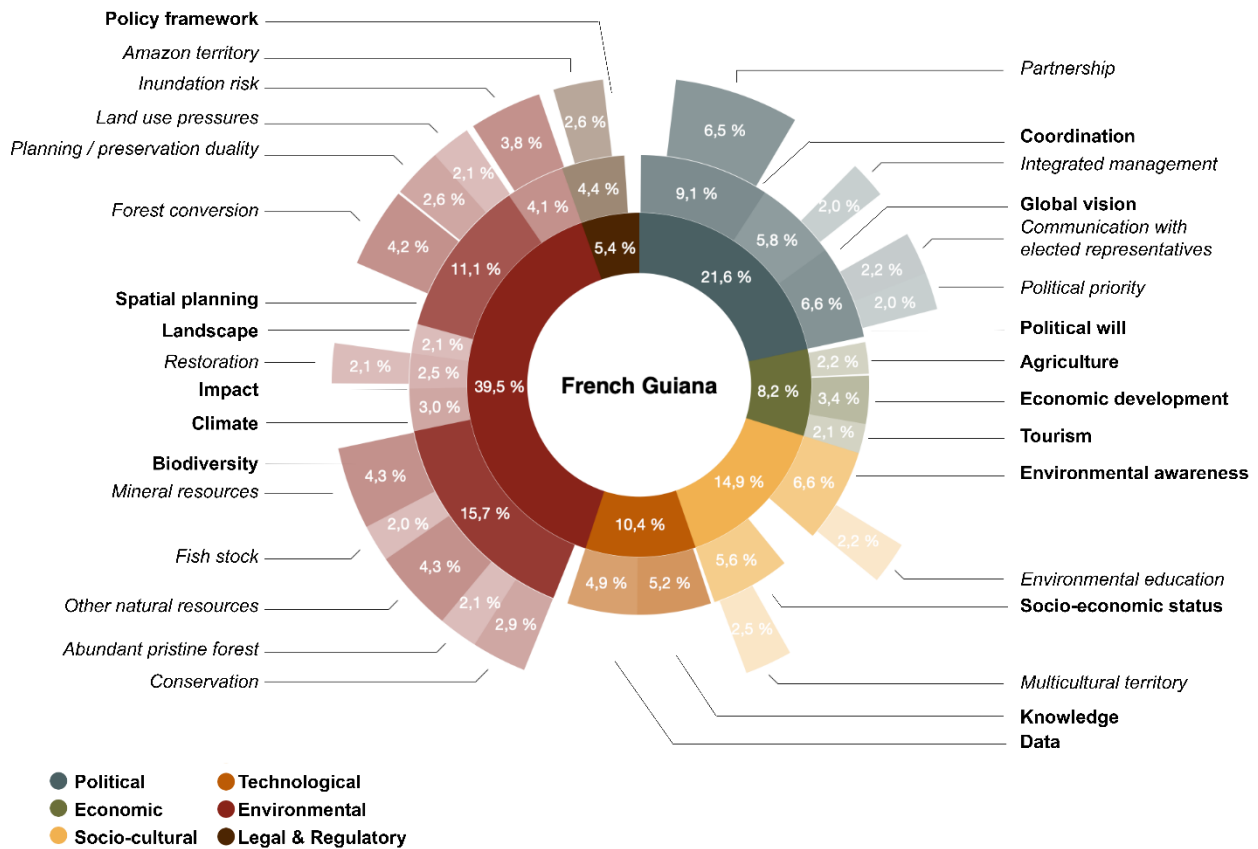


Figure 7 - PESTEL factors and subfactors most representative of French Guiana (in bold level 2 factors, in italics level 3 factors).

Table 7 summarizes the SWOT results from the interview's content analysis. Amongst the key factors identified across all four SWOT categories, the abundant natural resources and biodiversity was highlighted as the most important environmental Strength of French Guiana. This was followed closely by technological strengths, such as good funding for research programs and a strong commitment to technological innovation. However, a list of 18 factors within the Weakness category reflects the negative outlook of respondents for sustainable development. Gold mining, forest conversion, and important turnover rates in staff resources were the top three Threats as expressed by the respondents.

Table 7 - French Guiana SWOT matrix.

	Strength	Weakness	Opportunity	Threat
Environmental	<p>Other natural resources: Forest areas provide valuable natural resources such as timber, medicinal plants, and constitute a priority habitat for animal harvest. There is overall good management of natural resources, with exception for hunting.</p> <p>Climate: Effects of climate change are not yet observed in the territory.</p> <p>Land use planning / Preservation dichotomy: Environmental actors find it urgent to reconcile land use planning with natural area preservation by proposing solutions aiming at a balanced development of the territory.</p> <p>Abundant pristine forest: The territory is covered by a mainly pristine tropical forest hosting great biodiversity and is highly resilient to climate change and IAS disturbance. In addition, over 50% of the forest is covered by a protection regime.</p>	<p>Mineral resources: The gold mining industry, both legal and illegal, causes deforestation and alters water quality, affecting the trophic chain and causing health hazards.</p> <p>Forest conversion: Since 96% of the territory is covered by forests, the importance of forests is underestimated and considered as dispensable land. Construction operators lack guidelines and proceed to an automatic and complete forest clearing, with no consideration to forest networks.</p> <p>Climate: Despite the territory's vast forest, it is a net carbon emitter due to important deforestation rates.</p> <p>Conservation: Land pressures threaten savannas since they are considered as wasteland, easy to build upon. This ecosystem is in decline and is highly sensitive to biological invasions, which accelerate its decline.</p> <p>Land use pressures: The important public demand for infrastructures and crop development causes inevitable deforestation and habitat conversion. This situation causes land speculation and land uses contradictory to spatial planning documents.</p>	<p>Climate: Public agencies and research laboratories collaborate to develop forestry rules aiming at reducing carbon emissions and preserving biodiversity while achieving optimal economic returns.</p> <p>Landscape: Recent interest for coastal and savanna studies.</p>	<p>Mineral resources: Both legal and illegal mining rates remain high (130 exploited despite the control operations carried out by public forces.</p> <p>Forest conversion: Habitat fragmentation causes an increased risk of confrontation between man and large feline species.</p> <p>Inundation: With important needs for infrastructures, urban development often occurs in unforested areas such as wetlands, savannas, and coastal areas. This leads to an increased inundation risk as wetlands fail to buffer water discharges and causes a drastic decline of savannas.</p> <p>Fish resources: Fish stocks are abundant and fishing efforts regulations apply. However, important illegal catches carrying out selective fishing disturb stock regeneration and cause important impacts on turtle populations.</p> <p>Other natural resources: Due to the difficulty to control the harvest, there is a lack of knowledge on the sustainability of hunting efforts on fauna populations.</p>

	Strength	Weakness	Opportunity	Threat
<p>Political</p>	<p>Partnership: Dense and productive network of environmental actors with a strong willingness to work together, a high level of trust and cooperation, common goals and ideas, along with high involvement of NGOs.</p>	<p>Restoration: Regulations stipulate mining operators should restore watercourses at the term of the concession. However, this regulation fails to be applied, and in the rare cases where it is applied, operators lack guidance.</p> <p>Partnership: High turnover rates make it difficult to create long-term partnerships, especially with higher-level administrative representatives. Private companies express difficulty working with academics due to administrative burdens.</p> <p>Political will: Lack of top-level political will to fight against illegal gold mining, the major cause of environmental degradation in French Guiana.</p> <p>Communication with elected representatives: Environmental and elected actors (e.g., mayors) fail to communicate well as they do not have the same priorities. Stakes also hinder communication between inter-municipal groups. A fusion of two administrative levels into one unique region representative (Collectivité Territoriale de Guyane) failed to simplify this communication.</p> <p>Integrated management: Lack of comprehensive vision due to sector-specific strategies. This stems from the excessive fragmentation of government bodies. This issue is exacerbated by some contradictory regulations from one sector to another (e.g., agriculture regulations versus biodiversity regulations).</p>	<p>Political will: A change of political party in the last regional election led to a shift of focus of the regional representative, who is more sensitive to their economic interest.</p>	<p>Partnership: Some corruption is observed between political representatives and mining companies, each defending their economic interest.</p> <p>Political priority: Environmental matters are of low priority on the political agenda. Decision makers undergo important pressure to adapt to rising demographics, high poverty levels, low access to drinking water, and 'thousands living in slum areas'. In addition, the importance of the forest is underestimated due to its abundance and overall good ecological condition. This leads to anarchic land use and an emphasis on short-term solutions, often at the expense of sustainability.</p>

	Strength	Weakness	Opportunity	Threat
Socio-cultural	<p>Environmental awareness: Site managers and nature protection organizations are highly active in the field. They carry out numerous educational projects for schools and citizens, and develop new initiatives such as educational areas of nature.</p>	<p>Environmental awareness: The population remains misinformed of environmental matters such as coastal erosion, carbon emissions, water contamination, or waste management. Environmental matters are often perceived as sources of blockages for territorial development and the population fears excessive protection.</p> <p>Environmental education: There is low social awareness of environmental challenges partly due to the limited training programs dedicated to environmental management. In addition, students applying to these programs are essentially originating from mainland France. This tends to create a division between the population (political figures included) and environmental actors, the latter forming a small like-minded group of expats.</p>		
Technological	<p>Knowledge: Local preference for applied research leads to a quick transfer of scientific knowledge into management documents. Strong collaboration between environmental actors in the development of natural resource management. This is especially true in forestry where public agencies apply the methods and management rules developed by the researchers.</p>	<p>Knowledge: Studies are often duplicated instead of creating new knowledge. Participants agree on the abundant, extensive knowledge produced within the territory but regret the lack of a common vision to identify priority knowledge needs. The important staff turnover was found to affect the recordkeeping of previous work.</p> <p>Data: Data on gold mining is kept confidential by the Defense military department.</p>		

	Strength	Weakness	Opportunity	Threat
	<p>Data: Stakeholders willingly share data. Participatory approaches for data collection are increasingly used (birds, game, monitoring of site quality) and several networks of permanent plots are used to monitor long-term environmental changes and develop sustainable practices in resource utilization (e.g., forestry).</p>			
Economic	<p>Tourism: French Guiana's abundant natural resources and diversified culture could set the basis for an ecotouristic offer. There is a progressively growing interest in touristic development demonstrated by the creation of additional hiking trails, promotion of the yearly Cayenne carnival, and the training of professional Amazon nature guides.</p>	<p>Economic development: High rates of unemployment, low economic sector basis for an ecotouristic offer. There is a diversification.</p> <p>Agriculture: With evolving lifestyles (from nomadic to sedentary), slash-and-burn farming affects long-term soil fertility due to a decrease in crop rotation. Lack of professionalization of farmers.</p> <p>Tourism: French Guiana suffers a poor image; poorly dimensioned tourist accommodations; low accessibility, and poor road infrastructure. Actual tourism is 'opportunistic', i.e., tourists come to join expatriated family and friends working in French Guiana.</p>		<p>Agriculture: Exploding demographics create an imbalance between offer and demand, creating an important dependency on food imports and high food prices.</p>
Legal and Regulatory	<p>Amazon territory: Some mainland regulations are adapted to take into account traditional capacity organization systems (e.g., empowerment of tribal chiefs, recognition of land rights for customary use).</p>	<p>Policy framework: a lack of institutional capacity hinders the application of policies and contradictory regulations from one policy domain to another.</p>		<p>Amazon territory: French regulations are found difficult to transpose to French Guiana, where priorities are different from those of the mainland. French regulations are considered complex and as overbearing constraints. European frameworks also fail to apply well to the territory, due to continental Europe based indicators, not being fit for an Amazonian territory.</p>

Based on the SWOT matrix, two strategies for ES implementation are proposed to optimize strengths, seize opportunities, while overcoming weakness and threats.

Strategy 1 (S1): ES maps for flood risk awareness raising

Due to its low elevation, the abundance of flood plains, and high annual rainfall, French Guiana is particularly vulnerable to floods. This natural phenomenon was exacerbated in recent years by poor land-use planning. Indeed, construction projects occurred many times in areas unsuitable for construction (e.g., wetland buffer areas). We recommend taking advantage of the strong collaboration existing amongst environmental actors and their willingness to share methods and data, in order to raise awareness on the effects of land-use planning on risk mitigation. This can be done by making use of ES mapping to raise awareness on the location of ES hotspots and on the economic consequences of neglecting regulating services such as water buffering. (CICES code: 2.2.1.3). This could create common grounds for communicating with elected representatives who undergo great pressures (i.e., urgent need for infrastructures) and make decisions at the expense of environmental sustainability. This proposal is strategic due to opportunities relating to the recent regional political shift, with representatives 'more sensitive to sustainability'. As analyzed in the 5.1 MOVE-ON report (MOVE-ON 2022), a major constraint to French Guiana's implementation of environmental policy is the divergent policy agendas between national and regional levels. The regional level is focused on the economic development of its territory, while the national level aims at achieving environmental objectives and international commitments. These divergent agendas also occur between regional decision-makers and local environmental managers, the latter aiming at reconciling socio-economic development with environmental protection. A cross talk between both views is therefore crucial for French Guiana. Willingness to cooperate and share data is important for the use of multidisciplinary approaches such as ESs. This could allow for a pooling of environmental knowledge for an economic analysis of the costs avoided by strategic land use planning. Indeed, economic metrics constitute a strong argument to raise awareness on the purpose of nature conservation by demonstrating economic benefits conservation (Naidoo, 2008).

Strategy 2 (S2): ES maps for land use planning optimization

As opposed to the strategies proposed for the Canary Islands that can be implemented independently, French Guiana Strategies 1 and 2 are synergetic. Strategy 2 builds on the awareness raised by Strategy 1 to set the basis for optimized land-use planning. Some of the shortcomings for improved land use planning is the lack of institutional capacity and a poor comprehensive vision of the territories development. Policy measures are sector-specific and sometimes contradictory. Furthermore, decision-makers lack training in environmental management, which affects their capacity for integrated management. To accompany the development of the territory, ES mapping can be useful to guide decision-

making. Operational tools should be produced to guide decision-makers in the identification of priority areas for land use planning (e.g., where to develop crops, where to develop urban areas), to preserve ecological connections and ESs delivery (e.g., carbon sequestration). These maps should combine ES information with other ecological knowledge (e.g., habitat characterization, land connectivity, biodiversity-monitoring data). These maps should be used to inform municipal and intermunicipal land use planning documents (*Plan Local d'Urbanisme, Schéma de Cohérence Territoriale*). French Guiana has an online geographic information data infrastructure, well managed and up-to-date (*Géoguyane, Portail Géographique de la Guyane*). Vocational maps for spatial optimization could be made available within this tool.

According to the scope and the objectives of each strategy, Table 8 identifies an assessment and/or mapping methodology fit to achieve each strategy.

Table 8 - Ecosystem services assessment methodology per strategic orientations for French Guiana based on the ESMERALDA database.

	Dimension	Domain	Objective	Method name	Method purpose
S.1	Economic	Risk management	Project evaluation	Damage cost avoided	Calculates the avoided damage costs by preserving the regulation of environmental flows by an ecosystem (e.g., flood attenuation, storm buffering).
S.2	Biophysical	Spatial planning	Priority setting	Integrated modeling framework	ES modeling with GIS tools to produce maps that can assess trade-offs and scenarios for multiple services. Aiming at guiding decision makers in the identification of priority areas for investment in natural capital.

c. Reunion Island key factors

Interviews were analyzed and coded for Reunion Island and the dominance by the political factors followed by environmental factors. Political subfactors suggest a wide array of political issues such as overlapping competencies, communication with elected representatives. IAS, conservation, and timber are the main environmental subfactors (Fig. 8).

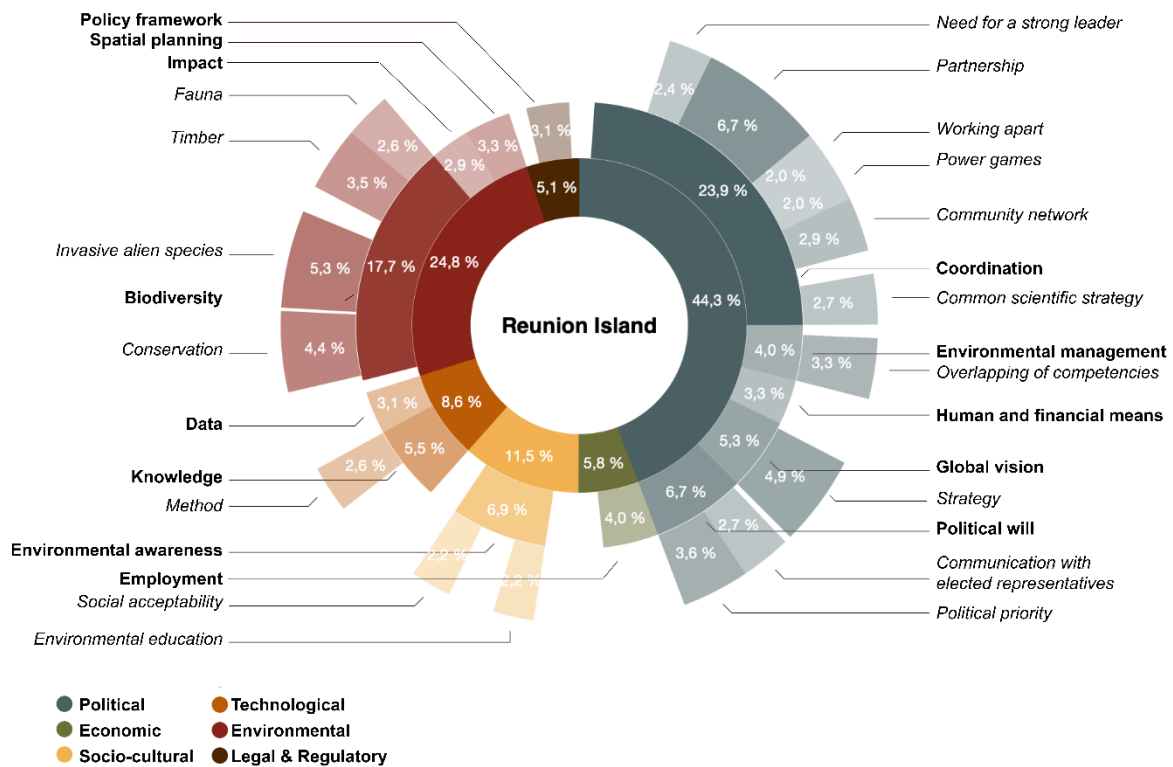


Figure 8 - PESTEL factors and subfactors most representative of Reunion Island (in bold level 2 factors, in italics level 3 factors).

Table 9 summarizes the SWOT results from the interview's content analysis and suggests the dominance from the political Weakness, as a source of an impediment to achieving sustainability goals within the territory (e.g., difficult partnership amongst environmental actors, environmental topics is not the political priority). IAS was highlighted as a key Threat of Reunion Island.

Table 9 - Reunion Island SWOT matrix.

	Strength	Weakness	Opportunity	Threat
Political	<p>Human and financial means: There are large funds for nature conservation and water management. The <i>Département</i> collects a tax of 5 to 6 million euros p.a. dedicated to conservation projects (<i>d'aménagement des espaces naturels sensibles</i>). There are highly skilled staff resources on-site and professionalization of nature management.</p>	<p>Partnership: Despite conventional agreements, partnerships remain difficult among stakeholders. Between professional and private end-user associations and environmental (taxe associations, relationships are tense).</p> <p>Strategy: The strategic document for biodiversity expired in 2020 and needs renewal (<i>Stratégie Régionale pour la Biodiversité</i>). However, the political interest calls for an theoretical leading actor in biodiversity, is weakened by a lack of staffing resources occupied with a controversial coastal road construction. A new environmental actor is slowly emerging (<i>ARB, Agence Régionale pour la Biodiversité</i>), freezing of the role of the regional biodiversity all initiatives for strategic planning of environmental actions.</p> <p>Political priority: Important socio-economic challenges outpace environmental protection (e.g., employment, education, economic growth).</p> <p>Overlapping of competencies: Organisms dealing with forest management have overlapping competencies, which causes conflicts and an unwillingness to work jointly.</p> <p>Communication with elected representatives: They are considered responsive to environmental protection, provided they find an advantage in acting. However, communication channels are not optimal and do not ensure an effective flow of information to elected representatives.</p> <p>Human and financial means: There is insufficient</p>	<p>Political priority: Managing natural resources takes more space on the balance of the island's development. Without a comprehensive vision for the development of the territory, current issues are likely to intensify.</p> <p>However, decisions are sometimes taken to please the population without ecological rationale (e.g., excessive plantation of trees). This growing political interest calls for an accompaniment in the development of strategies.</p> <p>Need for a strong leadership: Preliminary workshops for the definition of agency are ongoing (<i>ARB, Agence Régionale de la Biodiversité</i>). Participants are hoping for a strong leadership to help coordinate efforts, streamline methods, and advocate cooperation between actors. The main wish of participants in the workshop is to promote stakeholder networking.</p>	<p>Strategy: Lack of planning on the balance of the island's development. Without a comprehensive vision for the development of the territory, current issues are likely to intensify.</p>

	Strength	Weakness	Opportunity	Threat
Environmental	<p>Conservation: Reunion NP covers 76% of the island. Outside the NPs boundaries, there are many other areas under various protection regimes (<i>Espaces Naturels Sensibles</i>; <i>Biosphere reserves</i>; <i>Zones Naturelles d'Intérêt Écologique, Faunistique et Floristique</i>; <i>Arrêté de protection de biotope</i>; wetlands protected under the UN Ramsar Convention; national nature reserves), as well as a marine reserve.</p> <p>Timber: Early in the island's history, primary forests were logged and reforested with cedar wood (<i>Cryptomeria japonica</i>).</p>	<p>staff to control species entries in ports and airports. Pooling human resources could improve action effectiveness.</p> <p>Conservation: 76% of the island's surface is part of the Reunion NP. Outside the NPs boundaries, there are many coastal areas under various protection regimes (<i>Espaces Naturels Sensibles</i>; <i>Biosphere reserves</i>; <i>Zones Naturelles d'Intérêt Écologique, Faunistique et Floristique</i>; <i>Arrêté de protection de biotope</i>; wetlands protected under the UN Ramsar Convention; national nature reserves), as well as a marine reserve.</p> <p>Working apart: Lack of coordination of efforts against IAS. Institutions lead their own actions, and the absence of data sharing hinders the possibility for collaborative recordkeeping of successes and failures for a replication of the most effective actions.</p> <p>Power games: There are important conflicts between actors with overlapping competencies. Actors arguing legitimacy matters, thus preventing cooperation, common strategies, and effective measures in the field obstruct project development.</p>	<p>Spatial planning: Reunion island is the first French outermost region to have adopted a spatial planning strategy which prove ineffective to prevent further invasions.</p>	<p>IAS: The island's flora is highly threatened (e.g., the introduction of competitive species, trampling, climate changes, wildfires). The stake goes far beyond regulatory frameworks. It has been estimated that actions in the field should be increased four to fivefold to be effective. The territory risks a loss of UNESCO status</p>

	Strength	Weakness	Opportunity	Threat
	<p>Biosphere reserves; <i>Zones Naturelles d'Intérêt</i> This has caused an important loss in endemic <i>Écologique, Faunistique et Floristique</i>; <i>Arrêté</i> forests, currently relictuel at the scale of the <i>de protection de biotope</i>; wetlands island (<i>Belouve</i> and <i>Mare Longue</i> forests). protected under the UN Ramsar Convention; national nature reserves, marine reserves).</p> <p>Spatial planning: Land outside the NP's boundaries is mostly privately owned, impeding the possibility to harmonize spatial planning</p> <p>Timber: The wood sector is in decline, within the territory. The island's surface is very causing a reduction of pressures on forests. constrained, facing urban sprawl and high Forestry is shifting from timber to population density (345 inhab./km²), leading to conservation and product diversification habitat fragmentation and land artificialization. (e.g., beekeeping, vanilla, medicinal plant harvest).</p> <p>Spatial planning: Administrative and economic centers are centralized in the local capital <i>Saint-Denis</i>, causing an uneven development of the populations is peaceful, with fruitful regional territory and import congestions on road cooperation and high social acceptability. infrastructures. With the geographical With beach restoration and improvement in constraints of the island (steep slopes, limited lagoon protection, populations are spaces), projects for new road infrastructures increasingly returning to the island. cause an important impact on the already fragile ecosystems.</p> <p>Fauna: Large bird species populations have drastically declined with the arrival of the first human settlers on the island. The extinction actions are carried out but with limited results of keystone bird species affected forest (failure in bird nesting area restoration, in IAS regeneration (seed dispersal). Initiatives for control, restoration measures on inappropriate the reintroduction of closely genetic bird areas such as ancient lava flows). species from Mauritius island are under legal and social feasibility testing (<i>Mascarene Parakeet</i>).</p>			due to its inability to slow the rates of landscape degradation.
Socio-cultural	<p>Environmental education: Although efforts are still needed in terms of environmental environmental protection, however in practice, education (e.g., on waste management, initiatives struggle to be implemented against water resources), there are yet many strong social opposition. This is especially true initiatives in schools and the field on diverse when initiatives are related to changing natural topics. Citizen initiatives for environmental resource utilization due to a strong attachment</p>	<p>Social acceptability: Rising awareness for</p>		

	Strength	Weakness	Opportunity	Threat
	education are on the rise.	to land (e.g., logging, poaching, beekeeping, traditional uses such as medicinal plant gathering, hunting).		
Technological	<p>Social acceptability: Strong citizen acceptance and involvement in sea turtle conservation (e.g., participatory photo collection).</p> <p>Knowledge: Environmental actors try to comply with international commitments by adapting existing frameworks to the island's specificities (e.g., environmental compensation, environmental impact assessments, and forest management).</p> <p>Data: For marine and terrestrial fauna, regional and local cooperation contributed to extensive data collection. (e.g., sea turtle and bird monitoring).</p>	<p>Data: For terrestrial habitat management and data sharing among stakeholders and a lack of common methods for data collection, leading to inconsistencies in biodiversity monitoring data (e.g., invasion rates).</p> <p>Method: Applied research is needed for environmental restoration and IAS regulation.</p>		
Economic		<p>Employment: There is a lack of work opportunities. Even more so since the budget perceived by elected representatives populated and touristic territory, with decrease of the National Office of Forests as a means to create employment, this high competitiveness between touristic (<i>Office National des Forêts</i>), one of the island's utilitarian view of nature could operators, causing important pressures historical drivers for employment creation contribute to the opening of additional on natural sites and land caused a decline in openings. Reunion islanders work opportunities in other sectors than fragmentation (e.g., land are traditionally a farming population (sugar forestry (e.g., natural area artificialization, effects of trampling, cane) living off agriculture which has suffered conservation officers and technicians, increased sensitivity to IAS, while an important decline in the past 50 years with a nature tourism operators, restoration disturbance, and unsustainable use of radical transformation of the economy engineers). (increase of tourism and the tertiary sector).</p>	<p>Employment: As forestry is historically populated and touristic territory, with decrease of the National Office of Forests as a means to create employment, this high competitiveness between touristic operators, causing important pressures historical drivers for employment creation contribute to the opening of additional on natural sites and land caused a decline in openings. Reunion islanders work opportunities in other sectors than fragmentation (e.g., land are traditionally a farming population (sugar forestry (e.g., natural area artificialization, effects of trampling, cane) living off agriculture which has suffered conservation officers and technicians, increased sensitivity to IAS, while an important decline in the past 50 years with a nature tourism operators, restoration disturbance, and unsustainable use of water resources).</p>	

Based on the SWOT matrix, three strategies for ES implementation are proposed to optimize strengths, seize opportunities, while overcoming weaknesses and threats.

Strategy 1 (S1): Define an ecological baseline against which to assess ecosystem services.

The terrestrial ecosystems of Reunion Island are highly degraded, due to important rates of IAS threatening endemic flora and fauna. The island benefits from large funds for nature conservation but suffers a lack of coordination and cooperation among stakeholders. This leads to a multiplicity of scattered initiatives for nature conservation and restoration with little recordkeeping of successes and failures. There is a strong need for strategic planning to identify priority actions. For more effectiveness, it is important to determine which sites are too degraded to be restored, which ones are in a good ecological state and should be protected, and which ones are moderately degraded and could be successfully restored. This requires the setting of a baseline for ecological restoration. Such a baseline can comprise information on ecological functions and the expected supply of ES for a given ecological state. Ecological baselines would provide a blueprint for strategic conservation of ecosystems and provide an understanding of the current state of ecosystems. Indeed, at the date of the study, IAS maps of Reunion Island are still simplistic and need improvement to understand and predict invasions. The lack of stakeholder commitment and the lack of maps of island-wide biodiversity was identified in 2005 as major hindrances to effective conservation (Strasberg et al., 2005). More than 15 years later, only minor progress has been made towards stakeholder networking and island map production.

Strategy 2 (S2): Determine conditions affecting IAS distribution to predict better their evolution.

Temporal analysis can serve as a tool to analyze ecosystem trajectories and improve our understanding of biological invasion processes. Understanding ecosystem trajectories can help anticipate future changes and identify the main drivers of change. Evidence of past distribution patterns serve as a basis for future assessments. Reunion Island's IAS biological features are well understood (e.g., taxonomy, phenological states, and functional traits). However, additional information is still needed to fully understand the underlying processes favoring biological invasions. For example, to the date of the study, the impacts of landscapes on the spreading of IAS need further research. A map of invasion rates based on empirical biological data could help identify the effects of landscape on the distribution of IAS by combining for example, topographical information and biophysical data such as soil data. The combination of biological and geographic information could set the basis for better understanding threshold effects on invasion rates. The performance of restoration projects should also be analyzed spatially, allowing for an analysis of successes and failures in controlling the spreading of invasive species.

With the threat of losing the UNESCO status, which could affect the touristic image of the island, and with invasion rates exponentially increasing, it is important to build awareness among environmental stakeholders on the need to work jointly. The future Regional Biodiversity Agency (*Agence Régionale de la Biodiversité, ARB*) could constitute the needed actor to set strategic orientations and promote effort coordination.

According to the scope and the objectives of each strategy, Table 10 identifies an assessment and/or mapping methodology fit to achieve each strategy.

Table 10 - Ecosystem services assessment methodology per strategic orientations for Reunion Island based on the ESMERALDA database.

	Dimension	Domain	Objective	Method name	Method purpose
S.1	Biophysical	Biodiversity	Priority setting	Integrated modeling framework	ES modeling with GIS tools to produce maps that can assess trade-offs and scenarios for multiple services. Aiming at guiding decision makers in the identification of priority areas for investment in natural capital.
S.2	Biophysical	Biodiversity	Awareness raising	State and transition model (STM)	This model assumes there are a number of states in which a system can exist, but there are specific conditions that can drive the system between states. The focus of these models is the threshold point that separates one state from another and marks the transition between them. STMs examine natural systems by understanding and communicating changes in the ecosystem as well as providing broad predictive capabilities to assess and estimate potential future changes, given certain management and environmental conditions. The combination of STM with ES approach is useful for identifying multiple functions and benefits directed to improve decision-making.

4. Ecosystem services contribution to Sustainable Development Goals (SDGs)

The strategies developed in each of the three territories cover multiple ESs. From the CICES v5.1 ES classification, we identified which ESs would be positively impacted by the implementation of the strategies (Table 11). On average, the strategies are expected to affect the delivery of six ESs. A minimum of four ESs are affected with the 'Ecological baseline' strategy for Reunion Island (RE.S1) and a maximum of 11 ESs with the 'Spatial optimization' strategy for French Guiana (GF.S2).

Table 11 - Contribution of the strategies for sustainability to ESs, based on the CICES v5.1 classification system of ESs.

		CI.S1	CI.S2	CI.S3	GF.S1	GF.S2	RE.S1	RE.S2
Ecosystem Service (ES) Division	Simplified ES name	Ferry regulations	Protected areas	Aquaculture	Flood mitigation	Land use optimization	Ecological baseline	Invasive alien species
Biomass	<i>Food provision</i>		X*	X		X		
	<i>Raw materials</i>		X	X		X		
Genetic material	<i>Genetic resources (incl. medicinal)</i>		X	X		X	X	X
Mediation of wastes or toxic substances of anthropogenic origin	<i>Waste treatment (bioremediation, filtration, sequestration, storage, accumulation)</i>	X		X		X		
Regulation of baseline flows and extreme events	<i>Erosion control</i>				X	X		
	<i>Water flow regulation (flood control, coastal protection)</i>				X	X		
Lifecycle maintenance, habitat and gene pool protection	<i>Pollination, seed dispersal</i>		X			X	X	X
	<i>Habitat maintenance</i>	X	X		X	X	X	X
Pest and disease control	<i>Pest and Disease control</i>		X				X	X
Water conditions	<i>Water quality (chemical)</i>	X		X	X	X		
Atmospheric composition and conditions	<i>Air quality (temperature, humidity, chemical composition)</i>	X			X	X		
	<i>Carbon storage and sequestration</i>							
Physical and experiential interactions with the environment	<i>Recreation and Tourism</i>	X	X					X
Water	<i>Water provision (surface and groundwater)</i>					X		

*"X" if the strategy positively affects an ecosystem service supply, blank if there is no expected effect.

The most affected ESs amongst the seven study sites strategies are 'Habitat maintenance' (n = 6) and 'Genetic resources' (n = 5). Strategies contribute mostly to 'Regulation ESs' (Fig. 9), then to a lesser extent to 'Provision ESs', while 'Cultural ESs' are poorly addressed. Indeed, only 'Recreation and tourism' were expected to be strongly affected by the strategies.

Our results show strong interlinkages and effects of the strategies proposed to achieve multiple SDGs (Fig. 9). There is a substantial contribution of ES strategies for the three outermost regions to achieve SDGs 15 (Life on land), 2 (Zero hunger), 14 (Life below water), and 11 (Sustainable cities and communities). To a lesser extent, these strategies also contribute to SDGs 1 (No poverty), 6 (Clean water and sanitation), and 12 (Responsible consumption and production). These results demonstrate the ability of ES assessments to tackle the three sustainability pillars (social, economic, and environmental), and the potential of EU outermost regions to the achievement of international commitments such as SDGs.

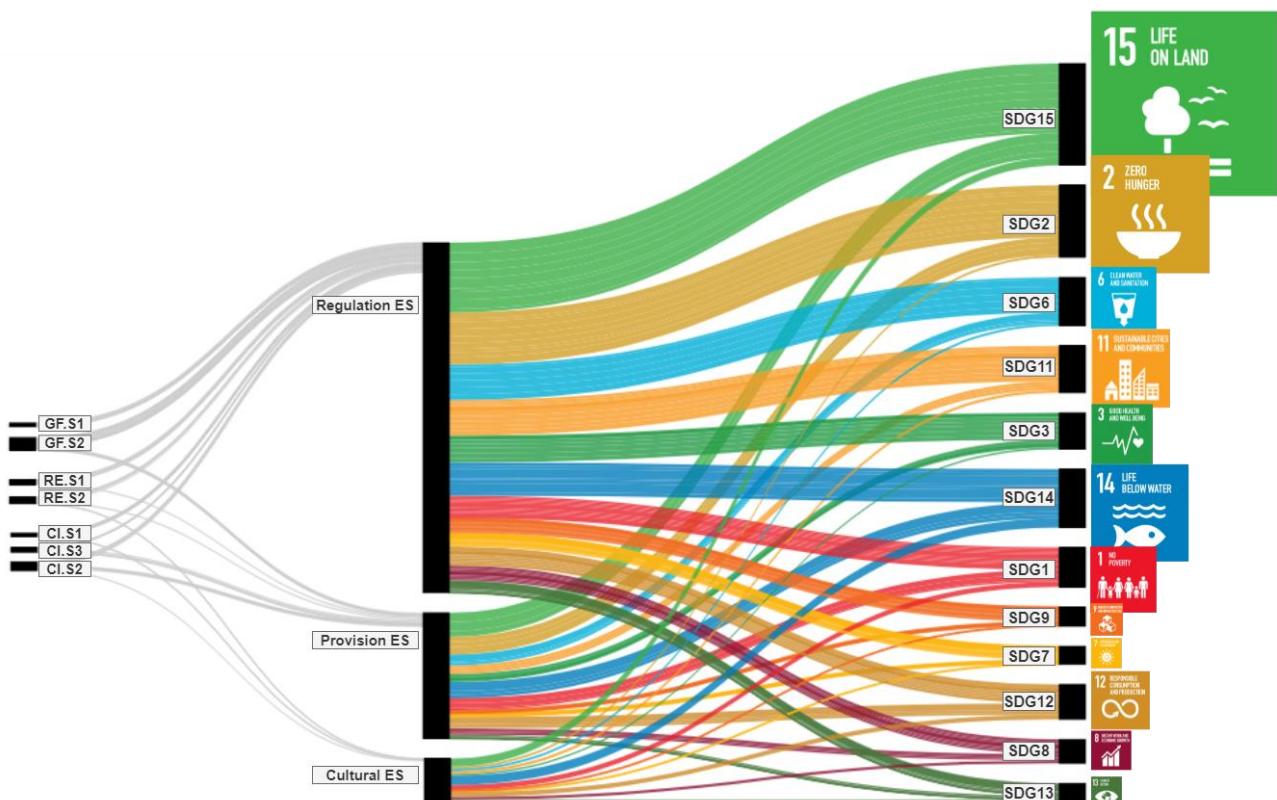


Figure 9 - Contributions of strategies for ecosystem services (ES) implementation (on the left) in the Canary Islands (CI), French Guiana (GF), and Reunion Island (RE), to the United Nations Sustainable Development Goals (SDG, on the right). Links between ES and SDGs are adapted from Wood et al. (2018). The size of the icons is proportional to the strength of ESs contribution to a given SDG.

DISCUSSION AND CONCLUSION

In this study, we used an extended SWOT approach to identify challenges and opportunities for the use of ES-based management in three EU outermost regions studied in the MOVE-ON project. Using qualitative data collected during semi-structured interviews, we identified key Political, Economic, Sociocultural, Technological, Environmental, and Legal and regulatory (PESTEL) features which facilitate or impede the achievement of sustainability goals and the possibility for ES-based management. The main PESTEL features were synthesized into SWOT matrices from which seven strategies for ES assessments emerged that could meet local needs while optimizing strengths and seizing opportunities.

With the sentiment analysis, we identified the Canary Islands and French Guiana displaying more positive attitudes towards ES (identified as 'facilitators') and Reunion Island displaying mixed sentiments (identified as 'blocker'). This analysis reflects sentiments that stem from experiences with ESs approaches implementation or hopes and fears for the use of this approach. On the one hand, the 'facilitators' group (the Canary Islands and French Guiana) could help support the project's initiative and promote ES-based management. However, the Canary Islands interviews were biased towards academics representing half the sample. In their study, Sieber et al. (2018) found academics tend to value forest and coastal regulating ESs more than other types of stakeholders. Therefore, positive sentiment towards ESs could be influenced by this unevenly distributed sample and should be considered suggestive. On the other hand, Reunion Island will need to be convinced of the importance and usefulness of ESs approaches. This could be one source of explanation for the poor uptake of MAES in this territory despite the work carried out in previous projects (MOVE project). In our previous work, we found studies including stakeholder analysis led to the development of research design more adapted to the local context (Bitoun et al., 2021). This was found to increase understanding and acceptance of ESs approaches. Further popularization of ESs concept's usefulness is therefore needed in Reunion Island to foster public awareness and build capacity. Considering the overall good relationship between attitude and sentiment, a quick analysis of stakeholders' attitudes towards ES approaches is sufficient to collect basic information regarding the perception of a sample about ESs and willingness to promote the projects' activities. This can serve as a basis for the identification of the type of ES assessment that will have the most impact on perceptions and subsequent ESs uptake. Study areas where perceptions of ESs are negative should favor ESs assessments for awareness-raising or preference assessment, whereas study areas where perceptions of ESs are positive should ESs assessments for direct inclusion in decision-making (e.g., accounting, instrument design, priority setting, or project evaluation).

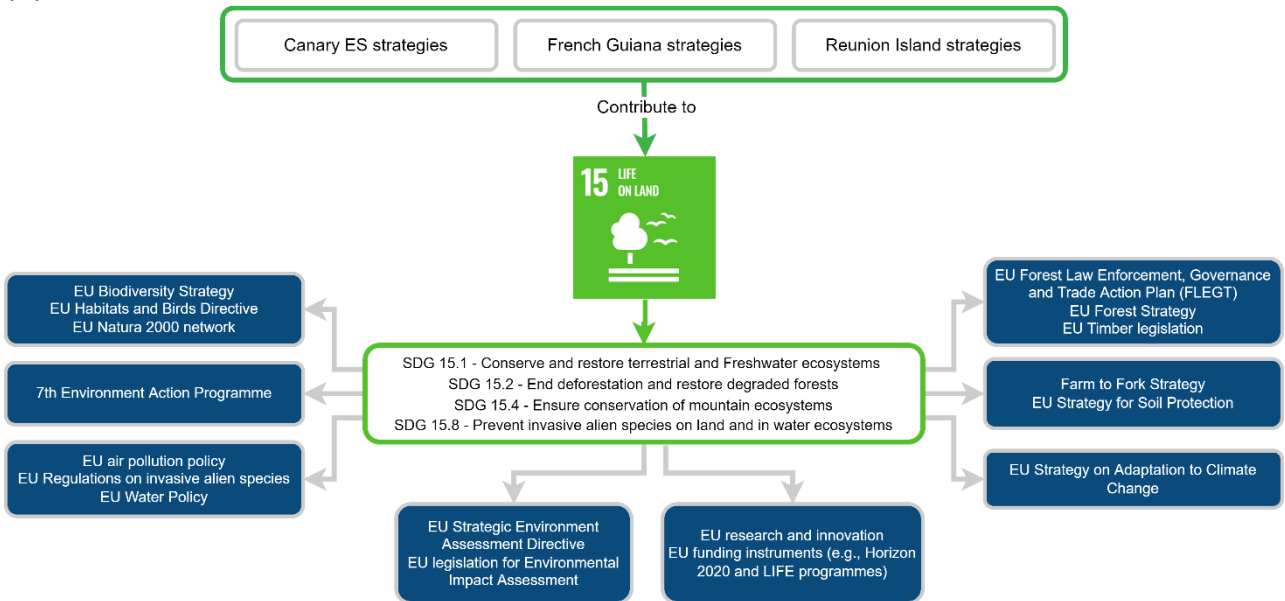
Poor funding is often considered a major impediment to environmental management and the implementation of ESs approaches (e.g., Bull et al., 2016, MOVE, 2021). Interestingly, the analysis of these case studies contradicts this common assumption. Indeed, all three

territories considered financial resources plentiful for good conservation practices but shared a common regret for lack of coordination of efforts. Important hindrances for coordination were identified on Reunion Island as being due to the absence of strong leadership, guiding and coordinating efforts towards a common strategy. In French Guiana, this issue is related to the lack of vision of what had been done in the past, caused by poor recordkeeping of previous studies, and by important turnover rates affecting the capacity for long-term strategic planning. For the Canary Islands, the lack of staffing resources hindered the capacity for action. Instead, political factors were found as major interferences with environmental management, like barriers or advantages depending on the context.

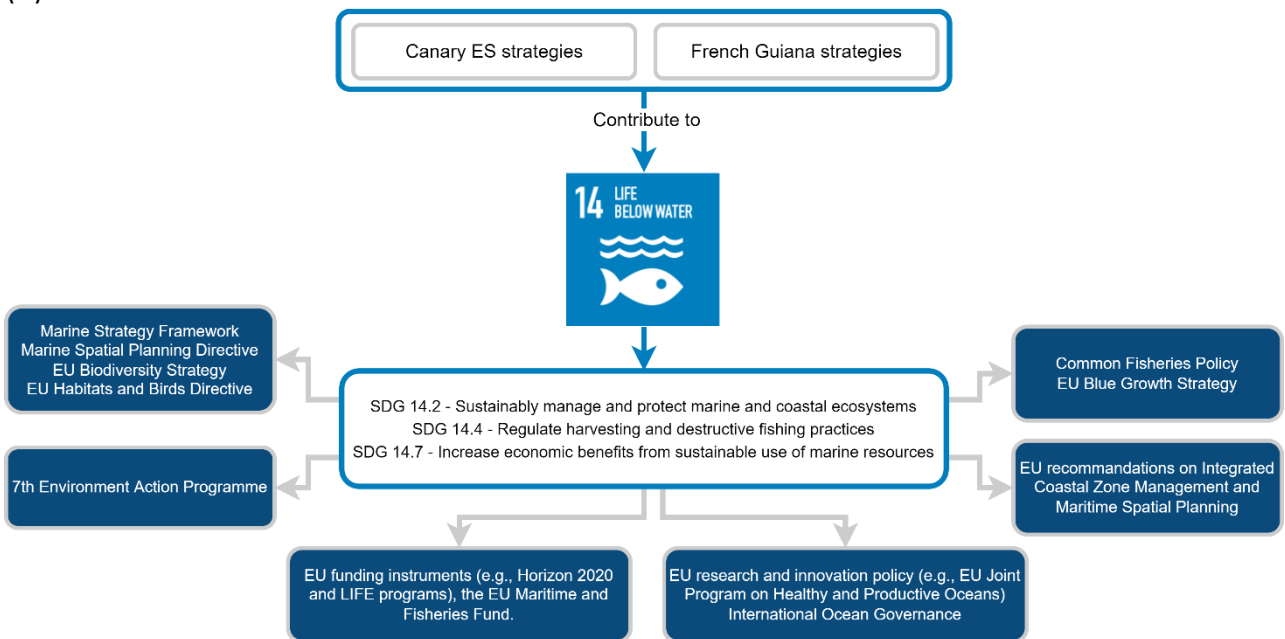
Our results highlight ESs being crosscutting themes to SDGs. Similarly, Erdogan et al. (2021) found many SDGs directly considering soil ESs, such as SDG 1 (No poverty), 2 (Food security), 6 (Clean water), 11 (Urban development), 12 (Consumption and production pattern), 13 (Climate), 14 (Land-based nutrient pollution of the seas), and 15 (Terrestrial ES sustainability). Assessing ES contribution to SDGs can serve as a basis for the identification of synergies with plural sectoral policy frameworks. Indeed, although EU policies are not directly coordinated with SDGs, SDGs link virtually to all EU policies (Steurer 2021). For example, the European Green Deal (EC, 2019) addresses 12 out of 17 SDGs. Synergies occur between SDGs implementation and other environmental policy objectives at the international and the EU level (Kluza et al., 2021). The mapping and the assessment of ES, accompanied by effective management of their supply, were found to contribute to SDGs beyond the sole sphere of biodiversity. Our findings highlight the cumulative effects of ES-based management on the achievement of multiple SDGs. Therefore, the scope of ES assessments can be much wider than that of a single target. For example, French Guiana's Strategy 2 on land use optimization should contribute to meeting the requirements of the EU LULUCF (Land Use, Land Use Change and Forestry) regulation and the air quality directives, by offsetting deforestation and reducing carbon emissions. The strategy should help provide access to suitable agricultural plots, which will increase livelihoods and contribute to the territories strategy for food autonomy by reducing dependency on food imports. This strategy could therefore contribute to the EU Farm-to-Fork strategy and social-related SDGs such as SDG 1 (No poverty), two (End hunger), eight (Decent work and economic growth), and 12 (Responsible consumption and production). At last, French Guiana's Strategy 2 is expected to have a positive impact on the delivery of 11 ESs, thus achieving advances towards the implementation of MAES.

The ESs strategies in this report advance the achievement of SDGs, and contribute to a wide array of EU regulations and policy frameworks. Figure 10 highlights policy contributions of the three most positively affected SDGs (Fig. 9), SDG 15, SDG 14, and SDG 2. Figure 10 is based on the European Commission report on the key European actions supporting the 2030 Agenda and the SDGs (EC, 2016) and updated with two policy reports (EC, 2021, and Caprile and Pichon, 2022),

(1)



(2)



(3)

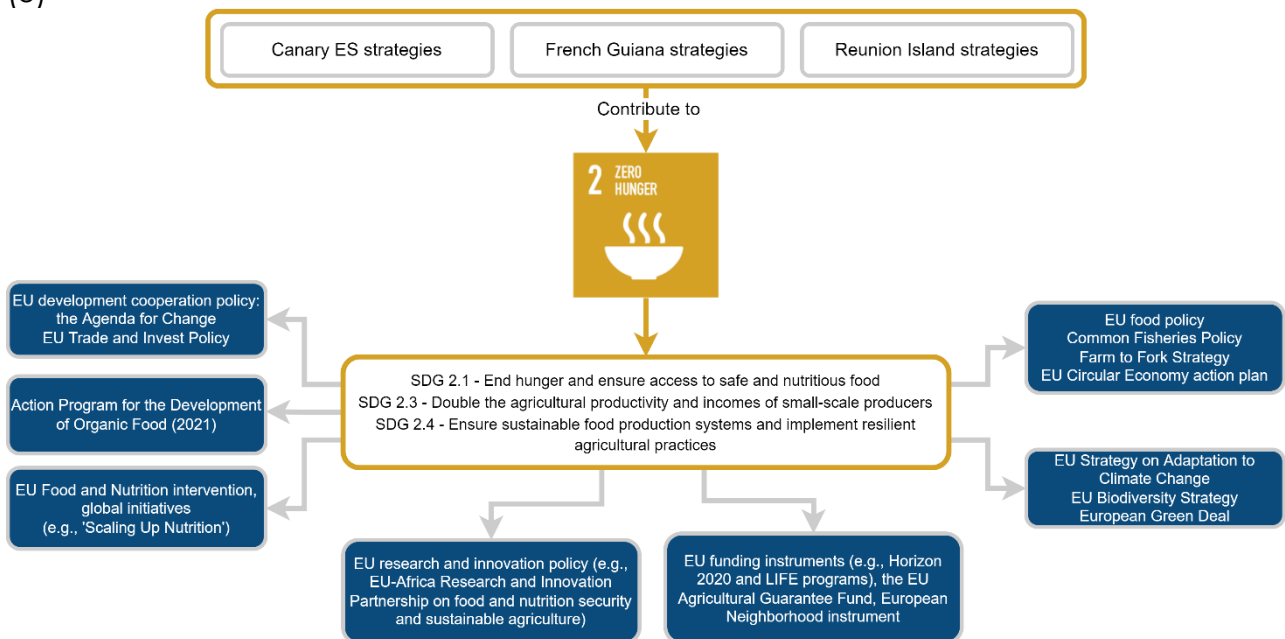


Figure 10 - Example of how strategies for ES implementation in three outermost regions contribute to achieving the Sustainable Development Goal 15 (SDG 15), and how it is translated into European actions supporting this goal, modified and adapted from EC (2016), EC (2021), Caprile & Pichon (2022).

This study has several limitations. Respondents to our interview were biased towards the natural sciences, similarly to Bull et al., (2016). Stakeholders were selected based on their knowledge of ESs, their influence in environmental management, and their availability for an interview, and were not selected randomly. The SWOT quadrants could have differed with a representative respondent sample (e.g., age, education level, field of work, role). Indeed, participants' age and the type of organization affects perceptions of ESs (Sieber et al., 2018). The views expressed in this report cannot be considered as representative of the case studies, but as an insight of challenges and opportunities for ES-based management as expressed by a limited number of participants. For this reason, conclusions could not have been drawn between types of stakeholders. Data limitations occurred for the Canary Islands case study. Only stakeholders from two of the eight islands were interviewed (Gran Canaria and Tenerife), which can lead to a biased vision of the archipelago's PESTEL challenges, especially in consideration of the unique identity of each island. As a result, the SWOT matrix and associated strategies may be more reflective of the reality of the two main islands of the archipelago rather than of the archipelago as a whole.

Our results could benefit from validation and adjustment with stakeholders participating in this study. Indeed, a common request of the participants was the wish to be informed of the outcomes of the study, therefore the report was sent to all participants. However, capacity building and social learning would have been greater with direct restitution of the results in the form of a webinar, for example. In these webinars, the content of the four quadrants SWOT analysis could have been presented along with the strategies for the

implementation of ES within the territory. The strategies developed could have integrated the outcomes of these sessions for result validation. Further research could anticipate the organization of participatory approaches to precise these strategies. For example, participants could have been asked to rank the importance of the SWOT factors (Panagiotou & van Wijnen 2005). This would have provided a quantitative basis for the identification of priority strategies to implement. For example, Arsić et al. (2018) used the Analytic Network Process methodology to give hierarchy to SWOT factors based on stakeholder assessment of the importance of the factors on a 1 to 9 scale. The study provides a set of priorities based on local opportunities for ES implementation in three territories. The views expressed here, are those that were given importance to by the interviewees. We propose a static vision of strategies for ES-based management, reflective of the situation at a given time, which may evolve quickly. Continued monitoring is necessary to obtain up-to-date strategies. Other factors could have been useful for the structuring of the interviews. Indeed, the pre-listing of factors does not necessarily cause the identification of the most relevant factors (Panagiotou & van Wijnen 2005). However, exhaustiveness was not as essential as perceived priorities were for this research. The purpose of this report is twofold. First, to foster acceptance of ES concepts. Second, to create a dialogue between stakeholders for them to implement strategies for sustainable management meeting their needs.

Further research is needed to explore the links between the codes per case study, for the identification of what works, and what can be duplicated for an improved ES-based management. To frame our study, we developed a deductive conceptual web based on the analysis of the literature (Fig. 2). This web identifies the key features to take into account for the proposal of pathways for ES implementation. From the analysis of local specificities, causal relationships between PESTEL subfactors per case study could have been assessed for the identification of key successes and failures for ES-based management in each territory.

In sum, the strategies we have outlined are suggestive of how strategic use of ESs could help achieve sustainability in consideration of the strengths, weaknesses, opportunities, and threats identified in this study. To promote ESs approaches uptakes, ESs studies should be carried out considering their usefulness (Lautenbach et al., 2019). Our analysis of the key features for achieving sustainability was a useful tool to "kick start the strategic planning process" (Panagiotou & van Wijnen 2005) for ESs approaches implementation. Our results provide insights on the potential for ES-based management in the selected case studies based on an assessment of local challenges and opportunities. The potential for the application of the framework we developed is not limited to European territories. Indeed, we defined strategies for the implementation of ESs approaches in three outermost regions of the EU, selected based on their current levels of implementation, but the studies' methodology could be replicated. Our method could be replicated in different biogeographic regions (e.g., Caribbean outermost regions), or territories with different

political statuses (e.g., sovereign countries or overseas territories such as the Falkland Islands, non-EU members). This would allow the examination of the extent to which location-effects influence results. With the global mainstreaming of good practices for environmental management, we can assume the features identified as factors for successful ES-based management can be replicated globally and not be only limited to EU case studies.

REFERENCES

- Alleway, H., Gillies, C., Bishop, M., Gentry, R., Theuerkauf, S., & Jones, R. (2019). The Ecosystem Services of Marine Aquaculture: Valuing Benefits to People and Nature, *BioScience*, 69(1), 59–68, <https://doi.org/10.1093/biosci/biy137>
- Arsić, S., Nikolić, D., Mihajlović, I., Fedajev, A., & Živković, Ž. (2018). A New Approach Within ANP-SWOT Framework for Prioritization of Ecosystem Management and Case Study of National Park Djerdap, Serbia. *Ecological Economics*, 146, 85-95. <https://doi.org/10.1016/j.ecolecon.2017.10.006>
- Atumane, A., & Cabral, P. (2021). Integration of Ecosystem Services into Land Use Planning in Mozambique. *Ecosystems and People*, 17(1), 165-177. <https://doi.org/10.1080/26395916.2021.1903081>
- Berte, E., & Panagopoulos, T. (2014). Enhancing city resilience to climate change by means of ecosystem services improvement : A SWOT analysis for the city of Faro, Portugal. *International Journal of Urban Sustainable Development*, 6(2), 241-253. <https://doi.org/10.1080/19463138.2014.953536>
- Bitoun, R. E., Trégarot, E., & Devillers, R. (2021). Bridging theory and practice in ecosystem services mapping : A systematic review. *Environment Systems and Decisions*. <https://doi.org/10.1007/s10669-021-09839-7>
- Birjali, M., Kasri, M., & Beni-Hssane, A. (2021). A comprehensive survey on sentiment analysis : Approaches, challenges and trends. *Knowledge-Based Systems*, 226, 107134. <https://doi.org/10.1016/j.knosys.2021.107134>
- Bull, J. W., Jobstvogt, N., Böhnke-Henrichs, A., Mascarenhas, A., Sitas, N., Baulcomb, C., Lambini, C. K., Rawlins, M., Baral, H., Zähringer, J., Carter-Silk, E., Balzan, M. V., Kenter, J. O., Häyhä, T., Petz, K., & Koss, R. (2016). Strengths, Weaknesses, Opportunities and Threats : A SWOT analysis of the ecosystem services framework. *Ecosystem Services*, 17, 99-111. <https://doi.org/10.1016/j.ecoser.2015.11.012>
- Caprile, A., & Pichon, E. (2022). SDG 2 - Zero hunger, and EU action against hunger and malnutrition (Briefing PE 698.894; EPRS. European Parliamentary Research Service, p. 12). European Parliament.
- Chen, T., Xu, R., He, Y., & Wang, X. (2017). Improving sentiment analysis via sentence type classification using BiLSTM-CRF and CNN. *Expert Systems with Applications*, 72, 221-230. <https://doi.org/10.1016/j.eswa.2016.10.065>
- Hammond, D., Gond, V., de Thoisy, B., Forget, P.-M., & De Dijn, B. (2007). Causes and Consequences of a Tropical Forest Gold Rush in the Guiana Shield, South America. *AMBIO: A Journal of the Human Environment*, 36(8), 661-670. [https://doi.org/10.1579/0044-7447\(2007\)36\[661:cacoat\]2.0.co;2](https://doi.org/10.1579/0044-7447(2007)36[661:cacoat]2.0.co;2)
- De Geyer, J.-F., Launay, J., Heuertz, M., Tysklind, N., Scotti, I., Molino, J.-F., Delprete, P., Engel, J., Frame, D., Lucas, E., Martin, C., & Sabatier, D. (2020). *Deuxième rapport sur l'état des ressources génétiques forestières mondiales. Rapport national de la France* (Tome 3. Guyane; p. 123). IRD ; INRAE.

Demougeot, L. & Baert, X. (2019). La population guyanaise à l'horizon 2050: vers un doublement de la population? Insee Analyses Guyane n°36. March 2019. <https://www.insee.fr/fr/statistiques/3902223>

EC (2016). Commission staff working document. Key European action supporting the 2030 Agenda and the Sustainable Development Goals. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016SC0390&from=FR>

EC (2019). The European Green Deal (Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions COM (2019) 640). European Commission.

EC (2020a). Stepping up Europe's 2030 climate ambition. Investing in a climate-neutral future for the benefit of our people (Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions COM(2020) 562). European Commission.

EC (2020b). A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system (Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions COM(2020) 381). European Commission.

EC (2020c). EU Biodiversity Strategy for 2030. Bringing nature back into our lives (Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions COM(2020) 380). European Commission.

EC (2021). Assessment of the existing EU policy tools in the field of Sustainable Development Goal (SDG) 14 and other ocean-related Agenda 2030 targets. Supporting material (European Climate, Infrastructure and Environment Executive Agency Unit D.D3 - Sustainable Blue Economy B-1049; p. 129). European Commission.

Erdogan, H. E., Havlicek, E., Dazzi, C., Montanarella, L., Van Liedekerke, M., Vrščaj, B., Krasilnikov, P., Khasankhanova, G., & Vargas, R. (2021). Soil conservation and sustainable development goals (SDGs) achievement in Europe and central Asia : Which role for the European soil partnership? *International Soil and Water Conservation Research*, 9(3), 360-369. <https://doi.org/10.1016/j.iswcr.2021.02.003>

European Parliament & European Council. (2021). Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law') (Legislative act L 243/1; Official Journal of the European Union).

Léglise, I. (2017). Les langues parlées en Guyane : Une extraordinaire diversité, un casse-tête pour les institutions (Bulletin de l'observatoire des pratiques linguistiques N° 29; Langues et cité: Les langues

de Guyane, p. 16). CNRS. <https://www.culture.gouv.fr/Thematiques/Langue-francaise-et-langues-de-France/Nos-missions/Observer-les-pratiques-linguistiques/Langues-et-cite/Langues-et-cite-n-28-les-langues-de-Guyane>

Lozano, M. & Vallés, J. (2007). An analysis of the implementation of an environmental management system in a local public administration. *Journal of Environmental Management*. 82(4):495-511. <https://doi.org/10.1016/j.jenvman.2006.01.013>

Hernández-Martín, R., Antonova, N., Cells Sola, D., Fernández Hernández, C., González Hernández, M., Herrera Priano, F., León González, C., Mendoza Jiménez, J., Padrón Fumero, N., Rodríguez González, P., Santana Talavera, A., & Simancas Cruz, M. (2021). Tourism observatory of the Canary Islands. Preliminary report. (p. 65). Cátedra de Turismo Caja Canarias-Ashotel de la Universidad.

Hilborn, R. & Hilborn, U. (2019). *Ocean Recovery: a sustainable future for global fisheries?* Oxford University press. <https://doi.org/10.1093/oso/9780198839767.001.0001>

Inkoom, J., Frank, S., & Fürst, C. (2017). Challenges and opportunities of ecosystem service integration into land use planning in West Africa – an implementation framework. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 13, 67-81. <https://doi.org/10.1080/21513732.2017.1296494>

Jetoo, S., & Lahtinen, V. (2021). The Good, the Bad and the Future : A SWOT Analysis of the Ecosystem Approach to Governance in the Baltic Sea Region. *Sustainability*, 13(19). <https://doi.org/10.3390/su131910539>

Kluza, K., Ziolo, M., Bqk, I., & Spoz, A. (2021). Achieving Environmental Policy Objectives through the Implementation of Sustainable Development Goals. The Case for European Union Countries. *Energies*, 14(8). <https://doi.org/10.3390/en14082129>

Lautenbach, S., Mupepele, A.-C., Dormann, C. F., Lee, H., Schmidt, S., Scholte, S. S. K., Seppelt, R., van Teeffelen, A. J. A., Verhagen, W., & Volk, M. (2019). Blind spots in ecosystem services research and challenges for implementation. *Regional Environmental Change*, 19(8), 2151-2172. <https://doi.org/10.1007/s10113-018-1457-9>

Longato, D., Cortinovis, C., Albert, C., & Geneletti, D. (2021). Practical applications of ecosystem services in spatial planning : Lessons learned from a systematic literature review. *Environmental Science & Policy*, 119, 72-84. <https://doi.org/10.1016/j.envsci.2021.02.001>

Miles, M., Huberman, M., & Saldaña, J. (2019). *Qualitative Data Analysis : A Methods Sourcebook* (4th Ed.). Thousand Oaks, CA: SAGE Publications Inc.

MOVE Project (2021). European Commission Directorate General Environment Grant Agreement no. 07.027735/2018/776517/SUB/ENV.D2. Deliverable D.5.2. Major constraints and solutions for the implementation of MAES tools and approaches.

- MOVE-ON Project (2021). European Commission Directorate General Environment Grant Agreement no. 07.027735/2019/808239/SUB/ENV.D2. Deliverable D.4.1. Database of MAES projects and experts.
- MOVE-ON project (2022), European Commission Directorate General Environment Grant Agreement no. 07.027735/2019/808239/SUB/ENV.D2. Deliverable 5.1 - Implementation of EU and International policies for biodiversity and climate change.
- Nahuelhual, L., Vergara, X., Bozzeda, F., Campos, G., Subida, M. D., Outeiro, L., Villasante, S., & Fernández, M. (2020). Exploring gaps in mapping marine ecosystem services : A benchmark analysis. *Ocean & Coastal Management*, 192, 105193. <https://doi.org/10.1016/j.ocecoaman.2020.105193>
- Naidoo, R. (2008). The role of economic valuation in the conservation of tropical nature. *Economics and Conservation in the Tropics: A Strategic Dialogue*. San Francisco, Conservation Strategy Fund, Resources for the Future, and the Gordon and Betty Moore Foundation, 6.
- Øivind Madsen, D., & Ove Grønseth, B. (2022). PESTEL analysis. In *Encyclopedia of Tourism Management and Marketing* (Vol. 1, p. 3904).
- Panagiotou, G., & van Wijnen, R. (2005). The « telescopic observations » framework : An attainable strategic tool. *Marketing Intelligence & Planning*, 23, 155-171. <https://doi.org/10.1108/02634500510589912>
- Reyes-Menendez, A., Saura, J. R., & Alvarez-Alonso, C. (2018). Understanding #WorldEnvironmentDay User Opinions in Twitter : A Topic-Based Sentiment Analysis Approach. *International Journal of Environmental Research and Public Health*, 15(11). <https://doi.org/10.3390/ijerph15112537>
- Ribalaygua, C., García, F., & García Sánchez, H. (2019). European island outermost regions and climate change adaptation : A new role for regional planning. *Island Studies Journal*, 14(1), 21-40. <https://doi.org/10.24043/isj.78>
- Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd Ed.). Thousand Oaks, CA: SAGE Publications Inc.
- Saliman, M., Benon, P., Gosset, M., Mariotti, S., Bracco, I., Julliot, C., Le Tellier, V., Staal, S., Besnard, A., Malfait, G., & Reilhes, C. (2017). La biodiversité à La Réunion à travers 20 indicateurs (p. 44). DEAL Réunion.
- Santos-Martin, F., Viinikka, A., Mononen, L., Brander, L.-M., Vihervaara, P., Liekens, I., & Potschin-Young, M. (2018). Creating an operational database for ecosystems services mapping and assessment methods. *One Ecosystem*, 3:e26719. <https://doi.org/10.3897/oneeco.3.e26719>
- Sevкли, M., Oztekin, A., Uysal, O., Torlak, G., Turkyilmaz, A., & Delen, D. (2012). Development of a fuzzy ANP based SWOT analysis for the airline industry in Turkey. *Expert Systems with Applications*, 39(1), 14-24. <https://doi.org/10.1016/j.eswa.2011.06.047>

Sieber, I. M., Borges, P. A., & Burkhard, B. (2018). Hotspots of biodiversity and ecosystem services: the Outermost Regions and Overseas Countries and Territories of the European Union. *One Ecosystem* 3 (2018).

Sieber, I. M., Campagne, C. S., Villien, C., & Burkhard, B. (2021). Mapping and assessing ecosystems and their services : A comparative approach to ecosystem service supply in Suriname and French Guiana. *Ecosystems and People*, 17(1), 148-164. <https://doi.org/10.1080/26395916.2021.1896580>

Steurer, R. (2021). Is the EU still committed to developing more sustainability? In *Environmental policy in the EU* (4th Ed., p. 20). Routledge.

Stocké, V., & Langfeldt, B. (2004). Effects of Survey Experience on Respondents' Attitudes Towards Surveys. *Bulletin de méthodologie sociologique*, 81, 5-32. URL : <http://journals.openedition.org/bms/1094>

Strasberg, D., Rouget, M., Richardson, D. M., Baret, S., Dupont, J., & Cowling, R. M. (2005). An assessment of habitat diversity and transformation on La Réunion Island (Mascarene Islands, Indian Ocean) as a basis for identifying broad-scale conservation priorities. *Biodiversity & Conservation*, 14(12), 3015-3032.

UN. (2015). *Transforming our world: The 2030 Agenda for sustainable development* (General Assembly 70th session A/RES/70/1). United Nations.

Walcker, R., Gandois, L., Proisy, C., Corenblit, D., Mougin, E., Laplanche, C., Ray, R., & Fromard, F. (2018). Control of "blue carbon" storage by mangrove aging: Evidence from a 66-year chronosequence in French Guiana. *Global Change Biology*, 24(6), 2325-2338. <https://doi.org/10.1111/gcb.14100>

Wood, S., Jones, S., Johnson, J., Brauman, K., Chaplin-Kramer, R., Fremier, A., Girvetz, E., Gordon, L. J., Kappel, C., Mandle, L., Mulligan, M., O'Farrell, P., Smith, W., Willemen, L., Zhang, W., & DeClerck, F. A. (2018). Distilling the role of ecosystem services in the Sustainable Development Goals. *Ecosystem Services*, 29, 70-82. <https://doi.org/10.1016/j.ecoser.2017.10.010>

Yang, S., Zhao, W., Liu, Y., Cherubini, F., Fu, B., & Pereira, P. (2020). Prioritizing sustainable development goals and linking them to ecosystem services : A global expert's knowledge evaluation. *Geography and Sustainability*, 1 (4), 321-330. <https://doi.org/10.1016/j.geosus.2020.09.004>

Supplementary Materials A - References on the application of SWOT analysis to ESs

A preliminary literature search on papers using SWOT analysis in relation to ESs led to the selection of the papers presented in the following table. These papers contributed to the development of the deductive framework used as guidelines for the semi-structured interviews (see section 2).

Citation	SWOT analysis goals	Full reference
Lozano & Vallés (2007)	Analyze the consequences of implementing an Environmental Management System in Spanish public administrations	Lozano, M. & Vallés, J. (2007). An analysis of the implementation of an environmental management system in a local public administration. <i>Journal of Environmental Management</i> . 82(4):495-511. https://doi.org/10.1016/j.jenvman.2006.01.013
Berte & Panagopoulos (2014)	Identify measures based on green infrastructure to improve ES delivery	Berte, & Panagopoulos, T. (2014). Enhancing city resilience to climate change by means of ecosystem services improvement: a SWOT analysis for the city of Faro, Portugal. <i>International Journal of Urban Sustainable Development</i> . https://doi.org/10.1080/19463138.2014.953536
Scolozzi et al. (2014)	Identify factors for ES-based management supporting or threatening the effectiveness of protected areas	Scolozzi, R., Schirpke, U., Morri, E., D'Amato, D., Santolini, R. (2014). Ecosystem services-based SWOT analysis of protected areas for conservation strategies. <i>Journal of Environmental Management</i> . 146. 543–551. https://doi.org/10.1016/j.jenvman.2014.05.040
Lillebø et al. (2015)	Define guidelines for ES-based management of four European lagoons	Lillebø, A., Spray, C., Alves, F., Stålnacke, P., Gooch, G., Soares J., Sousa, L., Sousa, A., Khokhlov, V., Yurii, T., Marín, A., Lloret, J., Bello, C., Bielecka, M., Różyński, G., Margonski, P., & Chubarenko, B. (2015). Chapter 19: European coastal lagoons: an integrated vision for ecosystem services, environmental SWOT analysis and human well-being
Bull et al. (2016)	Analyze perceptions on the ES concept and its applications, and identify opportunities and threats that may benefit or impede future development	Bull, J. W., Jobstvogt, N., Böhnke-Henrichs, A., Mascarenhas, A., Sitas, N., Baulcomb, C., Lambini, C. K., Rawlins, M., Baral, H., Zähringer, J., Carter-Silk, E., Balzan, M. V., Kenter, J. O., Häyhä, T., Petz, K., & Koss, R. (2016). Strengths, Weaknesses, Opportunities and Threats: A SWOT analysis of the ecosystem services framework. <i>Ecosystem Services</i> , 17, 99-111. https://doi.org/10.1016/j.ecoser.2015.11.012
Inkoom et al. (2017)	Integrate ES in land use planning based on the analysis of Ghana's and Nigeria's policy documents	Inkoom JN, Frank S, & Fürst C. 2017. Challenges and opportunities of ecosystem service integration into land use planning in West Africa – an implementation framework planning in West Africa – an implementation framework. <i>Int J Biodivers Sci Ecosyst Serv Manag</i> . 13 (2):67–81. https://doi.org/10.1080/21513732.2017.1296494
Arsić et al. (2018)	Prioritize scenarios for NP strategic planning	Arsić, S., Nikolić, D., Mihajlović, I., Fedajev, A., & Živković, Ž. (2018). A New Approach Within ANP-SWOT Framework for Prioritization of Ecosystem Management and Case Study of National Park Djerdap, Serbia. <i>Ecological Economics</i> , 146, 85-95. https://doi.org/10.1016/j.ecolecon.2017.10.006
Atumane & Cabral (2021)	Same as Inkoom et al. (2017) applied to Mozambique	Atumane, A., & Cabral, P. (2021). Integration of Ecosystem Services into Land Use Planning in Mozambique. <i>Ecosystems and People</i> , 17(1), 165-177. https://doi.org/10.1080/26395916.2021.1903081
Jetoo & Lahtinen (2021)	Identify features supporting or threatening the use of ES approaches in the Baltic Sea Region and the achievement of good environmental status	Jetoo, S., & Lahtinen, V. (2021). The Good, the Bad and the Future : A SWOT Analysis of the Ecosystem Approach to Governance in the Baltic Sea Region. <i>Sustainability</i> , 13(19). https://doi.org/10.3390/su131910539

Supplementary Materials B - Semi-structured interview guidelines

[The following semi-structured interview was used as a guideline for face-to-face meetings with selected stakeholders. The aim of the study was to explore key features enhancing or limiting sustainable development to propose strategies for Ecosystem Services (ES)-based management which could increase the territory's sustainability. Please note the following questions did not apply to all participants (e.g., some had no experience in assessing or mapping ESs), and were therefore modulated based on the stakeholder addressed. Moreover, some additional questions occurred during interviews, to explore further with participants some key features that were not anticipated. When confronted with contradictory statements between participants, we asked for further information to better comprehend events. Therefore, some context-dependent questions emerged to address previous statements with additional participants to increase the reliability of one's statement.]

1. Background information

Name - Institution - Position

2. Knowledge of ES concept and application

- 2.1. Do you know the concept of ESs? Was the concept applied in your organization? If yes, in what context? If not, why so?
- 2.2. Have you found the ESs concepts easy to use? Have some technical support helped you in your study (methodological reports, books, scientific literature, expert advice)?
- 2.3. What are the uncertainties related to your results and do you think the methodology you developed could be replicated?
- 2.4. [If ESs were mapped] Whom were the maps addressed to? (e.g., political maps addressed to decision-makers, communicational maps addressed to the general public)
- 2.5. There is a general observation of a weak uptake of ESs in overseas territories, which prompts us to investigate why. What is your opinion on this matter? What do you think are the reasons for this low uptake in the territory?

3. Networks and strategic development

- 3.1. In your task, which organisms do you work with and how do you work with them?
- 3.2. How do you keep informed of scientific findings? Do you collaborate with academic stakeholders? Do you have expectations towards academic stakeholders and the studies they carry out?
- 3.3. How advanced are participatory processes in the territory? What do you think are the local obstacles or opportunities for public participation?
- 3.4. How are your organisms' actions coordinated with organisms working on related themes? Are these relationships formalized or are these relationships the result of informal processes?

3.5. In your organization how are the strategic orientations defined (goals, methods to use, innovations)? Do you receive instructions on how to work (e.g., from local organizations, regional, national)?

3.6. Are non-governmental organizations and nature conservancy associations active in the territory? Do you think their message is taken into account?

3.7. Do you think policy- and decision-making for environmental (and land) management are locally based on scientific evidence?

4. Mental map

Can you sketch the interaction between the different institutions that influence according to you the decision-making process for environmental management in the territory? Place on this graph the position of your institution in relation to others.

Additional instructions: think about the diversity of stakeholders (NGOs, academia, private sector, administrations, citizens, etc.). Draw arrows to connect components to one another. The direction of the arrow can represent the hierarchy and influence on one another. Who influences whom? Which relationships are efficient? Which ones are conflictual? Are they peaceful and stable?

5. Additional contacts

Would you suggest we interview additional contacts for our research project?