KIWA INITIATIVE

PEBACC+
Pacific Ecosystem-based Adaptation to Climate Change Plus

SPREP

Project co-funded by FFEM

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Sciences Environnement Vulgarisation Expertise

MARCH 2025

Ecosystem and Socio-economic Resilience Analysis and Mapping (ESRAM) - FULL REPORT

New Caledonia

IN PARTNERSHIP WITH:

Pacific Community
Communauté du Pacifique

SPREP

IUCN

THIS INITIATIVE IS FUNDED BY:

EUROPEAN UNION

AFD

in partnership with Canada

Australian Aid

NEW ZEALAND FOREIGN AFFAIRS & TRADE Aid Programme

SPREP Library Cataloguing-in-Publication Data

Aubert, Marine; Vanmai, Samuel; et al

Analysis and mapping of the ecosystem and socio-economic resilience (ESRAM) of New Caledonia: resilience analysis and priority options for ecosystem-based adaptation. Apia, Samoa: SPREP, 2026.

198 p.; 29 cm.

ISBN: 978-982-04-1513-3 (print)
978-982-04-1514-0 (ecopy)

1. Ecosystem management – Economic aspects – New Caledonia. 2. Ecosystem management – Citizen participation - New Caledonia. I. Aubert, Marine. II. Vanmai, Samuel. III. Ullmann-Bizien, Charlotte. IV. Chamboredon, Cecile. V. Deandreis, Celine. VI. Durand, Suzie. VII. Vialon, Camille. VIII. Gaudimont, Killian. XI. Pacific Regional Environment Programme (SPREP). X. Title.

574.56409597

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Document history

Version	Submission Date	Date Comments Received	Comments received
V1	27.03.2025		CoTech
V2	6.06.2025		

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Glossary

Hazard

A hazard is a natural or human-induced event, unpredictable or difficult to control, that has the potential to cause damage characterized by its intensity, spatial probability of occurrence, and temporal probability of occurrence. Hazards may include extreme climatic events (cyclones, floods, droughts), geological disasters (earthquakes, volcanic eruptions), biological phenomena (spread of invasive species, epidemics), as well as human activities (pollution, industrial accidents, fires).

A hazard may be sudden and abrupt ("extreme" hazard, such as drought or intense rainfall) or gradual and chronic ("gradual" hazard, such as increasing seasonal average temperatures or sea-level rise). The intensity and frequency of a climate hazard depend on greenhouse gas emission scenarios (and associated warming levels) as well as geographic location.

Threat

Concerning ecosystems, a threat is a direct driver of biodiversity loss: a human activity or process that has had, has, or may have an impact on survival, extinction rates, or population decline of one or more taxa. This may include habitat destruction, pollution, overexploitation, the spread of invasive species, or climate change.

Pressure

Pressures encompass all hazards and threats to which an asset is exposed within a given spatial and temporal scale.

Asset (Stake)

An asset is an element or component of an ecological, socio-economic, or infrastructural system that may be affected by a hazard or threat. Assets may include human populations, ecosystems, infrastructure, and economic activities.

Exposure

Exposure refers to the nature, degree, and frequency with which a system is significantly exposed to a pressure, such as a climate hazard or anthropogenic threat, taking into account aggravating and/or mitigating factors linked to the territorial context.

Sensitivity

Sensitivity is the propensity of a socio-system or ecosystem to be affected—positively or negatively—by the physical consequences of climate variability or other pressures.

Adaptive capacity

Adaptive capacity encompasses all the resources available to an ecosystem or human community to prepare for (ex-ante) or cope with (ex post) the impacts of various pressures, including climate hazards (access to funding, information, knowledge, and resources in general).

Vulnerability

Vulnerability is the susceptibility of an asset to suffer damage due to its exposure to a hazard. It results from the combination of the hazard's intensity and frequency and the sensitivity of the asset. In other words, it reflects the degree of potential harm that ecological, socio-economic, or infrastructural systems may experience.

Resilience

Resilience is the capacity of a system—ecological, socio-economic, or infrastructural—to anticipate, absorb, recover, and adapt to disturbances or hazards. It results from reducing vulnerability through effective and sustainable management measures. Strengthening resilience improves systems' ability to maintain or quickly regain their essential functioning and structure after an impact.

Ecosystem services

Ecosystem services are the benefits humans derive from natural ecosystems to support their well-being. According to the Millennium Ecosystem Assessment (2005), they are classified into four main categories:

- **Provisioning services:** these are the material resources provided by ecosystems, such as water, food, traditional medicine, timber, fibres, and genetic resources.
- **Regulating services:** these include ecosystem functions that regulate climate, diseases, air quality, water, and pollinators.
- **Cultural services:** these are the non-material benefits linked to cultural, spiritual, recreational, and aesthetic experiences and practices that humans derive from nature.
- **Supporting services:** these encompass essential functions that enable the production of other ecosystem services, such as soil formation, photosynthesis, and nutrient cycling.

Ecosystem-based adaptation (EbA)

According to its official definition, established at the 2009 Conference of the United Nations Convention on Biological Diversity (CBD), EbA is "the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change."

This people-centred concept recognizes that human resilience depends on the health of ecosystems. The originality of EbA lies in combining traditional conservation approaches with sustainable socio-economic development within a comprehensive climate adaptation strategy.

Healthy ecosystems provide ecological functions that contribute both to climate change mitigation and adaptation, enabling the development of nature-based solutions beneficial to societies. They buffer local climate and reduce risks associated with extreme climate events.

I. Introduction

The ESRAM process (Ecosystem and Socio-economic Resilience Analysis and Mapping) is one of the three activities of the PEBACC+ project (Pacific Ecosystem-based Adaptation to Climate Change) in New Caledonia, coordinated by the Secretariat of the Pacific Regional Environment Programme (SPREP) and co-funded by the Kiwa Initiative and the French Global Environment Facility (FFEM). This project aims to promote climate change adaptation through nature-based solutions (NbS) in the Pacific, and particularly in New Caledonia.

New Caledonia, a global biodiversity hotspot, is especially vulnerable to the impacts of climate change, which calls for an integrated approach based on natural solutions to ensure the resilience of ecosystems and human communities.

Objectives of the ESRAM-NC process

The ESRAM-NC process aims to assess and map the resilience of New Caledonia's socio-ecological systems in the face of climate change and anthropogenic pressures. By identifying vulnerability factors and the least resilient sectors, and by proposing appropriate solutions, this process seeks to strengthen the capacities of local stakeholders and guide climate adaptation strategies toward concrete and sustainable actions.

The results of this analysis will help prioritize ecosystem-based adaptation (EbA) interventions and support their integration into policy and strategic frameworks.

At the national level, a key expectation is to clarify the number of jobs that could be created through nature-based solutions for climate change adaptation.

The process will conclude with the co-development of 4–5 concept notes or intervention frameworks addressing priority climate adaptation challenges based on nature-based solutions in priority geographic and thematic sectors.

Context

New Caledonia is characterized by unique ecological richness, hosting marine and terrestrial ecosystems of exceptional biodiversity and providing essential services for the well-being of its population. However, these natural environments and their fundamental ecological functions are threatened by human activities, invasive species, and increasingly extreme climatic phenomena.

In this context, the ESRAM approach aims to lay the groundwork for sustainable and inclusive adaptation, considering the complex interactions between natural systems and the human communities that depend on them.

Phase 2: Analysis and mapping of ecosystem and socio-economic resilience, and identification of priority options for ecosystem-based adaptation

This report presents the results of work carried out during Phase 2 of the ESRAM process, dedicated to collecting and analysing existing data according to the methodology consolidated in Phase 1, and to engaging public and private stakeholders in New Caledonia in prioritizing EbA across the territory.

Phase 2 aims to provide an analytical framework and decision-support tools for all stakeholders involved in the process, enabling them to define priority intervention areas and identify relevant EbA options for deployment.

This phase focused primarily on analysing and producing maps of ecosystem and socio-economic resilience at the municipal scale across New Caledonia.

In addition, staff from various operational departments of local authorities and their partners were supported through a participatory process to prioritize geographic areas and appropriate EbA solutions.

Technical experts were consulted to contribute to the cost-effectiveness assessment of the 10 prioritized EbA options, particularly regarding financial costs and associated labour inputs, effectiveness of similar projects already implemented in the territory, implementation barriers and enabling factors, monitoring and evaluation mechanisms, and research needs.

Public and private sector stakeholders were also engaged in an independent reflection on barriers and enabling factors for operationalizing and integrating EbA into public policies.

By presenting all these elements, this report aims to provide a solid information base for stakeholders to identify needs and explore prospects for EbA deployment across the territory.

Phase 3 of the ESRAM process will focus on developing ambitious EbA intervention frameworks in the form of structured concept notes for up to five priority thematic or geographic sectors. This participatory and inclusive approach will be conducted in close collaboration with stakeholders concerned by the defined intervention areas.

II. Analysis and mapping of socio-ecological resilience in New Caledonia

Socio-ecological vulnerability results from the exposure and sensitivity of a human community and its environment to disturbances—such as climate hazards or other environmental pressures—and from their varying capacity to cope with or recover from impacts. Adapting a socio-ecological system to climate change involves reducing its vulnerability to the potential impacts of climate change and ecosystem degradation.

Strengthening resilience requires increasing the capacity of ecosystems, populations, and the economy to withstand stressors or to rebuild and recover their previous functioning, identity, and structure if damaged, including through systemic changes that reduce future vulnerability. Management measures that reduce the vulnerability of ecological, social, or economic assets, or that enhance their adaptive capacity, therefore contribute to increasing resilience.

Climate **resilience** in New Caledonia was assessed at the municipal level by characterizing the spatial distribution of exposure and sensitivity of **assets** to **pressures**, as well as the resources allocated to their management. **Risk management** was addressed through the evaluation of the territory's current capacities to respond to hazards to safeguard ecological, health, social, and economic assets. This was measured using indicators related to regulatory, financial, material, and human resources dedicated to managing pressures on natural environments, ecosystem restoration, healthcare structures, operational disaster response, and available equipment to cope with climate hazards.

A. Methodology

1. Standardised analysis of the ecosystem vulnerability and socio-economic issues

The method used to assess the resilience of ecosystems and key socio-economic sectors in New Caledonia applies the recommendations of the Reference Guide on Vulnerability – Concept and Guidelines for Conducting Standardized Vulnerability Analyses (GIZ, 2019). It is based on a pragmatic and scientifically grounded approach to vulnerability analysis and its use for monitoring and evaluating adaptation. This standardized method has been tested at national and sub-national scales, applied to various sectors, and successfully implemented in several countries across Europe, South America, Asia, and Africa.

Climate change vulnerability refers to the cause-and-effect relationships underlying climate change and its impacts on natural environments, people, human activities, and the economic sectors that depend on them. The vulnerability of an ecological or socio-economic system is its propensity to suffer damage, resulting from its sensitivity to pressures (climate hazards and anthropogenic threats) to which it is exposed and from its limited capacity to cope and adapt (IPCC, 2018). The accumulation of pressures is a key driver of ecosystem vulnerability.

Conversely, system resilience refers to its capacity to withstand disturbances or hazardous events, enabling it to reorganize while preserving its essential function, identity, and structure, and maintaining its capacity for evolution and transformation (IPCC, 2018).

Ecosystems possess an intrinsic capacity to adapt to climate hazards within their own physical tolerance thresholds. Management measures aimed at reducing the intensity, frequency, or cumulative effects of ecosystem exposure to pressures enhance adaptive capacity and resilience. Socio-economic adaptive capacity encompasses resources contributing to individual, institutional, and sectoral adaptive capacity.

The main components of resilience—determining the effects of climate change on ecosystems and socio-economic assets—are therefore exposure, sensitivity, and adaptive capacity.

For this study, ecosystem resilience analysis consists of assessing the respective value of these three components for each major ecosystem group and then aggregating them into an overall resilience score.

2. IUCN Red List of Ecosystems Assessment Criteria

By aligning with the framework proposed by the IUCN Red List of Ecosystems (RLE), ecosystem resilience assessment may facilitate the reuse of its results for future RLE assessments in New Caledonia at regional or global scales. This approach contributes to the pooling of evaluation efforts by promoting coherence and interoperability between initiatives.

Ecosystem vulnerability to climate change is shaped by ecological characteristics and by the nature and intensity of pressures acting on ecosystems. By accounting for all drivers of ecosystem degradation—whether natural or anthropogenic, including climate change impacts—the resilience assessment is consistent with the RLE approach and increases the likelihood of success of adaptation solutions developed based on ESRAM results.

The overall approach of this study enables the assessment of a wide range of ecosystems (and socio-economic assets) across New Caledonia, albeit at a relatively coarse resolution. It does not aim to replace an RLE assessment; however, efforts were made to incorporate key elements of the RLE methodological framework while respecting the standardized approach described above. Both methods share the use of conceptual models to clarify cause-and-effect relationships leading to ecosystem degradation, as well as the measurement of relevant indicators to characterize this degradation.

To ensure synergy with the RLE tool, the indicators selected and associated with resilience components were considered according to underlying mechanisms such as loss of area or connectivity, degradation of environmental conditions, associated biodiversity, and ecosystem functioning.

3. General framework for resilience analysis

This analysis aims to characterize the resilience of ecosystems and socio-economic assets in all their diversity across New Caledonia, in the face of climate hazards and anthropogenic threats to which they are currently exposed. The resilience analysis covers the entire territory, using a harmonized municipal-level analytical scale.

The analysis relies on a set of indicators derived exclusively from existing quantitative and qualitative data, either publicly accessible or generously provided by their owners. Georeferenced data or data with spatial distribution information were prioritized.

Some of the data used are confidential; therefore, while all data sources are cited, they are not necessarily illustrated. Only results derived from prior processing are represented cartographically.

Data standardization

Each indicator is expressed in its own measurement unit and spatial-temporal resolution. To ensure comparability, all indicator values were standardised into a common interpretative scale. In this study, the normalization process converted raw indicator values into a standardized score range from 1 to 4, where 1 represents a critical situation, 2 a rather negative situation, 3 a rather positive situation, and 4 an optimal situation.

This transformation follows a conversion rule and applies thresholds defined specifically for each indicator, consistent with the interpretation of its contribution to resilience. Depending on the component considered, a low indicator value reflects high exposure or sensitivity to a pressure, or low adaptive capacity, whereas a high value indicates low exposure or sensitivity, or strong adaptive capacity.

Weighting of indicators

For a given municipality and ecosystem type, the score attributed to each of the three resilience components depends on the score of each indicator composing it. However, indicators may have different levels of influence on a component. For example, the indicators "presence of a marine protected area" and "presence of reef monitoring stations" both contribute to marine ecosystem adaptive capacity, but the former has a stronger influence.

To account for this, a simple weighting system was applied: indicators deemed to have a significant influence on a component received double weight (coefficient 2) compared to other indicators (coefficient 1).

Regarding socio-economic resilience, each asset was weighted according to its relative importance at the municipal scale (for instance, fisheries receive a zero-weighting coefficient in inland municipalities such as Farino and Sarraméa) and according to the priority level assigned to that sector by the relevant provincial authority.

Aggregation of scores

Each resilience component is a composite indicator resulting from the aggregation of its individual indicators. The score for a component (exposure, sensitivity, or adaptive capacity) is calculated as a weighted average: individual indicator scores are multiplied by their respective coefficients, summed, and divided by the total of the coefficients.

Similarly, the scores of each component are then aggregated to obtain an overall resilience score. Following a conservative approach—accounting for uncertainty regarding the effectiveness of adaptation measures—this second level of aggregation was not weighted. Thus, a high adaptive capacity score can only partially offset the combined effects of exposure and sensitivity to climate hazards and other threats.

$$\boldsymbol{Resilience = Hazard + Sensitivity + Adaptive\ Capacity}$$

In the socio-economic resilience analysis, a preliminary step involved measuring vulnerability using the same approach but in reverse: scores from 1 to 4 represent vulnerability from lowest to highest. Results were then inverted to indicate corresponding resilience values according to the following scale:

Vulnerability	Resilience	Threshold
Low	Low	1 to 1.75
Moderate	Moderate	1.75 to 2.5
High	High	2.5 to 3.25
Very High	Very high	3.25 to 4

The diagram below summarizes the steps of the standardized analysis of ecosystem resilience.

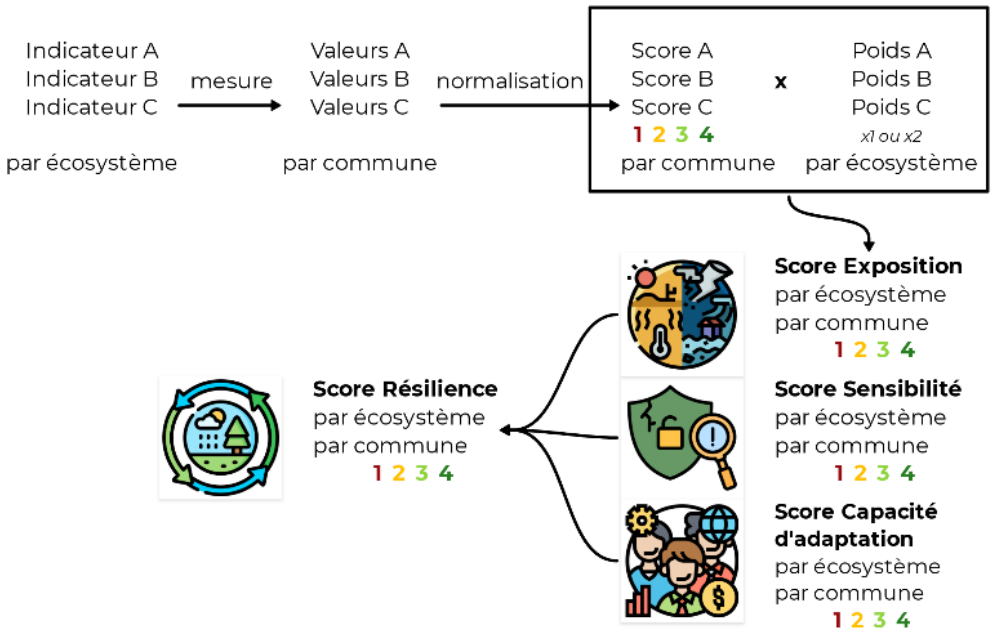


Figure 1 : Summary diagram of the steps for calculating the ecosystem resilience score at the municipal level

4. Methodological limitations

The methodological approach adopted to assess ecological and socio-economic vulnerability in New Caledonia relies on the aggregation of specific indicators, meaning that the resulting scores are representative only of the variables included in the calculation. However, indicators were selected based on data availability and therefore provide only a partial representation of the situation.

As the number of GIS-formatted datasets available was limited, several indicators were examined through the analysis of reports and consultation of maps produced by different institutions in New Caledonia at both provincial and territorial scales. Data availability varies significantly across provinces. The dataset for the Loyalty Islands was particularly limited, making the analysis results for this area highly uncertain.

The inclusion of additional indicators could significantly alter the results and the hierarchy of identified vulnerabilities. Consequently, conclusions should be interpreted regarding the selection of indicators and their ability to capture local dynamics comprehensively.

Furthermore, the data analysed are highly heterogeneous in terms of production date. For example, the most recent agricultural census dates to 2010, whereas data on drinking water supply networks are from 2024. This temporal disparity, while enabling analysis of existing data, raises issues regarding data updating and may provide a slightly biased overall picture.

In addition, the municipal scale chosen for the analysis represents an administrative simplification that does not necessarily reflect ecological and economic realities. Municipal boundaries do not constitute clear discontinuities in vulnerability: a single ecosystem or economic sector may extend across several municipalities with similar or contrasting vulnerability levels. This limitation implies that interpretation of results should be nuanced and complemented by analyses at finer spatial scales where possible.

Another methodological aspect concerns data normalization, which relies on relatively defined thresholds. For example, the threshold of 20% of Utilized Agricultural Area (UAA) used to qualify agricultural pressure as strong is subjective. Although consistent with the local context, this threshold does not rely on universal scientific justification but rather on an empirical differentiation of pressures between municipalities. Similarly, indicator weighting reflects a prioritization of vulnerability drivers but does not imply a strictly proportional relationship between these factors and their actual impacts. Assigning a higher weighting coefficient to mining pressure (×2) compared to urban pressure on forest ecosystems is relevant in the New Caledonian context, but this does not mean that mining impacts are precisely twice as strong as urbanization impacts.

These methodological limitations highlight the importance of cautious interpretation of results and the need for complementary local-scale approaches to refine the understanding of local resilience factors.

5. Data collection

The inventory of available data was carried out through a literature review and a broad outreach campaign targeting public and private organizations likely to hold relevant information in various formats (geospatial data, technical reports, expert knowledge, etc.).

The relative importance of different socio-economic sectors at the provincial level was assessed during a workshop involving departments from the North and South Provinces. The Loyalty Islands Province did not respond to this request. During this exercise, provincial departments were asked to allocate a total of 100 points among sectors to establish a ranking based on their priority level for the community.

Adaptive capacity for each sector was also assessed during these workshops at the provincial scale. Two key elements of sectoral adaptive capacity were estimated by local authority staff: the existence of "safeguards" limiting potential impacts on a sector affected by hazards, and the sector's transformational potential. Participants were therefore encouraged to reflect on the

possibility of fundamentally rethinking certain sectors, including relocation, new objectives, practices, tools, or products.

Due to difficulties in obtaining quantitative data on sectoral sensitivity, an expert-based estimation was adopted. The assessment was conducted at the provincial rather than municipal scale to avoid overburdening experts. Staff from operational departments, technical agencies, and the private sector were invited to assign sensitivity scores for each sector and province using a scale from 1 (low) to 4 (very high). Only sectors related to agriculture, fisheries and aquaculture (CAP-NC), tourism (NCT), drinking water supply networks, food and water security (DAVAR), and public health (DASS) could be assessed; no feedback was received for other sectors.

A field survey was also conducted to evaluate various criteria of individual adaptive capacity. A questionnaire aimed to measure the adaptive capacity of New Caledonians in relation to climate change. The survey was structured into four sections:

1. Respondent profile: general information such as age, gender, occupation, place of residence, education level, and housing type.
2. Access to essential services: assessment of accessibility to key services such as education, healthcare, water, and energy.
3. Dependence on ecosystems: analysis of the role of ecosystems in respondents' livelihoods, particularly regarding food, health, and income-generating activities.
4. Perception and response to climate hazards: understanding experienced climatic events and strategies implemented to cope with them.

Between January and February 2025, 172 individuals across the territory participated in the survey, which specifically targeted potentially vulnerable populations, including women, sexual minorities, persons with disabilities, youth, elderly people, individuals in geographically isolated situations, and the territory's ethnic diversity.

The data collected through literature review and consultations were used to inform the indicators included in the ecological and socio-economic resilience assessment.

B. Analysis and mapping of climate hazards in New Caledonia

The climate hazards identified across New Caledonia were also mapped to locate at-risk areas. The objective is to cross-reference these with the spatial distribution of assets to analyze their exposure to climate change. The hazards selected include heavy rainfall and flooding, coastal submersion, drought, cyclones, terrestrial heatwaves, and marine heatwaves.

The landslide hazard was not included in the study. As landslides are highly localized phenomena, the municipal scale is not well-suited for their analysis. They are most often triggered during heavy rainfall events and can therefore be indirectly captured through the assessment of the heavy rainfall hazard.

1. Heavy rainfall and flooding

The heavy rainfall hazard was analyzed using precipitation values associated with a 10-year return period (24-hour cumulative rainfall) for the period 1981–2010. This dataset, provided by Météo-France, covers the entirety of New Caledonia at a 1 km spatial resolution (SHYREG method). These extreme rainfall events are likely to cause flooding through runoff or river overflow, as well as landslides.

The geographical distribution of rainfall and its extremes is strongly influenced by New Caledonia's topography. The steep eastern mountain range concentrates high rainfall totals, with maxima observed around Mount Panié and Mount Humboldt (light grey in Figure 1). Behind this mountain barrier, the west coast—sheltered from easterly trade winds—receives significantly less rainfall, resulting in less intense and less frequent extreme rainfall events.

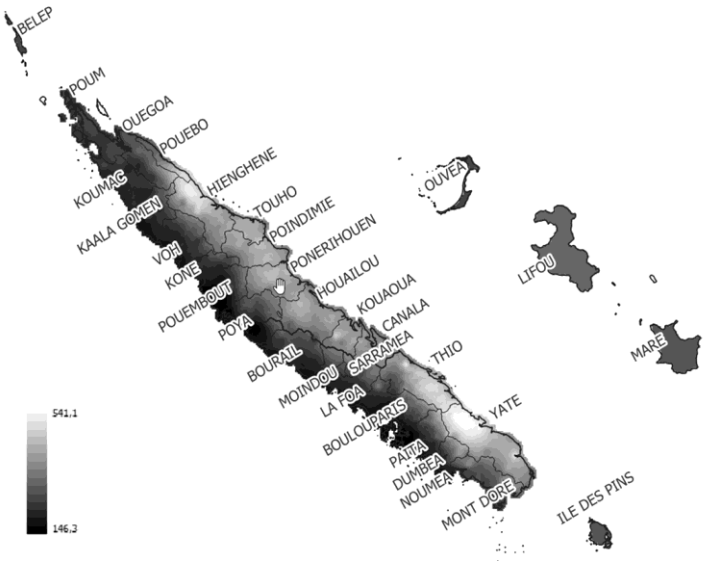


Figure 2: Distribution of extreme rainfall in New Caledonia

A heavy rainfall exposure score ranging from 1 (low) to 4 (high) was assigned to each municipality based on the ten-year rainfall values observed within its territory (relative analysis using a quantile approach). High exposure scores are observed in municipalities along the East Coast and in the southern urban area (Dumbéa, Nouméa, Mont-Dore), while lower exposure scores are characteristic of West Coast municipalities.

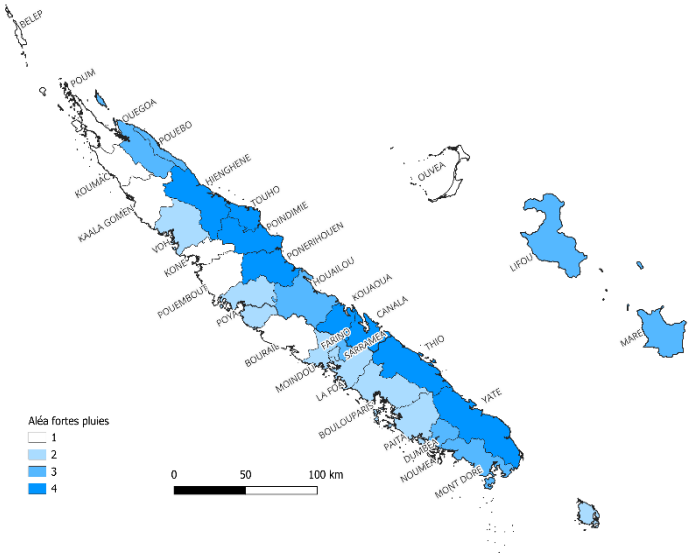


Figure 3: Heavy rain hazard rating

The climate projection data currently available for New Caledonia are of insufficient quality to conduct a reliable assessment of future climate conditions. Nevertheless, the available data provided by Météo-France via the "DRIAS, les futurs du climat" portal were analysed, including a simulation for New Caledonia produced using the Météo-France ALADIN model. Regarding rainfall, only projections of annual precipitation totals are available. Projections of this parameter in the short, medium, and long term under both a moderate greenhouse gas emissions scenario (median) and an unmitigated emissions scenario (pessimistic) are presented in Figure 3. These projections indicate a decrease in precipitation along the East Coast and in the far South of the territory (particularly under the pessimistic scenario), which could lead to reduced extreme rainfall events in these areas. These results will need to be confirmed once data from the CLIPSSA project becomes available.

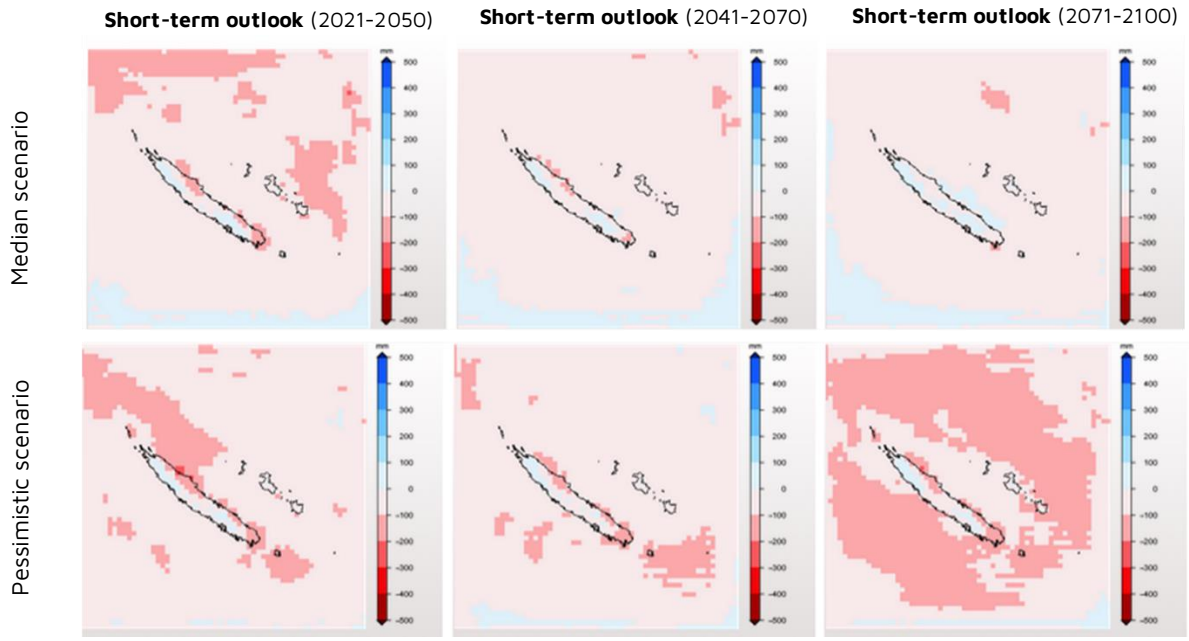


Figure 4: Evolution of precipitation according to a median scenario and a pessimistic scenario, and for 3 horizons (Source: Drais, climate futures)

Flood-prone area data from the Explo Cart'Eau application were also analysed. These data are partial and cover only areas that have benefited from detailed flood risk studies. While highly valuable for fine-scale diagnostics, they cannot be used to estimate exposure levels for all municipalities across the territory.

2. Coastal Submersion

The marine submersion hazard was assessed using data produced by the New Caledonia Geological Survey (SGNC) and BRGM as part of the New Caledonia Coastal Observatory (OBLIC). The indicator used is the percentage of coastline susceptible to marine submersion per municipality (Figure XXX). An exposure score ranging from 1 to 4 was assigned to each municipality according to the following classification method: Level 1: 0–25% of coastline susceptible to submersion; Level 2: 25–50%; Level 3: 50–75%; Level 4: more than 75%.

Based on this scoring, the municipalities of Koumac, Pouébo, Poindimié, and La Foa show level 4 exposure, with more than 75% of their coastlines susceptible to submersion. Koné, Kouaoua, Bélep, Lifou, and Maré present low exposure levels. All other municipalities show intermediate exposure levels between 2 and 3, except Farino and Sarraméa, which are inland and therefore not exposed to marine submersion risk.

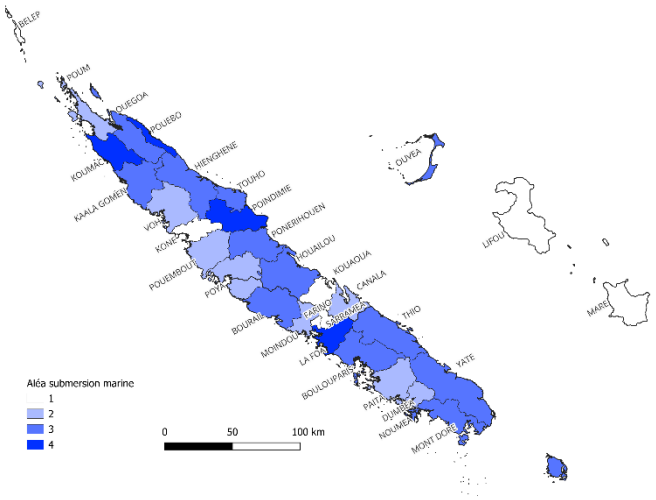


Figure 5: Rating of the marine submersion hazard

Sea-level rise exacerbates marine submersion risk along New Caledonian coastlines. Between 1957 and 2017, sea level locally rose at an average rate of 0.9 mm/year, corresponding to an increase of 5.4 cm over 60 years (Aucan, 2017). Observations in Nouméa indicate acceleration in recent decades, with sea-level rise increasing from 0.5 mm/year (1957–1997) to 1.9 mm/year (1977–2017) and 2–3 mm/year during the past decade. Sea-level rise is expected to continue in the future. IPCC projections for Nouméa indicate an increase of 40–80 cm by 2100 (IPCC AR6).

3. Drought

Droughts were analysed using the Standardised Precipitation Indicator (SPI), the indicator used by Météo-France to characterise meteorological droughts in New Caledonia (WMO[1]). This indicator can be calculated at different temporal scales: SPI values over 3 months or less are useful for routine drought monitoring, SPI values over 6 months are relevant for agricultural impacts, and SPI values over 12 months or more help detect hydrological impacts. In this study, a 6-month accumulation period was used.

[1] Manual on Drought Indicators and Indices – WMO-No. 1173; the SPI is zero for a median precipitation amount (relative to a reference mean climatology calculated over 30 years), negative for drought conditions, and positive for wet conditions.

McKee et al. (1993) defined SPI thresholds to classify drought severity. This study focused on SPI values below –1.5, corresponding to severe to extreme droughts.

An exposure score from 1 (low) to 4 (high) was assigned to each municipality based on drought occurrence measured at the meteorological station representative of the municipality over the period 1991–2020 (relative analysis using a quantile approach).

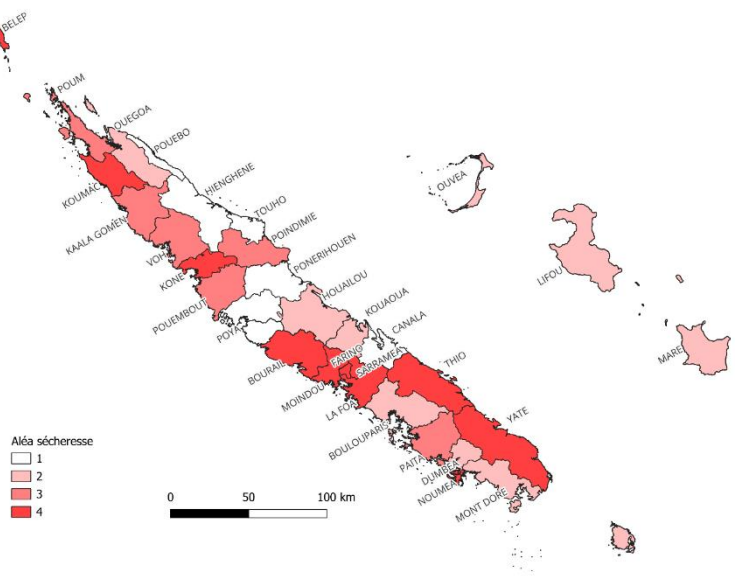


Figure 6: Drought hazard rating

Higher exposure is observed in municipalities of the South Province, with Bourail, Moindou, La Foa, Farino, Sarraméa, Thio, Yaté, and Nouméa showing level 4 exposure. In the North Province, Koumac, Koné, and Bélep are the most exposed municipalities. In contrast, municipalities in the Loyalty Islands exhibit moderate exposure levels.

Currently, no high-resolution climate projection data are available to assess future drought evolution at the municipal level.

4. Heat waves

To assess heatwaves, the Heatwave Frequency (HWF) indicator provided by Météo-France New Caledonia was used. This indicator was available from four meteorological stations: Koumac, Nouméa, Houaïlou P., and Ouanaham. An exposure score for the heatwave hazard was determined based on the frequency of heatwaves (Table 1).

Table 1: Number of heatwave days measured on average over the period 1981-2020 and associated score

Weather stations	Frequency of heat waves	Exposure Score
Koumac	19 days/year	2
Noumea	15 days/year	1
Houailou P.	26 days/year	4
Ouanaham	16 days/year	1

Heatwave risk mapping (Figure 7) was carried out by assigning the score of each meteorological station to all municipalities located within the corresponding climatic zone (personal communication, Météo-France NC). However, these four stations do not cover the entire territory. As a result, exposure to the heatwave hazard could not be assessed for 12 municipalities (see grey area – Figure 7).

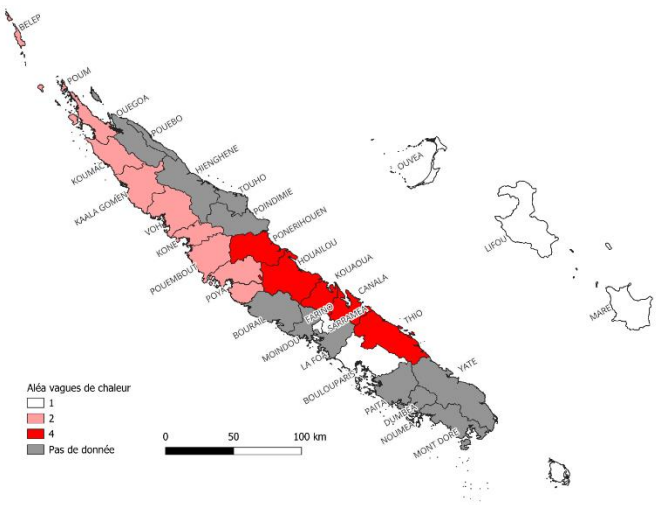


Figure 7: Heatwave hazard rating

Based on the available data from these four stations, the municipalities along the East Coast (Ponérihouen, Houaïlou, Kouaoua, Canala, and Thio), associated with the Houaïlou station, exhibit the highest exposure level. Municipalities located along the West Coast of the North Province, the Loyalty Islands, and the municipalities of Boulouparis, Nouméa, Sarraméa, and Île des Pins are less exposed to this hazard.

As with the analysis of extreme precipitation, projections of maximum temperature evolution provided by Météo-France through the "DRIAS, les futurs du climat" portal were also examined. The results indicate that maximum temperatures are expected to increase significantly in the future, particularly under the pessimistic scenario over the long term. The areas most affected by this rise in maximum temperatures are located inland. This temperature increase is likely to result in a substantial rise in both the frequency and duration of heatwaves across the territory (Dutheil, 2018).

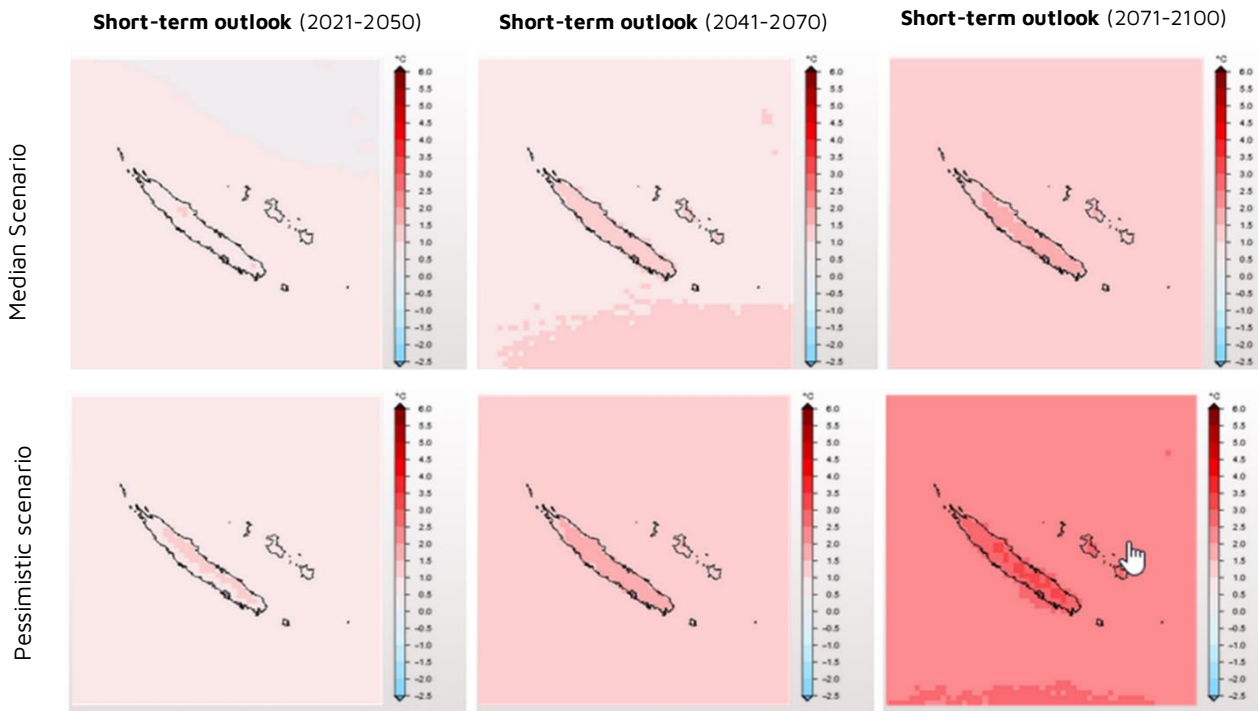


Figure 8 : Evolution of maximum temperatures according to the Aladdin model of Météo-France (source: DRIAS, the future of the climate)

5. Wildfires

The wildfire hazard analysis was based on burned-area data collected from the public Vulcain tool of OEIL (derived from Sentinel-2 imagery analysed between 2017 and 2020). This database provides homogeneous fire information across the territory over several years, allowing exceptional events and cyclical variations in fire-favourable conditions to be smoothed. Although imperfect (fires below a minimum detectable size, depending on substrate, may be missed, and detection is impossible under cloud cover), it remains the most representative dataset of the spatial distribution of wildfires across the territory.

Exposure to this hazard is classified as very high across most of the territory. The municipalities least affected include Nouméa, as well as Ouvéa, Lifou, Île des Pins, Bélep, and on Grande Terre the municipalities of Dumbéa, Yaté, Farino, and Sarraméa.

Regarding future climate change, a global temperature increase of +4°C could lead to an increase of nearly 30% in forest fires in the Oceania region (Altman et al., 2024). However, high-resolution climate projections are not currently available to assess the evolution of wildfire hazard at the municipal scale in New Caledonia.

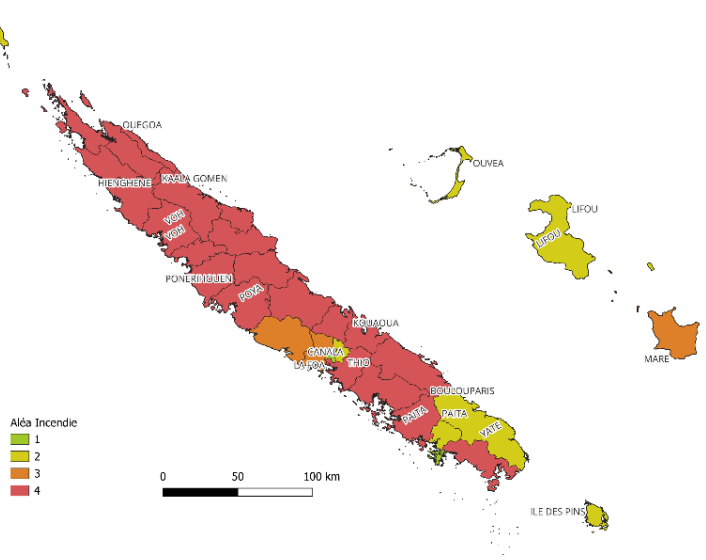


Figure 9: Fire hazard rating

6. Cyclones

New Caledonia is regularly affected by depressions of varying intensity and severity. Cyclone risk in New Caledonia is considered high according to the Think Hazard tool (GFDRR, World Bank). Based on available data, the probability of strong winds capable of causing damage within the next ten years is estimated to exceed 20%. This risk level is considered homogeneous across all municipalities of New Caledonia.

Regarding climate change, simulations from the IPCC Sixth Assessment Report (AR6) indicate that cyclone intensity is likely to increase. Average cyclone intensity is projected to rise by 5%, while the proportion of very intense cyclones (categories 4 and 5 relatives to total cyclones) could increase by 14%. Cyclonic rainfall is also expected to increase, with a robust trend of approximately 12% for 2 °C of global warming. Furthermore, sea-level rise will increase flood risk associated with tropical cyclones (Météo-France, Cyclones and climate change, 2024). These projections remain subject to significant uncertainty.

7. Marine Heatwaves

In 2016, the Southwest Pacific experienced an unprecedented marine heatwave resulting from the simultaneous occurrence of two major climate phenomena: El Niño and the negative phase of the Madden-Julian Oscillation. This exceptional situation caused abnormal warming of ocean surface waters (30–50 m depth), which remained at record levels throughout February 2016. Ecological consequences were severe: coral bleaching in New Caledonia and mass fish mortality in Vanuatu and Fiji.

According to several studies, the frequency and intensity of marine heatwaves are likely to increase during the 21st century. CMIP5 climate projections indicate a significant increase in both the intensity and the annual number of marine heatwave days. This increase is expected to accelerate, with many ocean regions reaching a near-permanent marine heatwave state by the end of the century (Oliver et al., 2019).

New Caledonia is not expected to be spared (Figure 10). While current observations indicate a relatively limited number of marine heatwave days (around 30 days per year, corresponding to moderate exposure), projections suggest that this could increase to more than 250 days per year by mid-century, representing high exposure.

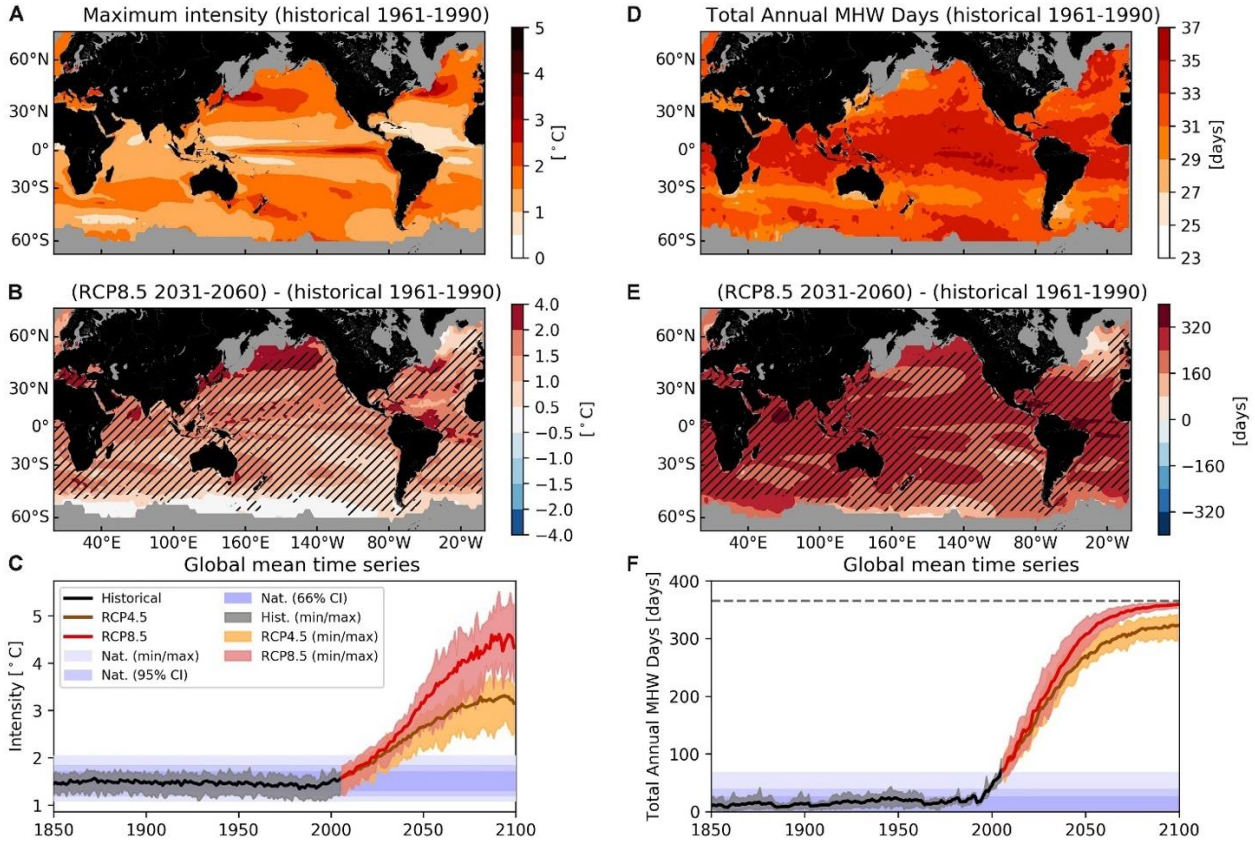


Figure 10: A, D) Multi-model mean properties derived from historical series for the period 1961–1990; (B, E) Change between the RCP8.5 simulation (average for 2031–2060) and the historical simulation (average for 1961–1990). Hatching indicates that all models agree on the direction of change. (C, D) Annual time series for the historical period (black), RCP4.5 (brown), and RCP8.5 (red). (Source: Oliver et al., 2019)

C. Analysis and mapping of the resilience of New Caledonia's ecosystems

1. New Caledonia's ecosystems

The resilience analysis of New Caledonian ecosystems covers four major ecosystem groups, comprising nearly twenty distinct ecosystems associated with functional groups referenced in the IUCN Global Ecosystem Typology. To facilitate potential future use of this analysis, each ecosystem has been named in French using a common or easily understandable designation and linked to the hierarchical code and English reference typology of the corresponding IUCN classification.

For each of the four ecosystem groups, the report presents a description of their ecological characteristics, the main ecosystem services they provide, and the key pressures (climatic hazards and anthropogenic threats) to which they are exposed.

A conceptual diagram synthesizes, at the ecosystem group level, simplified cause–effect relationships between pressures acting on ecosystems and the degradation of the ecosystem services they provide, along with potential consequences for human well-being and community functioning. This diagram highlights key mechanisms involved at the scale of the ecosystem. It identifies potential vulnerability drivers but does not indicate impact intensity or the relative importance of pressures, which are detailed through the selection, measurement, and weighting of resilience indicators described in the following section.

a. Forest ecosystems

i. Montane/Highland forests - *T1.3 Tropical/Subtropical montane rainforests*

The montane forests, also known as mountain forests or cloud forests of New Caledonia, are humid subtropical forests whose development is closely linked to conditions favourable to cloud formation. These conditions are generally encountered above 900 m elevation, though in some cases they may occur from 500 m. These forests occur on both volcano-sedimentary substrates and ultramafic substrates rich in heavy metals (nickel, manganese, and chromium).

Altitudinal gradients in temperature, precipitation, wind exposure, and UV-B radiation strongly shape the structure and functioning of these ecosystems. Landslides represent an important disturbance on steep slopes, intensified by extreme rainfall. Successional dynamics are influenced by gap phases caused mainly by tree falls, landslides, or extreme cyclone winds.

In New Caledonia, montane forests often feature a canopy dominated by gymnosperms forming emergent clusters that enhance fog interception. Forest structure and taxonomic diversity decline with altitude, and trees may exhibit dwarf forms. Despite abundant rainfall, productivity is limited by cool temperatures, wind exposure, and sometimes shallow soils. Beneath the canopy, a humid and shaded microclimate provides stable habitat for unique fauna and flora with high species richness and micro-endemism.

Tree branches are covered with epiphytes such as ferns, bryophytes, lichens, orchids, and bromeliads that exploit ambient moisture. Clouds frequently contact vegetation, allowing water to accumulate on leaves and stems and drip to the forest floor—a phenomenon known as occult precipitation or cloud stripping. Montane forests are estimated to capture about 40% additional moisture, even without rainfall. Slow tree growth means most of this water reaches streams, making cloud forests significant contributors to the water supply.

Climate change may raise cloud base altitude, reducing cloud forest extent, which is constrained by the relatively modest elevation of New Caledonian peaks. This reduction could impact streamflow, particularly during the dry season.

Mining is the main direct threat to montane forests on ultramafic substrates. The vegetation of many mining massifs has already been degraded or destroyed by deforestation for nickel extraction. One third of the 981 plant taxa of montane forests and shrublands assessed in New Caledonia are listed on the IUCN Red List (CR, EN, or VU).

Invasive animal species such as rats, feral dogs, and cats threaten endemic fauna, particularly birds and reptiles. Invasive ungulates, including deer and feral pigs, damage woody regeneration. Trampling and soil disturbance can increase erosion and generate sediment loads downstream.

ii. Humid, Riparian and mesophilous forests - *T1.1 Tropical/Subtropical lowland rainforests*

Located mainly along the Central Range, on the East Coast of Grande Terre, as well as on Île des Pins and the Loyalty Islands, the humid forests of New Caledonia develop in areas receiving abundant rainfall, often exceeding 2,000 mm per year. Precipitation exceeds evapotranspiration, with low intra- and interannual variability, creating a reliable water surplus throughout the year, while closed canopies maintain a humid and shaded microclimate. Temperatures are relatively warm, with low to moderate diurnal and seasonal variation. Soils are moist but not peat-forming. Most nutrient capital is stored in vegetation or recycled through a dynamic litter layer that is essential for nutrient retention, which would otherwise be leached or lost through runoff.

These closed-canopy, multilayered forests, sometimes referred to as "primary forests," possess complex structure and high primary productivity, supporting substantial biomass and high functional and taxonomic diversity.

More than 2,000 vascular plant species have been recorded in New Caledonian humid forests, over 82% of which are endemic. Iconic species such as Amborella trichopoda, considered the most ancient evolutionary lineage of flowering plants, highlight the antiquity and uniqueness of these ecosystems. The diversity of plant life forms includes buttressed trees, bamboos, palms, epiphytes, lianas, and ferns. Leaf-size variation reflects rapid growth and turnover.

Many plants grow in the shade of the canopy. The understory forms seedling banks that take advantage of gap dynamics caused by tree falls or canopy disturbance from tropical storms. Some species germinate on tree trunks, accessing canopy light more rapidly, while their roots absorb microclimatic moisture until reaching the ground.

These forests also host remarkable fauna, including endemic bird species such as the kagu (Rhynochetos jubatus) and various giant geckos. Bats and birds play essential roles in seed dispersal and pollination. Fungi, microbes, and numerous decomposer and detritivore invertebrates dominate forest soils and subsoils.

Humid forests of New Caledonia play a major role in regulating hydrological cycles, stabilizing soils, and maintaining air quality—ecosystem services essential to human communities. They contribute to local climate regulation, water purification, erosion control, and carbon sequestration.

For Kanak communities, these forests provide food, construction materials, and medicinal plants, and hold central cultural significance. The forest is perceived not only as a material resource but also as a sacred space imbued with memory and spirituality. It is a place of ritual practices, knowledge transmission, and social cohesion, forming a cornerstone of cultural identity and well-being.

However, New Caledonian forests face strong pressures. It is estimated that two-thirds have already been destroyed, mainly due to mining, agriculture, and urbanization. Mesophilous forests, located at the lower end of the altitudinal and rainfall gradient within the forest continuum (transition between dry and humid forest) and thus more accessible to human communities, are the most degraded due to land clearing for agriculture and urban expansion. More than 37% of the 1,250 humid forest plant taxa assessed in New Caledonia are listed on the IUCN Red List of threatened species.

Anthropogenic wildfires represent a major threat, destroying approximately 20,000 hectares of vegetation annually, or more than 1% of the territory. Fires, typically originating in savanna areas, spread to forest edges and compromise natural regeneration.

In addition, invasive alien species disrupt ecological balance. The rusa deer (Rusa timorensis) and feral pig (Sus scrofa), introduced by humans, cause extensive damage through trampling vegetation, consuming seedlings, destroying understory vegetation, disturbing soils, and sometimes destroying ground-nesting bird nests. These animals hinder forest regeneration and significantly degrade ecosystem services.

The Caribbean pine (Pinus caribaea), introduced in the 1960s for economic afforestation projects, rapidly colonizes forest edges and burned shrublands, forming dense stands that outcompete native vegetation. Its needles, rich in flammable compounds, promote fire spread, creating a feedback loop that perpetuates degradation and the retreat of humid and mesophilous forests.

Among climate change impacts, increasing frequency and duration of droughts are expected to heighten fire risk and threaten species sensitive to microclimatic conditions that may be radically altered.

Unfavourable climate trends, recurrent fires, and invasive species thus represent a cumulative set of pressures on forests and tend to reinforce each other, undermining natural regeneration and intensifying forest ecosystem degradation.

iii. Dry Forests - *T1.2 Tropical/Subtropical dry forests and thickets*

In New Caledonia, sclerophyll forest—more commonly referred to as dry forest—is a rare and extremely threatened ecosystem characterized by biodiversity adapted to low rainfall and prolonged drought conditions typical of the West Coast. Soils, often poor and well-drained, favour drought-adapted vegetation.

The flora is dominated by evergreen species with tough, leathery leaves and generally low canopy height. Among the 876 native plant species recorded in sclerophyll habitats, nearly 60% are endemic to New Caledonia. Certain species, such as Araucaria rulei and Pittosporum tanianum, are strictly confined to this habitat. Fauna includes a variety of reptiles, insects, and birds, several of which are endemic and threatened.

Fungi and other microbes play key roles as decomposers of the abundant leaf litter, and nitrogen-fixing plants may be common. Most nutrient capital is stored in vegetation or recycled through the litter layer.

Many woody plants are wind-dispersed, while others are dispersed by vertebrates, allowing recruitment in shaded microsites. Trees generally have thin bark and low fire tolerance.

Although dry forests once covered most low-altitude areas (excluding ultramafic soils) under dry climatic conditions (below 500 m elevation and with annual rainfall under 1,100 mm), this ecosystem is now highly fragmented and occupies only about 3% of its original extent, approximately 175 km², as remnant patches. Furthermore, half of the 139 dry forest plant taxa assessed in New Caledonia are listed on the IUCN Red List of threatened species: 25 Critically Endangered (CR), 28 Endangered (EN), and 17 Vulnerable (VU).

This decline results from the combination of multiple pressures acting on this fragile ecosystem. Agricultural expansion and urbanization along the West Coast have driven large-scale clearing of dry forest. Wildfires also regularly contribute to the gradual destruction of sclerophyll vegetation, which is highly flammable and particularly vulnerable due to its proximity to savannas with high fuel loads.

Invasive animal and plant species further reduce regeneration capacity, primarily through grazing, predation, and competition.

iv. Synthesis of forest ecosystem degradation mechanisms

The diagram below summarizes the main pressures affecting forest ecosystems in New Caledonia and the potential consequences of their degradation for human well-being.

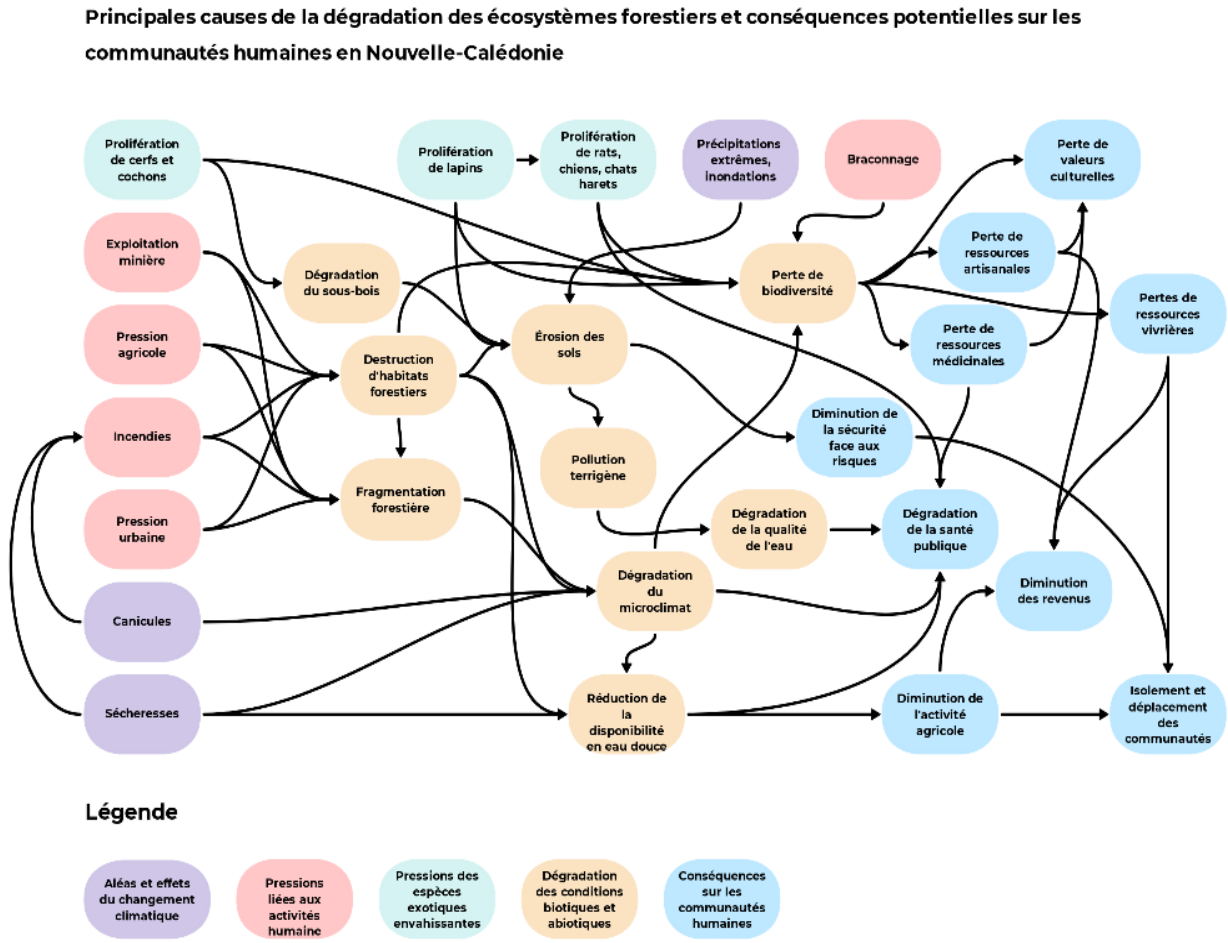


Figure 11 : Conceptual Diagram of the Mechanisms of Degradation of New Caledonia's Forest Ecosystems and Loss of Associated Ecosystem Services

b. Secondary and anthropogenic terrestrial ecosystems

i. Maquis – *T3.1 Seasonally dry tropical shrublands*

The so-called "mining maquis" of New Caledonia are shrubland formations or open low forests composed mainly of shrubs and small woody plants that thrive under direct sunlight exposure. Some areas may be dominated by a sparse layer of endemic conifers, such as columnar pines and certain kauri species. Recurrent fires (occurring on decadal or longer cycles) contribute to the downward regulation of vegetation structure and composition.

These distinctive ecosystems have developed on ultramafic soils rich in metals (nickel, chromium, cobalt) and magnesium but poor in essential nutrients such as phosphorus, potassium, and calcium, resulting in strong nutrient imbalance. Maquis plants have evolved a variety of adaptive mechanisms to survive under these harsh conditions, including tolerance to high concentrations of heavy metals. Thick, glossy, leathery leaves and invaginated stomata reduce water loss and enable vegetation to withstand severe seasonal droughts and moderate recurrence of dry-season fires. Clustered root systems, carnivorous plant structures, and microbial and fungal root mutualisms (mycorrhizae) enhance nutrient capture and retention. Nectarivorous and insectivorous birds and reptiles dominate the vertebrate fauna.

The biodiversity of mining maquis ecosystems is characterized by very high levels of endemism, representing a major asset for resilience to disturbances. Maquis vegetation contributes to regulating hydrological regimes and preventing soil erosion.

Across the territory, mining maquis are subject to several anthropogenic pressures. Mining activities represent a major threat, causing vegetation destruction and soil disturbance. Repeated fires at excessively high frequency further degrade these ecosystems by disrupting vegetation structure and worsening already nutrient-poor soil conditions. The proliferation of invasive alien species, such as the Caribbean pine and deer, threatens maquis flora by altering local ecological dynamics, including through the amplification of fire regimes and erosion processes.

ii. Savannah and shrub thickets – *T4.2 Pyric tussock savannas*

Savannas in New Caledonia, particularly niaouli savannas, are characteristic ecosystems of the West Coast and the northern part of Grande Terre. They primarily result from the degradation of original forests under anthropogenic pressures such as land clearing, repeated fires, and grazing. They develop mainly in areas with rainfall deficits.

Savannas form open landscapes dotted with scattered trees and shrubs within a dominant herbaceous layer, sometimes invaded by dense monospecific thickets of invasive alien species (lantana, sensitive plant, cassia, etc.). They are dominated by tussock grasses (such as sorghum) that grow tall during humid summers and dry out during dry winters. Plant traits such as deciduous leaves and deep root systems enhance tolerance to seasonal drought and enable rapid resource exploitation.

Under grazing conditions, floristic composition is dominated by grasses but may also include legumes and other herbaceous plants. Plant diversity is essential for maintaining productivity and resilience of cattle ranching by providing balanced forage and contributing to soil fertility. However, invasive species can alter plant composition and reduce forage quality.

In savannas, recurrent fires are the primary factor limiting tree dominance and maintaining tree–grass coexistence. The herbaceous layer forms highly flammable biomass. Cattle grazing and deer proliferation also help maintain this balance by hindering forest regeneration and favouring less palatable species. Woody savanna plants are shade-intolerant during establishment and develop fire-resistant traits (thick bark, underground buds, etc.). Localized fires promote vegetation heterogeneity at the landscape scale, particularly in tree cover, and maintain dominance of flammable grasses.

Savannas influence hydrological regulation and erosion processes. When located upstream of forested areas, they tend to increase soil water saturation, enhancing surface runoff and erosion risks. This is exacerbated by invasive ungulates (deer and pigs), which disturb soil structure and promote subsurface flow exfiltration, contributing to erosion and increased flood discharge.

Savannas mainly provide provisioning ecosystem services. They are key areas for cattle ranching, an emblematic agricultural activity of New Caledonia's West Coast. They are also frequented for deer hunting for subsistence and informal markets. Niaouli is harvested for its medicinal and aromatic properties, particularly for essential oil production. In Kanak culture, the collection of straw, niaouli bark, and gaiac wood is common for building huts, traditional houses, or temporary shelters. Gaiac posts are an important resource for durable fencing, especially in agricultural areas. Shaped in part by these uses, savanna landscapes hold strong aesthetic and cultural value in New Caledonia.

As ecosystems derived from forest degradation and adapted to specific pressure factors, savannas are relatively less affected by other pressures impacting natural habitats. However, overgrazing can lead to soil degradation and loss of vegetation cover, triggering erosion processes. Deer also disrupts ecological balance by competing with livestock for food resources.

Under climate change, the projected increase in wildfire frequency—driven by prolonged drought following intense rainfall that promotes combustible biomass production—may reduce savanna species' regeneration capacity and lead to soil impoverishment, structural degradation, and increased erosion.

iii. Agroecosystems – *T7.1 Annual croplands*

Agricultural ecosystems in New Caledonia, formed through the modification of natural habitats by human activity, underpin local food production. New Caledonian farming systems are established on soils with diverse characteristics, ranging from fertile coastal plains to more arid inland areas, generally sharing good accessibility and/or terrain suitable for mechanization.

Natural water availability from seasonal rainfall and periodic flooding is often supplemented by human inputs such as irrigation and landscape drainage modifications (earthworks, river diversions, etc.). Similarly, nutrient availability in fertile soils is commonly enhanced through the application of chemical or organic fertilizers. Artificial disturbance regimes, such as annual

ploughing, maintain soil turnover, aeration, nutrient release, and relatively low organic carbon content.

The structure and composition of plant communities are maintained through sowing or controlled reproduction of target species and typically through periodic application of herbicides and pesticides, as well as land clearing and soil cultivation, to exclude non-target organisms such as weeds, pests, and pathogens. This results in a wide range of practices and production systems, from subsistence agriculture—generally characterized by diversified crops on small plots—to commercial agriculture, often highly artificialized through mechanization and automated irrigation, facilitating large-scale monoculture.

Compared with the ecosystems that previously occupied these areas, croplands are structurally simple, display low biodiversity, and are largely devoid of endemism. Subsistence croplands, including shifting cultivation systems, are generally more diverse than industrial croplands. Productivity largely depends on resource availability and on the capacity of cultivated varieties to capture resources or tolerate harsh environmental conditions, predators, and diseases.

Agroecosystems provide a range of ecosystem services essential to local populations. They ensure food production, contributing to territorial food security. Depending on farming practices, croplands may exert positive or negative—and more or less significant—effects on hydrological regulation and soil erosion.

Biodiversity within agroecosystems is crucial for maintaining productivity and resilience to disease and climatic variability. Agroecological infrastructures, such as hedgerows and grass strips, promote beneficial species that support pollination and biological pest control. The intentional planting of trees through agroforestry practices, or the conservation and restoration of forest corridors, can help replicate natural ecological cycles, improving soil fertility and water management.

Cultivated species coexist with local fauna and flora, some of which exploit production ecosystems opportunistically through efficient dispersal, mobile foraging strategies, rapid establishment, high fecundity, and fast population turnover.

Across the territory, agroecosystems face several challenges. Land degradation—manifested through significant erosion, declining soil fertility, biodiversity loss, and reduced soil porosity—threatens agricultural sustainability. Monoculture systems promote the spread of plant diseases and pests, including invasive species, affecting yields and potentially impacting local biodiversity. Climate change exacerbates these issues by altering precipitation regimes and increasing the frequency of extreme climatic events.

iv. Forestry plantations – *T7.3 Plantations*

Forestry plantations in New Caledonia, primarily composed of Caribbean pine (Pinus caribaea), were established from the 1960s onward to develop a local timber sector. These plantations aimed to meet demand for construction and industrial timber while contributing to the reforestation of degraded areas.

Pinus caribaea, native to Central America, was introduced for its rapid growth and its ability to adapt to poor soils and local climatic conditions. Plantations are generally monospecific and cover approximately 9,200 hectares, representing 0.4% of the territory. The Tango Plateau in northern Grande Terre is one of the main plantation areas, with about 4,500 hectares planted between 1975 and 1984.

These plantations were established on degraded lands, particularly savannas and mining maquis, where native species struggled to regenerate. Pinus caribaea has shown good resistance to fire and drought, making it an economically suitable resource under local conditions.

Caribbean pine plantations contribute to the production of timber used in construction, carpentry, and pallet manufacturing. Although modest, the forestry sector represents a growing share of the local economy.

These plantations also contribute to carbon sequestration, thereby supporting climate change mitigation. In addition, they can stabilize soils and reduce erosion in degraded areas.

However, Pinus caribaea plantations present several ecological drawbacks. The species is considered invasive in New Caledonia: its monospecific nature limits biodiversity and can disrupt local ecosystems. Its ability to rapidly colonize mining maquis and savannas, particularly after fires, hinders the regeneration of endemic species. Pine needles form a dense ground layer that inhibits germination of native plants. The dense root system also competes strongly for water resources, to the detriment of local species. Moreover, the presence of this fire-resistant species may increase wildfire risk due to the high flammability of its needles.

Regulations and operational initiatives have been implemented to control the spread of this species. For example, since 2002 the South Province has prohibited its introduction into natural environments without authorization, and the North Province supports ecological forest restoration projects that include Pinus removal operations. Efforts are also underway to diversify plantations by introducing native species such as kaori or sandalwood, to preserve biodiversity and meet local cultural needs. Economic afforestation programs incorporating endemic species are supported by provincial initiatives, such as the public–private company SAEM "Sud Forêt" in the South Province.

v. Urban vegetation – *T7.4 Urban and industrial ecosystems*

Urban vegetation forms complex and highly heterogeneous landscape mosaics at small spatial scales, consisting of tree-covered and/or grassed areas (parks, vegetated streets and roundabouts, public and private gardens), bare soils, and above-ground vegetation embedded within an artificialized environment of buildings, paved surfaces, transport infrastructure, and waste areas. Some of these formations result from the management of partially preserved relic ecosystems, such as dry forest remnants within Ouen Toro Park and the Montravel hill in Nouméa. These mosaics of parcels are temporally dynamic and largely influenced by socio-economic factors.

Interactions between parcel types and human social behaviours generate complex feedback among system components and interactions with other ecosystem types. Land use and vegetation cover, biodiversity, hydrology, and climate are deeply modified by resource consumption, altered flows (soil sealing, drainage systems, etc.), and waste discharge. Energy, water, and nutrient sources in urban ecosystems are largely derived from external inputs.

Urban community structure is characterized by low functional and taxonomic diversity and residual local endemism. Urban biota include humans, dependent species (pets, cultivated plants), opportunistic species, and transient organisms. Species thriving in artificial environments typically exhibit broad dispersal capacity, high fecundity, and short generation times. Persistence of dependent species is maintained through human management of migration, reproduction, temperature, and essential resources such as nutrients and water. Pest species are controlled through herbicides, pesticides, or removal, which may produce collateral effects on non-target species.

In New Caledonia, urban vegetation comprises both native and exotic species selected for their adaptability to artificial conditions and local climate. These green spaces contribute to urban microclimate regulation by providing shade, reducing heat island effects, regulating humidity and air circulation, and improving air quality through atmospheric pollutant capture. They also support biodiversity by providing habitats for various animal species, including birds and pollinating insects.

Urban green spaces serve as areas for relaxation, recreation, education, awareness-raising, and social interaction, contributing to the physical and mental well-being of urban residents. By improving air quality and reducing noise pollution, urban vegetation helps create a healthier living environment.

Human governance systems influence the import and availability of water, nutrients, and energy. Artificial lighting increases night-time illumination, while outdoor temperatures are elevated by heat production (including cooling of indoor spaces) and by solar energy absorption by built and paved surfaces. Soil sealing promotes surface runoff and reduces infiltration.

Pollution, excessive trampling, and the introduction of invasive species threaten the health and diversity of urban flora, including endemic species targeted by conservation efforts. Local biodiversity, as well as fauna and flora in nearby natural ecosystems, may be affected by chemical and particulate air pollution, light pollution, and noise pollution. Increasing urbanization exerts significant pressure on green spaces, favouring the expansion of infrastructure and residential areas.

vi. Synthesis of degradation mechanisms affecting secondary and anthropogenic terrestrial ecosystems

The diagram below summarizes the main pressures affecting secondary and anthropogenic terrestrial ecosystems in New Caledonia and the potential consequences of their degradation for human well-being.

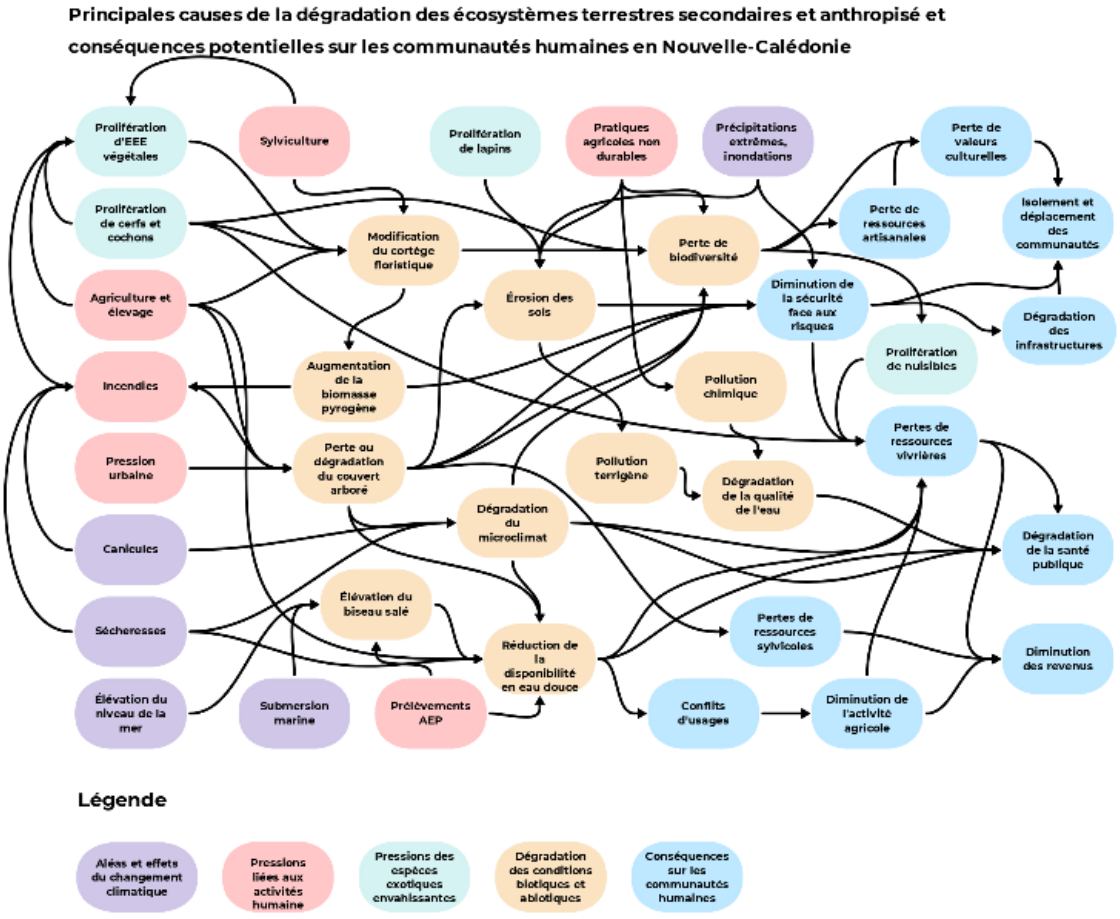


Figure 12 : Conceptual Diagram of the Mechanisms of Degradation of Secondary and Anthropogenic Terrestrial Ecosystems of New Caledonia and Loss of Associated Ecosystem Services

c. *Freshwater ecosystems*

i. Alluvial wetlands – *TF1.4 Seasonal floodplain marshes*

Located in the South Province, the Grand Sud Lakes region covers approximately 44,000 hectares and constitutes the largest wetland complex in New Caledonia. It encompasses a diversity of environments, including permanent and seasonal lakes, marshes, rivers, and streams, supported by a unique underground hydrological network.

Dolines—water-filled karst depressions formed naturally or resulting from mining activity on ultramafic substrates—are characteristic of this region. More than 8,600 of these distinctive "water holes" have been recorded in the Grand Sud area. Dolines typically contain acidic, weakly mineralized, and low-turbidity waters, creating conditions favourable for specialized species.

Regular seasonal flooding and drying cycles are driven by river flow regimes reflecting seasonal precipitation. During dry phases, obligate aquatic organisms are confined to moist refuges, while some invertebrates persist through dormancy traits. High abundance and diversity of invertebrates, waterbirds, and reptiles exploit resource availability, particularly when prey becomes concentrated during flood recession phases.

These unique abiotic conditions support exceptional aquatic biodiversity with a high proportion of endemic species. Galaxias neocaledonicus, a small fish relic from Gondwanan fauna found in two lakes of the Plaine des Lacs wetland complex, is classified as Critically Endangered (CR) by the IUCN. Several rare, sometimes micro-endemic species of crustaceans, gastropods, and insects have also been recorded in these still understudied habitats.

In terms of ecosystem services, the complex hydrological system of this wetland network provides natural flow regulation, reducing flood and drought risks. Wetlands contribute to flood mitigation, groundwater recharge, and water purification. These ecosystems also supply drinking water and provide food and artisanal resources to local communities, while holding significant cultural and spiritual value for Kanak populations.

Under climate change, alterations in precipitation regimes are expected to increase the vulnerability of these ecosystems. Alluvial wetlands in New Caledonia face several pressures. In the Grand Sud, mining activities cause habitat degradation and terrigenous water pollution. Anthropogenic wildfires disrupt hydrological regimes and promote erosion, increasing sedimentation in freshwater ecosystems.

The proliferation of aquatic invasive alien species, including several predatory fish introduced for recreational fishing, also threatens endemic biodiversity in certain lakes.

ii. Rivers and streams – *F1.1 Permanent upland streams*

New Caledonian rivers display considerable variability depending on their location. Those on the east coast, often confined and fast-flowing, contrast with the slower and more sinuous watercourses of the west coast. This diversity reflects the geomorphological contrasts of the Grande Terre.

Aquatic biodiversity is remarkable, with high levels of endemism, particularly among aquatic insects (75%) and riparian plants (55%). Endemism rates for freshwater fish and crustaceans in southern rivers on ultramafic substrates are the highest in New Caledonia, due to elevated heavy metal concentrations and low calcium levels in the water. Rivers also provide essential ecological connectivity, enabling the migration of many amphihaline fish species that require movement between freshwater and marine environments to complete their life cycles, such as the black mullet.

These ecosystems deliver numerous services, including the provision of drinking water and support for economic activities such as agriculture, artisanal fishing, and nature-based tourism. Rivers also contribute to local climate regulation, groundwater recharge, and the maintenance of coastal water quality by retaining sediments and nutrients.

They also hold strong cultural and spiritual significance for Kanak communities, for whom water resource management has long been central to daily life—both practically (notably for irrigated taro cultivation) and symbolically, culturally, historically, and socially, as it played a role in hierarchical power structures in pre-colonial society (Lejars et al., 2019).

New Caledonia's rivers face multiple anthropogenic pressures. Mining activities increase soil erosion and transport sediment loaded with heavy metals into waterways, affecting water quality and aquatic ecosystem health. Deforestation, proliferation of invasive ungulates (deer and pigs), wildfires, and urbanization also contribute to bank degradation, increased terrigenous inputs, and habitat fragmentation. Excessive water withdrawals for agriculture and urban use reduce flows and degrade water quality.

The introduction of aquatic invasive alien species such as tilapia and black bass disrupts ecological balances and threatens endemic species. Furthermore, climate change is altering hydrological regimes, with longer drought periods and more intense rainfall events, exacerbating flood and erosion risks.

iii. Groundwater – *SF1.1 Underground streams and pools*

Underground streams, pools, and aquatic cavities are low-productivity systems devoid of light. Their taxonomic and functional diversity is generally limited, yet they may host locally endemic species depending on connectivity with surface waters and between cave systems. Most of these caves formed through the chemical weathering of soluble rocks. New Caledonia's geological

diversity strongly influences the nature of its aquifers. On the Grande Terre, ultramafic formations—particularly peridotites—contain complex karst aquifers characterized by networks of fractures and cavities that facilitate groundwater infiltration and circulation.

The waters in these cavities lack light and are generally low in dissolved oxygen, nutrients, and food resources, while showing limited temperature variability. Although biodiversity in these subterranean environments remains poorly known, recent studies conducted under the "La Planète Revisitée" program by the National Museum of Natural History (MNHN) and the NGO Pro-Natura International in several aquifers across the territory (Plaine des Lacs, Koumac, and Hienghène) revealed the presence of micro-endemic fauna adapted to these conditions. For example, small aquatic gastropods have been identified in groundwater, some restricted to a single watershed.

Groundwater aquifers represent an essential source of drinking water for local populations in areas where surface resources are limited. They also contribute to regulating river flows, thereby supporting surface aquatic ecosystems, particularly during drought periods.

These subterranean systems play a role in natural water filtration by trapping sediments and degrading certain pollutants, thus helping regulate water quality for domestic and agricultural uses.

Pressures on groundwater ecosystems in New Caledonia are mainly linked to human activities. Mining, especially in southern Grande Terre, can alter karst structures and contaminate aquifers with heavy metals. Overexploitation of water resources for agriculture and urban development may lower piezometric levels, affecting water availability and the health of dependent ecosystems.

Climate change represents an additional threat through alterations in precipitation regimes that may disrupt aquifer recharge. Moreover, saltwater intrusion into coastal aquifers—driven by sea-level rise, marine flooding events, and overextraction of freshwater—can compromise freshwater quality and negatively impact the agricultural potential of coastal lands.

iv. Synthesis of the mechanisms of degradation of freshwater ecosystems

The diagram below summarizes the main pressures exerted on New Caledonia's freshwater ecosystems and the potential consequences of their degradation for human well-being.

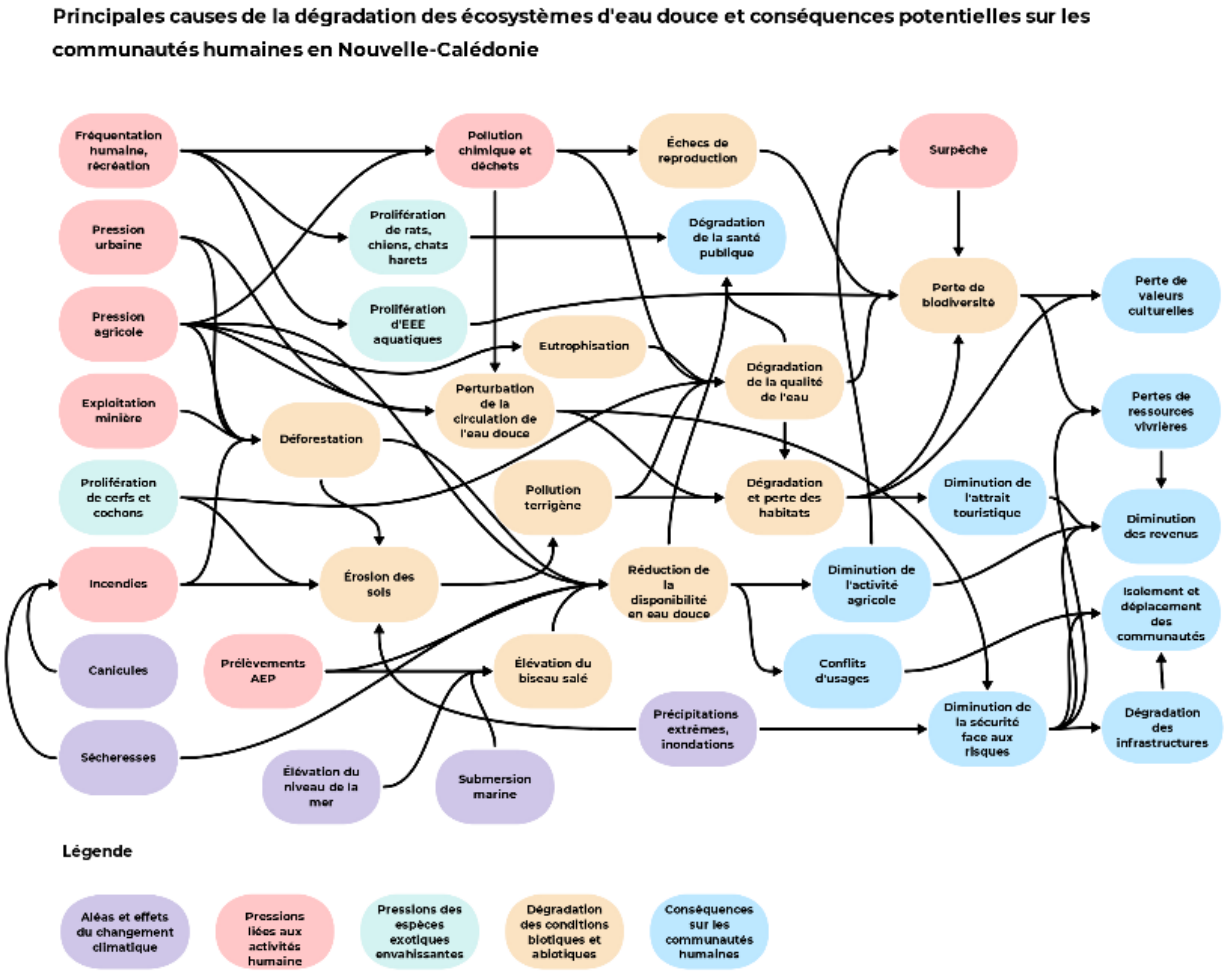


Figure 13 : Conceptual diagram of the mechanisms of degradation of New Caledonia's freshwater ecosystems and loss of associated ecosystem services

d. Marine and coastal ecosystems

i. Littoral vegetation and islets – MT2.1 Coastal shrublands and grasslands

Littoral vegetation and coastal forests in New Caledonia develop on upper beaches and low-lying islets, where they form plant communities adapted to the proximity of the marine environment. Islets are often covered with xerophytic vegetation capable of tolerating arid and saline conditions. These ecosystems are characterized by plant species resistant to salt spray and nutrient-poor soils.

Shrublands and low forests, generally of low productivity on exposed coasts, are constrained by salt inputs, water deficit, substrate instability, and recurrent disturbances such as wave and tidal action, wind-driven sediment movement, marine flooding events, wind shear, and tropical storms. Floristic diversity is organized along a succession gradient from sea to land, shaped by varying exposure to these disturbances. Most plant species exhibit salt tolerance traits, including succulent leaves or specialized salt-excreting organs.

Within these habitats, taxonomic diversity is relatively low, yet nearly all plants and animals display strong dispersal abilities, including movements between adjacent terrestrial and marine environments. Fauna is highly mobile, although some taxa—such as ground-nesting seabirds—may remain sedentary during parts of their life cycle.

Coastal ecosystems play an important role in protecting shorelines from erosion and storms, contribute to carbon sequestration, support artisanal fisheries, and provide opportunities for tourism and recreation. Upper-beach vegetation and islets are particularly valued leisure environments for New Caledonians, who seek shade there, often combined with lagoon-based recreational activities.

However, increasing urbanization, pollution, and unregulated tourism contribute to their degradation. Human disturbance and rodent proliferation exert significant pressure on seabirds, whose reproduction and survival may be affected by trampling, predation, disturbance, or disorientation. Climate change also threatens these environments, as sea-level rise and the intensification of extreme events accelerate coastal erosion and habitat loss—especially in artificialized areas where vegetation cannot migrate landward.

ii. Beaches, reef flats, and rocky shorelines – *MT1.1, MT1.3 Rocky and sandy shorelines*

New Caledonian beaches, mainly composed of shell-derived sand rich in calcium carbonate, host diverse microfauna. This substrate promotes intense biological activity, contributing to water filtration and sediment stabilization.

Beaches, sandbanks, and coastal spits are exposed to waves and tides. Their nutrients originate from drifting algae and phytoplankton in breaking-wave zones. These environments support diverse fauna, including polychaete worms, bivalve mollusks, small crustaceans, and other invertebrates that burrow into shifting sediments, while larger vertebrates such as seabirds and sea turtles also occur periodically. Marine flooding events, tides, and waves continuously reshape sediments and strongly influence the characteristics of organisms inhabiting these highly dynamic systems.

Reef flats and rocky shorelines, primarily found along high-energy coasts, offer a mosaic of microhabitats such as intertidal pools and cliffs. These areas are particularly important for certain seabird species that find protected nesting sites there.

Waves, tides, and exposure gradients determine the structure and functioning of these productive intertidal ecosystems. Filter-feeding species (mussels, oysters, barnacles) compete for limited space. Grazing organisms such as sea urchins consume small sessile algae, while predators including crabs, fish, and birds feed on a wide variety of prey. Organisms either occupy low-tide microhabitats (rock pools, crevices) or have developed shells and other adaptations to withstand high temperatures, salinity fluctuations, and desiccation.

Like littoral vegetation, these ecosystems contribute to coastal protection against erosion. They also provide diverse food resources typically harvested through artisanal fishing and enhance the attractiveness of coastal landscapes for tourism and recreational activities. For Kanak communities, beaches and shorelines are closely tied to clan histories, with lineage narratives preserving the memory of ancestral arrival sites from other Pacific islands.

However, New Caledonian beaches and reef flats may be degraded by urbanization, pollution, and terrigenous inputs resulting from watershed soil erosion. Biodiversity may also be threatened by overharvesting of resources. Climate change impacts—particularly sea-level rise and the intensification of extreme events—further contribute to habitat degradation.

iii. Mangroves, salt flats, and mudflats – *MFT1.2, MT1.2 Intertidal forests and shrublands, muddy shorelines*

New Caledonia hosts more than 25,000 hectares of mangroves, in addition to nearly 10,000 hectares of tannes and marshes. These mangroves develop mainly in estuaries, bays, and lagoons, where they form dense forests dominated by mangrove trees such as Rhizophora and Avicennia spp.

Mangroves are physiologically intolerant to low temperatures but adapted to low nutrient availability, particularly nitrogen and phosphorus. Rainfall reduces salinity stress, while sediment inputs from rivers and marine currents promote mangrove establishment and persistence. Conversely, waves and strong tidal currents destabilize and erode mangrove substrates and regulate salinity. The balance and circulation of inputs from watersheds, rainfall, and the marine environment influence the local distribution dynamics and health of these ecosystems.

Mangroves form remarkable ecological structures. Organisms within them display unique features such as pneumatophores (aerial roots specialized for gas exchange), salt-excreting glands, vivipary, and floating propagules, which enhance survival and recruitment in poorly aerated, saline, mobile substrates periodically flooded by tides.

These systems are among the most productive coastal environments. They generate large quantities of plant detritus, which may be buried in waterlogged sediments and consumed by crabs or decomposed by fungi and bacteria, mobilizing carbon and nutrients to higher trophic levels. Mangroves are also significant carbon sinks, with high capacity to store organic matter both in sediments and living biomass.

Crabs are the most abundant invertebrates. Their burrows oxygenate sediments, facilitate groundwater penetration, and provide habitat for other invertebrates such as mollusks and worms. Mangrove pneumatophores create complex habitats that protect juveniles from predators, serve as hard substrates for algae, bivalves, sponges, and gastropods, and stabilize sediments. Mangrove canopies host diverse fauna, particularly large bird communities. Species distribution reflects local variations in sediment distribution, tidal regimes, and gradients of flooding and salinity.

Tannes, saline and often barren zones located behind mangroves, result from salt accumulation and soil acidification. They may be bare or partially vegetated with halophytic plants. Mudflats, submerged at high tide and exposed at low tide, provide feeding grounds for many wading birds.

Mangroves provide numerous ecosystem services beneficial to human communities. They protect coastlines against erosion and storms, filter pollutants, store carbon, and serve as nurseries for many marine species, including those harvested for subsistence and commercial fisheries. Tannes and mudflats provide habitat for migratory birds and contribute to coastal hydrological regulation. Mangroves supply nutrients for phytoplankton, the base of marine food webs. They are also used for aquaculture and as a source of construction wood for fishing communities. As culturally significant areas rich in biodiversity, New Caledonia's mangroves are among the best preserved worldwide.

Mangrove degradation or destruction would release substantial greenhouse gases (carbon dioxide and methane) as well as pollutants previously sequestered, particularly in urban environments.

Across the territory, mangroves are moderately affected by various pressures. Soil erosion linked to mining increases sediment inputs that may suffocate mangrove trees. Aquaculture can lead to continuous water discharge into mangroves, disrupting species distribution normally structured along salinity gradients from sea to land. Coastal development poses a serious threat to urban mangroves, exposing them to pollution (hydrocarbons, macro-waste) and intentional obstruction of freshwater circulation pathways.

Under climate change, rising atmospheric carbon dioxide and temperatures may favour mangrove growth, but sea-level rise shifts coastal salinity gradients. To adapt, mangroves tend to migrate inland, particularly by colonizing salt flats; urbanization may hinder this migration. On Ouvéa, a low-lying island where mangrove species distribution is influenced by sandbank movement, mangroves are highly sensitive to sea-level rise due to limited sediment supply.

Conservation and restoration efforts are regularly implemented across the territory to protect these ecosystems. Research and ecological monitoring projects are also conducted to better understand mangrove dynamics—especially biogeochemical processes and climate change effects—and to guide management actions.

iv. Seagrass beds – *M1.1 Seagrass meadows*

Seagrass beds, true underwater meadows, extend in dense to diffuse formations over approximately 940 km² within New Caledonia's lagoons, representing 75% of the total seagrass area in French overseas territories. Their distribution around the archipelago is uneven: the largest areas are mainly found off the west coast and in the far north of Grande Terre, with the largest New Caledonian seagrass meadow located on the Massacres Plateau along the Voh coastline.

These meadows are primarily composed of marine phanerogams—flowering plants that colonize shallow lagoon areas. Eleven phanerogam species belonging to six genera have been recorded in New Caledonian seagrass beds. This marine vegetation forms dense, generally multi-specific mats distributed according to water depth, wave speed and energy, tidal exposure, and light intensity within the water column.

Seagrass beds provide numerous ecological services beneficial both to marine biodiversity and human populations. These ecosystems exhibit high primary productivity, comparable to tropical forests. Their capacity for carbon sequestration is considerable, contributing significantly to climate regulation. They profoundly modify their environment by influencing the physical, sedimentary, chemical, and biological processes of the surrounding waters. Their canopy slows currents and promotes particle sedimentation, reducing water turbidity and enhancing light availability for photosynthesis. They also contribute to water oxygenation, seabed stabilization, and localized reduction of current velocity through wave dissipation, thereby helping limit coastal erosion.

Coral reefs protect seagrass beds from wave energy, while seagrass meadows reduce sediment impacts on corals. Together, these two ecosystems act synergistically to mitigate coastal erosion driven by wave action.

Additionally, seagrass beds produce organic matter and serve as feeding grounds, breeding areas, and refuges for rich biodiversity, including numerous fish (particularly juveniles), echinoderms (starfish, sea cucumbers, sea urchins), sea snakes, marine turtles, and the dugong, which can graze up to 40 kg of seagrass per day.

Human activities associated with coastal development—such as urban expansion, port and navigation channel construction, tourism development, and destructive fishing practices—damage these ecosystems. Nearshore seagrass beds are particularly sensitive to riverine inputs resulting from soil runoff (pollutants, particles, nutrients), as well as increased turbidity and sedimentation linked to watershed erosion. Excessive inputs generally favour algal growth at the expense of phanerogams, leading to deterioration in seagrass health. Seagrass beds are also threatened by boating activities, as they grow in sheltered and shallow waters.

Climate change—through sea-level rise, ocean acidification, increasing water temperatures, and extreme climatic events—may further affect seagrass health. These ecosystems are especially sensitive to strong swells that can uproot or dislodge plants, as well as to the transport of large quantities of terrestrial sediments during intense rainfall events, which may cause smothering or burial.

v. Coral reefs and lagoon – *M1.3 Photic coral reefs*

Coral reefs are structures that form and develop through the accumulation of calcium carbonate. The formation of a new reef or the natural recovery of a degraded reef generally occurs over about ten years. Reef-building corals consist of colonies of coral polyps living in symbiosis with photosynthetic zooxanthellae that assimilate solar energy and nutrients, providing most of the host's metabolic needs. Corals build their skeletons by extracting dissolved carbonate from seawater and depositing it as aragonite crystals. Colony growth occurs mainly through asexual reproduction, although sexual reproduction also takes place, typically via synchronized spawning events linked to annual lunar cues.

Other sessile organisms, such as sponges, soft corals, and algae, contribute to the diversity and structural complexity of coral reef ecosystems. Thanks to this three-dimensional complexity, reefs provide a wide variety of habitats and resources for rich and locally endemic invertebrate biodiversity. Globally, it is estimated that one-quarter of marine life depends on the food resources and refuges provided by coral reefs.

Coral reef and lagoon ecosystems are characterized by exceptionally high diversity across all taxonomic levels, resulting in highly complex trophic networks involving primary producers, herbivores, detritivores, suspension feeders, predators, and microorganisms responsible for coral diseases that also contribute to reef dynamics. Reef-associated fish and other vertebrates exhibit diverse diets, social behaviours, and reproductive strategies.

New Caledonia possesses the second-largest reef complex in the world, including a lagoon exceeding 35,000 km², with about 4,500 km² of consolidated reefs. This reef-lagoon complex is among the richest and most diverse globally, with a rare variety of reef morphologies including internal barrier reefs, nested and multiple barrier systems, and coastal reefs. This geomorphological diversity is linked to the wide range of hydrological and geological conditions, depth, light intensity, turbulence, exposure, and sedimentation found in New Caledonian waters.

This exceptional reef system hosts one of the rare double barrier reefs, important breeding grounds for numerous remarkable marine species (including marine turtles, dugongs, humpback whales, and seabirds), and high levels of endemism. In recognition of its outstanding universal value, 60% of New Caledonia's lagoons and reefs have been listed as a UNESCO World Heritage site since 2008, as a serial property across six geographic areas.

The economic value of ecosystem services linked to tourism and recreation in the New Caledonian lagoon is estimated at around 3 billion CFP francs per year. Tourism and recreational activities in reef-lagoon environments primarily pose risks of reef structure damage, pollution, and wildlife collisions or disturbance.

Fishing is widely practiced in the lagoon in multiple forms. Professional fishing (fish, crustaceans, trochus, and sea cucumbers) accounts for only about 20% of catches, with most extraction occurring through recreational, subsistence, or undeclared (including illegal) fishing. The economic value of the reef fisheries ecosystem services is estimated between 6 and 8 billion CFP francs annually. Coastal areas near population centres are more vulnerable to overfishing pressure, particularly during economic or food supply crises. Evidence of fishing impacts on some fish and invertebrate species has been observed on coastal reefs of Grande Terre and the Isle of Pines, with decreasing impacts offshore, while anthropogenic pressure remains relatively low outside inhabited areas.

Although susceptible to physical degradation under strong wave conditions, reefs act as submerged breakwaters, protecting coastlines by attenuating wave energy. Coastal protection is the most economically valuable ecosystem service provided by coral reefs and associated ecosystems (including mangroves), estimated at 14–26 billion CFP francs per year across the territory.

Environmental conditions favourable to coral reefs are relatively constrained: they occur in open coastal waters with variable but generally warm temperatures (17–34 °C), shallow depths (typically a few tens of meters), clear and nutrient-poor waters, and salinity between 3.0 and 3.8%. Coral thermal tolerance is limited: low temperatures hinder growth, while excessive heat causes bleaching through breakdown of coral–zooxanthellae symbiosis.

Reefs undergo cycles of destruction and renewal linked to extreme climatic events such as cyclones and marine heatwaves. Intense rainfall also disturbs reef ecosystems by reducing salinity through freshwater influx, especially near river mouths, which may also carry terrigenous particles responsible for heavy sedimentation.

Sedimentation is one of the main pressures on coral reefs: it smothers corals and other sessile organisms and reduces the light required for photosynthesis by symbiotic zooxanthellae. Lagoon sedimentation results largely from terrigenous pollution caused by erosion of exposed soils during heavy rains. Soils degraded by mining, fires, invasive species (deer, feral pigs, rabbits), agricultural clearing, overgrazing, land reclamation, and coastal development are particularly prone to erosion.

Water eutrophication from excessive nutrient inputs—often linked to poor agricultural fertilizer management—can lead to algal blooms. Chemical pollution (hydrocarbons, metals) and mainly plastic waste, often associated with inadequate wastewater and stormwater management in urban areas, also contribute to coral degradation and lagoon fauna disturbance.

In New Caledonia, reef health is regularly monitored through several programs, including the coral reef observation network (RORC), monitoring of Greater Nouméa reefs (including marine protected areas), UNESCO-listed reef monitoring, and mining impact assessments. Most monitored reefs remain in good ecological condition and display strong resilience, often recovering satisfactory structure within about a decade after cyclones or bleaching events. However, some coastal reefs of Grande Terre, particularly on the east coast, show a general trend of ecological degradation due to unfavourable conditions such as high sedimentation.

Despite their current resilience, rising ocean temperatures and increasing marine heatwave frequency may significantly reduce coral recovery capacity, as bleaching events could occur too frequently for recovery. Ocean acidification is another major threat: coral carbonate skeletons are sensitive to pH, and increased acidity weakens reef structures and slows rebuilding processes. Without sufficiently long recovery periods (on the order of a decade), climate change could ultimately lead to large-scale coral loss in the medium to long term.

vi. Synthesis of degradation mechanisms of marine and coastal ecosystems

The conceptual diagram below summarizes the main pressures exerted on New Caledonia's marine and coastal ecosystems and the potential consequences of their degradation on human well-being.

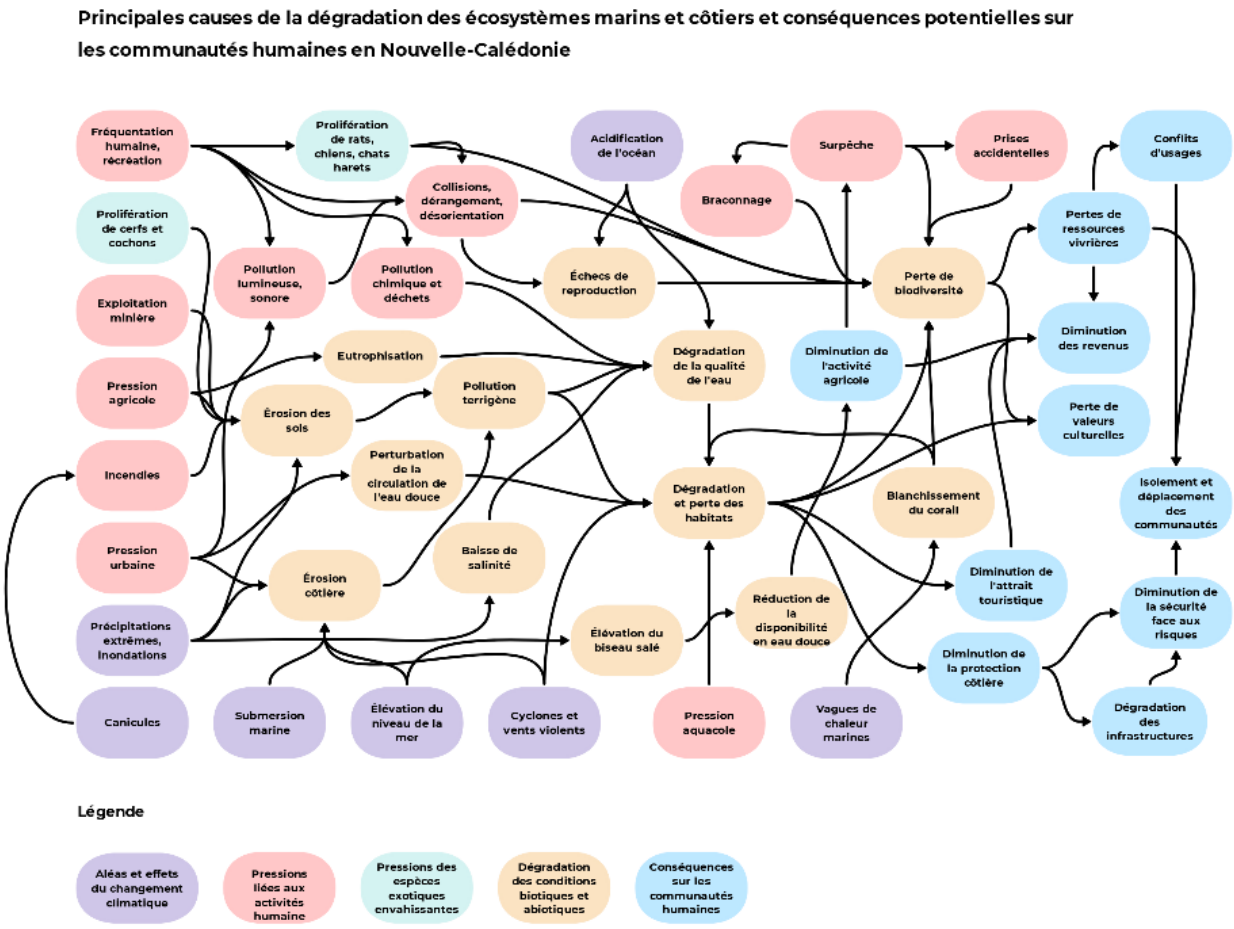


Figure 14 : Conceptual Diagram of the Mechanisms of Degradation of New Caledonia's Marine and Coastal Ecosystems and Loss of Associated Ecosystem Services

2. Exposure: Pressures on ecosystems

To determine ecosystem exposure levels, three types of pressure were considered: anthropogenic threats related to human activities, threats from invasive alien species, and climatic hazards.

For consistency, indicators of pressure from human activities rely on the data used to characterize socio-economic issues presented in the following section. Likewise, indicators of exposure to climatic hazards build on the hazard characterization described previously. Corresponding cartographic representations are provided in the relevant sections.

The direction of these data was adjusted to align with the resilience analysis: scores from 1 to 4 systematically represent a progression from the highest to the lowest level of pressure. Where necessary, scoring thresholds were revised to best reflect the estimated effects of the pressures on ecosystems; these may therefore differ from thresholds applied to the same data when used as socio-economic indicators.

To ensure compatibility with the methodological framework of the IUCN Red List of Ecosystems (RLE)—particularly its evaluation criteria typology—the main degradation mechanisms associated with each pressure factor were described. These mechanisms may involve potential loss of ecosystem area and/or connectivity (fragmentation), degradation of the abiotic environment and/or biotic processes, and barriers to ecosystem expansion or natural migration.

a. Indicators of exposure to anthropogenic threats

i. Mining pressure

Mining activities in New Caledonia led to a significant loss of forest cover, particularly on ultramafic massifs rich in nickel. Mining operations cause habitat fragmentation, reducing ecological connectivity and limiting the migration of forest species.

Furthermore, extraction and metallurgy strongly alter the abiotic environment through soil erosion, accumulation of mining waste, and pollution of runoff water loaded with terrigenous particles and heavy metals. Vegetation destruction and altered hydrological conditions also disrupt biotic processes by affecting nutrient cycles and ecosystem regeneration.

Current mining activity (active mining cadastre) threatens about one third (31%) of plant taxa assessed on the New Caledonian Red List of threatened species.

Already modified or anthropized environments (agricultural lands, fallows, urban areas) are less impacted by extractive activities, which are concentrated on specific geological formations. These ecosystems have already undergone major transformation and generally do not exhibit ecological sensitivity to this pressure.

Mining operations have major impacts on freshwater ecosystems, primarily through sediment and metal-laden runoff that degrades water quality and disrupts biotic processes (toxicity to aquatic fauna and shifts in biological communities).

Mining extraction and metallurgy also exert strong pressure on marine and coastal ecosystems via massive sediment export to the lagoon, resulting in abiotic degradation (increased turbidity and reef siltation). Excessive sedimentation reduces coral regeneration capacity, affecting biotic processes and weakening the entire marine trophic chain. In addition, port infrastructure associated with metallurgical industries contributes to coastal artificialization, limiting natural migration of coastal habitats.

The table below presents the scoring thresholds for the mining pressure indicator by municipality, and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Relative importance of mining and metallurgical activity by municipality**		
Source:	Mines and Quarries Department of the DIMENC		
Scoring rules and thresholds:			
1	2	3	4
At least 2 active mining and/or metallurgical sites	1 mining and/or metallurgical sites in operation	0 mine or mill, authorized quarry volume> 100,000 m3	0 mine or factory, authorized quarry volume< 100000 m3
Exposure weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
2	0	2	2

ii. Urban pressure

Urban expansion leads to the direct conversion of forests into built-up areas, although this pressure generally remains more localized than mining. Nevertheless, it contributes to forest habitat fragmentation, limiting ecological connectivity and species migration. In addition, urbanization alters the abiotic environment through soil sealing and the increase of urban heat islands, which can affect forest microclimates near urban areas.

Urbanization represents a threat to 7% of plant taxa assessed on the New Caledonian Red List of threatened species.

Anthropized environments are directly affected by urban expansion, which reduces space available for other uses, particularly agricultural, pastoral, and recreational activities. Land conversion results in area loss for these ecosystems and increased fragmentation. Urbanization also intensifies soil and water pollution while creating physical barriers to vegetation and animal species migration. Furthermore, urban growth increases light and noise pollution, disrupting biological rhythms in many species. Excessive nighttime lighting alters natural plant and animal cycles, particularly affecting pollinators and the movements of nocturnal fauna (birds, bats, insects).

Urbanization impacts freshwater ecosystems through riverbank artificialization, channelization of watercourses, and increased domestic and industrial discharges. These disturbances degrade water quality (chemical and organic pollution) and affect biotic processes, notably by reducing aquatic habitats and promoting eutrophication. However, this pressure is generally concentrated around major urban centres.

Coastal urbanization constitutes a major threat to marine and coastal ecosystems due to the destruction of mangroves, seagrass beds, and coral reefs near urbanized areas. Coastal artificialization and infrastructure development (roads, ports, landfills) result in habitat loss and create physical barriers to natural habitat migration. Moreover, urban discharges (organic pollution, hydrocarbons, heavy metals) contribute to abiotic degradation and disrupt marine biotic processes.

Light and noise pollution also represent significant threats to marine and coastal ecosystems, particularly for sea turtles nesting on beaches. Artificial lighting in coastal areas disorients hatchlings, reducing survival rates by preventing them from reaching the sea. In addition, urban lighting alters the behaviour of many fish and invertebrate species, modifying predator–prey interactions and reproduction. Noise generated by port infrastructure and maritime traffic also affects marine fauna, especially marine mammals that rely on echolocation for navigation and hunting.

The table below presents the scoring thresholds for the urban pressure indicator by municipality and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Log (built-up area) by municipality**		
Source:	Government of New Caledonia, Land Use (2014)		
Scoring rules and thresholds:			
1	2	3	4
Log(built) > 6	5.5 < Log(cast) < 6	5 < Log(built) < 5.5	Log(built) <5
Exposure weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
1	2	1	2

iii. Agricultural pressure

The expansion of agricultural land in New Caledonia leads to the partial conversion of forests into pasture or cropland, resulting in habitat loss and fragmentation of forest ecosystems. This fragmentation reduces ecological connectivity, limiting wildlife movement and seed dispersal. Agricultural pressure has historically been a driver of deforestation in the territory—particularly on the West Coast—but is now moderate, with impacts depending on the intensity and destructiveness of farming practices.

Agriculture represents a threat to 3% of plant taxa assessed on the New Caledonian Red List of threatened species.

Agricultural areas are directly linked to this indicator, as the intensification of farming practices profoundly alters these environments. Overgrazing promotes soil degradation and vegetation cover loss, increasing erosion and the spread of invasive plant species. The reduction of tree cover affects the local microclimate and may lead to decreased agricultural productivity. Simplification of agricultural landscapes (reduced plant diversity, monocultures) encourages pest proliferation due to the absence of natural predator regulation. This results in greater reliance on plant protection treatments and increased risk of pesticide resistance.

The use of chemical inputs affects biotic processes by reducing local biodiversity and disrupting nutrient cycles. Heavy pesticide use—especially insecticides—reduces pollinator populations, impacting both pollination-dependent crops and the natural regeneration of native plant species. The loss of hedgerows, fallow land, and other semi-natural habitats also limits pollinator resources and nesting sites. Additionally, the cultivation of new plots reduces land availability for other uses and increases land pressure on already transformed environments.

Agriculture impacts freshwater ecosystems mainly through runoff of fertilizers and pesticides, leading to diffuse pollution in rivers and wetlands. This promotes eutrophication, altering biotic processes and affecting aquatic communities. Intensive irrigation may also modify water availability for these ecosystems, causing local hydrological disturbances. Agricultural impacts on aquatic ecosystems are often indirect and depend on the farming practices employed.

Agricultural pressure does not directly affect marine and coastal ecosystems. However, diffuse pollution from agricultural watersheds (sediment, nitrate, and phosphate inputs) can degrade coastal water quality. Because this indirect impact is more limited than other major pressures such as urbanization or mining, it was not considered a significant pressure factor for these environments in this study.

The table below presents the scoring thresholds for the agricultural pressure indicator by municipality and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Share of the agricultural area used in the total area of the municipality (2012)**		
Source:	2012 General Agricultural Census, general characteristics (ISEE, DAVAR)		
Scoring rules and thresholds:			
1	2	3	4
UAA> 20%	5 < UAA< 20%	1 < UAA< 5%	UAA< 1%
Exposure weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
1	2	1	0

iv. Aquaculture pressure

As aquaculture is concentrated in coastal areas, it does not exert a direct impact on terrestrial ecosystems. Aquaculture in New Caledonia is primarily marine (shrimp farming) and does not directly affect freshwater environments. There are a few fish farms, and the introduction of exotic species into freshwater (tilapia, carp) remains marginal compared with other pressures.

Shrimp farming exerts pressure on coastal ecosystems due to the occupation of natural habitats, such as mangroves, for the construction of ponds. Although New Caledonian aquaculture follows relatively sustainable management practices, it can lead to habitat loss for certain coastal ecosystems and modify abiotic conditions through organic discharges (excreta, uneaten feed), which may promote local eutrophication. This activity can also affect biotic processes by increasing nutrient loads and altering trophic interactions in farming areas. However, its overall impact remains more limited than that of other major pressures such as urbanisation or mining, which justifies a moderate weighting.

The table below presents the scoring thresholds for the aquaculture pressure indicator by municipality, and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Number of aquaculture holdings by municipality**		
Source:	Number of aquaculture farms by municipality (IEOM, 2023)		
Scoring rules and thresholds:			
1	2	3	4

NA	3 or more	1 or 2	0
Exposure weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
0	0	0	1

v. Overfishing

Forest ecosystems are not affected by overfishing, which is a pressure exclusively linked to aquatic environments. In New Caledonia, overfishing mainly concerns marine and coastal ecosystems. Although some freshwater species may be exploited locally, fishing pressure in freshwater remains negligible compared with other threats, such as sedimentation resulting from erosion processes or bank artificialisation.

Overfishing, however, represents a significant threat to New Caledonia's marine and coastal ecosystems. It locally reduces populations of commercially important fish and disrupts trophic chains, which can modify biotic processes on a broad scale. The overexploitation of certain key species may also lead to ecological imbalances, for example, promoting algal proliferation due to the decline of herbivores.

The impact of overfishing is not limited to harvested biomass: it can also affect the abiotic environment, particularly through habitat destruction (for instance, abandoned or improperly used nets that damage corals and seagrass beds). Furthermore, illegal and unregulated fishing constitutes a potential obstacle to the natural resilience of marine ecosystems by limiting their capacity to recover from other environmental pressures.

The table below presents the scoring thresholds for the overfishing indicator by municipality, and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Qualitative perception of fishing pressure by local actors**		
Source:	Vulnerability map of the PacPath project in New Caledonia		
Scoring rules and thresholds:			
1	2	3	4
Degraded conditions	Average conditions	Good conditions	NA
Exposure weight, by ecosystem type:			

Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
0	0	0	2

vi. Marine pollution

Terrestrial environments are not directly affected by marine pollution, but they can be an indirect source through runoff carrying chemical or terrigenous pollutants toward coastal environments. Similarly, freshwater ecosystems are not directly impacted by marine pollution, yet pollutants originating from watersheds may be transported to marine ecosystems via rivers.

Marine pollution is a major threat to New Caledonia's coastal and marine ecosystems. It may originate from industrial and urban discharges, maritime traffic, plastic waste, and diffuse land-based pollution (pesticides, heavy metals, hydrocarbons, sediments, etc.), leading to significant degradation of the abiotic environment. Water quality is altered by increased turbidity, the introduction of toxic contaminants, and the development of eutrophication processes, which can promote harmful algal blooms and the formation of hypoxic zones. These disturbances also affect biotic processes by compromising the growth, reproduction, and/or survival of various marine organisms such as corals, fish, and molluscs. The accumulation of pollutants within the food chain constitutes an additional threat to biodiversity as well as to human consumers.

Furthermore, marine pollution can contribute to habitat loss and fragmentation in coastal areas, notably through the progressive degradation of coral reefs, seagrass beds, and mangroves, particularly in zones subject to intense industrial and port activity.

The table below presents the scoring thresholds for the marine pollution indicator by municipality, and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Qualitative perception of marine pollution by local stakeholders**		
Source:	Vulnerability map of the PacPath project in New Caledonia		
Scoring rules and thresholds:			
1	2	3	4
Degraded conditions	Average conditions	Good conditions	NA
Exposure weight, by ecosystem type:			

Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
0	0	0	2

vii. Fire pressure

Wildfires represent one of the main threats to New Caledonia's forest ecosystems: they can lead to significant losses of forest cover and increase the fragmentation of natural habitats. Fire destroys vegetation cover, exposes soils to erosion, and profoundly alters biogeochemical cycles.

By modifying forest structure and composition, it also disrupts biotic processes by reducing floral and faunal diversity and compromising the natural regeneration of endemic species. "Bushfires" facilitate colonisation by invasive fire-adapted species, particularly grasses and conifers, which tend to hinder the restoration of forest ecosystems and increase their vulnerability by forming combustible biomass that promotes recurrent fires.

Under the effects of fire, savannas, shrublands, and agricultural areas may undergo lasting changes in vegetation composition, with a loss of diversity and the proliferation of flammable species that favour repeated burning. The destruction of vegetation cover intensifies soil erosion, compromises soil fertility, and degrades landscapes. Fires also affect ecological interactions by reducing available habitats for fauna and disrupting pollination and seed dispersal cycles.

Fire is the primary pressure affecting rare and threatened plant species in the territory, posing a threat to 61% of plant taxa assessed on the IUCN Red List in New Caledonia.

Although fires do not directly affect aquatic environments, their indirect impacts can be significant. Post-fire erosion results in a massive influx of sediments into rivers, wetlands, and the lagoon, potentially altering hydrodynamics and reducing water clarity. This turbidity is harmful to aquatic communities because it limits the photosynthesis of submerged vegetation and can suffocate certain organisms, such as corals, seagrass beds, and benthic fauna. In addition, ash and burned organic matter may contain toxic elements (heavy metals, carbon compounds) that degrade water quality and impact the health of aquatic organisms.

The table below presents the scoring thresholds for the wildfire risk indicator by municipality, and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Share of the total area burned in the municipal area, weighted by the number of fires recorded**		
Source:	Vulcain Pro, Sentinel 2 data (OEIL)		
Scoring rules and thresholds:			
1	2	3	4
>500	100 to 500	1 to 100	<1
Exposure weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
2	2	1	1

b. Indicators of exposure to invasive alien species

viii. Relative pressure of deer and feral pigs

Deer and feral pigs represent a major threat to New Caledonia's forest ecosystems, whose endemic flora evolved in the absence of large herbivores. Their high abundance leads to significant vegetation destruction through browsing of the understory and trampling, compromising the regeneration of native forest species and promoting the expansion of less palatable plants. Habitat fragmentation is further aggravated by the creation of trails and open areas resulting from repeated animal movement. These herbivores disrupt biotic processes by exerting strong pressure on young seedlings and degrade the abiotic environment through soil compaction and erosion.

Deer and pigs respectively threaten 24% and 14% of plant taxa assessed on the IUCN Red List of threatened species in New Caledonia.

In secondary and anthropogenic environments, feral deer and pigs directly affect landscape structure and composition. Overgrazing reduces vegetation cover and promotes soil erosion, particularly in savannas and shrublands. This pressure affects habitat connectivity by altering plant diversity and reducing resource availability for local fauna, including livestock, while also diminishing agricultural production for human or animal consumption. Moreover, these invasive species can transmit diseases that affect wildlife and domestic livestock, further disrupting already fragile ecosystem processes.

Freshwater ecosystems are indirectly subjected to significant pressure from deer and feral pigs. By frequenting riverbanks and wetlands, these animals intensify erosion and degrade riparian vegetation, reducing its capacity to stabilize soils and filter pollutants. Increased water turbidity,

caused by trampling and the washing of eroded soils, disrupts aquatic biotic processes by limiting photosynthesis and promoting sedimentation of benthic habitats. Additionally, these introduced species may contaminate freshwater environments through their droppings, encouraging the proliferation of bacteria and pathogens. This impact can extend to the lagoon, although the relative effect of deer and pigs on marine ecosystems is considered more moderate.

Two indicators were used to assess ecosystem exposure to deer and feral pigs: relative abundance in accessible areas and the presence of refuge areas inaccessible to hunters.

Relative abundance in accessible areas—estimated based on local hunting success—provides an indication of the pressure exerted by these species on environments open to human activities (accessible forest areas near settlements, forest edges, agricultural land, riparian zones, etc.). The higher their density, the greater the ecological impacts: excessive browsing, seedling destruction, soil trampling, bank destabilisation, and increased sediment runoff into rivers and lagoons.

The presence of refuge areas inaccessible to hunters—represented by areas with null or negligible hunting data—is a key indicator for understanding population dynamics. These zones, typically steep forested areas of the Central Range of Grande Terre, provide favourable conditions for reproduction and the maintenance of high population densities, which can subsequently spread into surrounding environments. In the absence of natural regulation, densities in these refuges can reach critical levels, with major repercussions for the ecosystems they occupy.

Together, these two indicators allow assessment of both the current exposure of natural environments to deer and pig populations and their capacity to sustain high densities over time, thereby amplifying ecological pressure.

Each indicator represents part of the overall influence of exposure to deer and feral pigs, for which a total weight of 2 (terrestrial and freshwater ecosystems) or 1 (marine and coastal ecosystems) was assigned within the overall exposure score.

The table below presents the scoring thresholds and weighting coefficients applied to each major ecosystem type for these two indicators.

Indicator:	**Maximum hunting success in a management unit of the municipality**		
Source:	Operation Jaws 2008-2015 (ANCB, Rural Agency)		
Scoring rules and thresholds:			
1	2	3	4
> 11.1	5.3 to 11.1	< 5.3	No or very few deer and pigs (data not usable)

Exposure weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
1	1	1	0

Indicator:	**Proportion of municipal area without hunting success data**		
Source:	Operation Jaws 2008-2015 (ANCB, Rural Agency)		
Scoring rules and thresholds:			
1	2	3	4
< 40% (empty UGs that are essentially inaccessible, therefore high pressure)	> 40% (empty GUs including accessible areas, therefore moderate pressure)	0 (municipality entirely covered by LUs with direct debits)	No or very few deer and pigs (data not usable)
Exposure weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
1	1	1	1

ix. Risk of invasion by rabbits

Rabbits represent a moderate threat to New Caledonia's forest ecosystems. Although they prefer open habitats, they can colonise forest edges and degraded areas surrounding sclerophyll forests. Their impact is mainly expressed through browsing of young shoots and consumption of forest seedlings, which can hinder the regeneration of certain endemic plant species. However, their overall effect on the structure and connectivity of forest ecosystems remains limited compared with other invasive alien species such as deer or feral pigs.

In contrast, open and anthropogenic environments are particularly vulnerable to rabbit invasion, as these habitats offer optimal conditions for proliferation. Intensive grazing reduces vegetation cover, promoting soil erosion and compromising the fertility of agricultural land and natural grasslands. Furthermore, rabbit burrows destabilise soils and increase the risk of collapse in areas with weak geological cohesion.

Rabbits also influence biotic processes, particularly plant and animal dynamics. On the one hand, their feeding behaviour may favour grazing-resistant plant species while limiting the regeneration of endemic flora. On the other hand, rabbits provide a new prey source for birds of prey, potentially altering trophic chains and affecting populations of other prey species. They also constitute prey for stray dogs and feral cats, which may locally increase the abundance of these predators that are harmful to endemic fauna.

Rabbits are highly sensitive to humidity and prefer dry, open environments. The projected increase in the frequency and intensity of droughts associated with climate change could enhance their invasion potential in New Caledonia by making large areas more favourable for their establishment and spread. In secondary and anthropogenic terrestrial ecosystems, drier climatic conditions could intensify vegetation loss and reduce the competitiveness of native species in favour of drought-tolerant plants, thereby facilitating rabbit expansion. In addition, droughts may affect certain raptor species, further weakening natural population control.

In forest ecosystems, currently less favourable to rabbits, progressive drying of forest edges and secondary forests could create new opportunities for colonisation, particularly in degraded areas.

Rabbits do not exert a significant direct impact on aquatic environments. However, their indirect effects—such as increased soil erosion in colonised areas—may contribute to sediment runoff into rivers and the lagoon, although this influence is considered marginal compared with other pressure factors.

The table below presents the scoring thresholds for the indicator of invasion risk by feral rabbits at the municipal level and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Location of established populations and reports of rabbits in areas potentially favourable to their establishment**		
Source:	ANCB, IRD (2012-2025)		
Scoring rules and thresholds:			
1	2	3	4
Presence of at least one established population	Presence of at least one reported population	Municipalities adjacent to the established or reported population, with favourable areas	Rest of the municipalities
Exposure weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic	Freshwater ecosystems	Marine and coastal ecosystems

	terrestrial ecosystems		
1	2	0	0

x. Risk of rhinoceros beetle invasion

The rhinoceros beetle (Oryctes rhinoceros) is a serious pest of coconut palms and other palm species, feeding by boring into their crowns to access internal tissues. In New Caledonia, its impact is mainly observed in secondary and anthropogenic terrestrial ecosystems, where these plant species are widely cultivated, particularly in agricultural and peri-urban areas. The beetle's larvae develop in decomposing organic matter, especially plant debris and agricultural residues, which promotes its proliferation in environments modified by human activity.

Infestation by this pest can weaken palm structure, reducing their ability to provide ecosystem services such as shade, soil stabilisation, and habitat for certain animal species. The progressive destruction of coconut palms and ornamental palms may also alter the landscape and economic dynamics of affected areas. However, its overall impact remains moderate compared with other degradation factors affecting these secondary terrestrial ecosystems.

Forest ecosystems are not favourable habitats for the rhinoceros beetle because, aside from a few endemic palm species, most forest vegetation does not serve as a preferred host for this insect. Its impact is therefore considered negligible in these ecosystems.

Similarly, although coconut palms are an iconic component of New Caledonia's coastal landscape, the rhinoceros beetle's impact on marine and coastal ecosystems is indirect and relatively limited. Its presence does not affect water quality, marine biodiversity, or coastal ecological dynamics. Consequently, no weighting was assigned for this ecosystem type.

The table below presents the scoring thresholds for the indicator of invasion risk by the rhinoceros beetle at the municipal level and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Location of established populations and detections of rhinoceros beetles**		
Source:	DAVAR		
Scoring rules and thresholds:			
1	2	3	4
Presence of an established population	Individuals detected	Rest of the municipalities	NA

Exposure weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
0	1	0	0

c. Indicators of exposure to climatic hazards

i. Coastal erosion

Coastal erosion represents a major threat to New Caledonia's marine and coastal ecosystems, from upper beach vegetation to coral reefs. Shoreline retreat leads to a loss of habitat area and connectivity by progressively destroying the substrate of coastal ecosystems that play a crucial role in coastal protection and the filtration of runoff waters.

Erosion also alters the abiotic conditions of the environment by increasing the load of fine sediments in coastal waters. This turbidity reduces light penetration, negatively affecting photosynthesis in corals and seagrass beds and promoting the silting of benthic habitats. Over the long term, these effects may disrupt biotic processes, interfering with species interactions and reducing ecosystem resilience to other environmental stressors such as pollution, climate change, and ocean acidification.

In coastal development contexts, shoreline erosion can further hinder the natural expansion or landward migration of marine and coastal ecosystems, increasing their vulnerability to extreme climatic events.

The table below presents the scoring thresholds for the coastal erosion indicator by municipality, and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Qualitative perception of coastal erosion by local stakeholders**		
Source:	Vulnerability map of the PacPath project in New Caledonia		
Scoring rules and thresholds:			
1	2	3	4
Significant erosion	Average erosion	Low erosion	NA
Exposure weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic	Freshwater ecosystems	Marine and coastal ecosystems

	terrestrial ecosystems		
0	0	0	2

ii. Drought

The intensification of drought periods is likely to lead to a degradation of biotic processes and an alteration of the abiotic environment of forest ecosystems. Prolonged water deficits tend to reduce tree growth, increase vulnerability to diseases and insect pests, and limit the natural regeneration of plant species. Reduced soil and vegetation moisture also heightens the risk of ignition and wildfire spread, with potential repercussions for forest fragmentation and loss of forest cover. Changes in local microclimatic conditions may also affect forest fauna by reducing the availability of food resources and disrupting the biological cycles of species dependent on humid climates.

Secondary and anthropized terrestrial ecosystems are particularly sensitive to prolonged droughts, which exacerbate vegetation degradation and soil erosion. By favouring species—sometimes invasive—better adapted to arid conditions, droughts also influence plant species dynamics and the composition of ecological communities. In agricultural areas, reduced soil moisture leads to lower yields, which may result in overexploitation of water resources and the conversion of new land for agriculture to compensate for reduced productivity, thereby increasing pressure on natural ecosystems.

Freshwater ecosystems are also directly impacted by droughts, which reduce river flows, dry out wetlands, and increase water temperatures. These disturbances alter biotic processes by affecting aquatic fauna that depend on stable hydrological regimes and minimum flow levels. Increased evaporation and reduced natural water supply can also concentrate pollutants and degrade water quality, affecting all aquatic organisms. The fragmentation of freshwater habitats caused by drying rivers limits opportunities for dispersion and migration of aquatic species, potentially impairing reproductive success or even survival for some species.

Mangroves and estuarine zones may experience indirect drought effects through reduced freshwater inputs from rivers and the consequent increase in salinity. However, these effects remain localized and relatively limited in intensity compared with other stressors affecting marine and coastal ecosystems.

iii. Extreme rainfall and flooding

Forest ecosystems are generally resilient to extreme precipitation due to their strong capacity to absorb rainfall and their regulatory role in hydrological cycles. Forests significantly contribute to reducing runoff and stabilizing soils, thereby playing an essential role in limiting the negative

impacts of floods. Intense rainfall may have localized effects on forest ecosystems, such as landslides or soil erosion in degraded areas, but these impacts do not affect the overall structure and functioning of these ecosystems.

In contrast, extreme precipitation and flooding have a notable impact on secondary and anthropized terrestrial ecosystems, particularly by aggravating erosion and causing soil leaching in agricultural and urban areas. Floods can reduce soil fertility and lead to the transport of pollutants (pesticides, fertilizers) into aquatic environments. Furthermore, flooding may promote the proliferation of diseases and pests, which can affect agricultural production and livestock.

Freshwater ecosystems are also sensitive to episodes of extreme rainfall and flooding, which alter river flows, turbidity, and water quality. A sudden increase in precipitation can result in a massive input of sediments and pollutants harmful to aquatic organisms. In addition, floods can modify the morphology of rivers and wetlands, potentially destroying spawning grounds or disrupting the dynamics of migratory species.

Similarly, heavy rainfall and flood events affect marine ecosystems through excessive inputs of sediments, nutrients, and pollutants from watersheds. These inputs can degrade coastal water quality, cause hypoxic episodes and temporary reductions in salinity, and consequently impact coral reefs, seagrass meadows, and mangroves.

iv. Marine submersion

Coastal ecosystems are naturally exposed to marine submersion events, although impacts vary depending on local conditions. Mangroves, coral reefs, and seagrass meadows can play a protective role by attenuating wave energy and reducing the impact of submersion on coastlines. However, more frequent or intense marine submersion can lead to beach and mangrove erosion, excessive salt inputs into soils and vegetation (potentially causing the mortality of certain species), and disruption of the reproductive cycles of many organisms. In reef areas, rising water levels may also modify ecosystem dynamics by affecting habitat availability and species interactions.

Although freshwater ecosystems are not directly exposed to marine submersion, this hazard can affect estuarine areas and coastal lagoons where freshwater and seawater interact. Saline intrusions into rivers and coastal wetlands alter water chemistry and impact freshwater species sensitive to salinity. Such intrusions can disrupt biotic processes by affecting the reproduction and survival of freshwater species and degrade the abiotic environment, particularly through salt deposits in riparian soils, which may reduce their fertility and alter associated vegetation.

Forest ecosystems and secondary and anthropized terrestrial ecosystems located outside the direct influence of marine submersion are not exposed to this hazard.

The geographical distribution of these climatic hazards is presented in the previous section. The table below summarizes the weighting coefficients applied in calculating the exposure score for the hazards considered, for each of the major ecosystem groups.

Exposure weight, by ecosystem type:				
	Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
Drought	2	2	2	0
Extreme rainfall and flooding	0	1	1	1
Marine submersion	0	0	1	1

The heatwave hazard was not considered, as the available data cover too small an area of the territory to be used in this analysis. The cyclone and marine heatwave hazards have uniform values across the entire territory and therefore do not influence the analysis results.

d. Mapping result: global level of pressure on ecosystems

The maps below show the overall exposure score, calculated by municipality for each major ecosystem type based on all the above indicators and their weighting.

Due to the lack of local data on forest ecosystems, the Loyalty Islands were not included in the analysis of their exposure level.

In the North and South Provinces, only the forests of the municipalities of Bélep and Île des Pins display a very low level of exposure to the pressures considered, including anthropogenic threats, invasive alien species, and climate hazards. The municipalities whose forests are the most exposed are all located on the west coast, from Poya to Koumac (excluding Koné) in the North, and Païta and Boulouparis in the South. This high exposure is mainly linked to the cumulative pressures of mining, agriculture, fires, and invasive deer and feral pigs.

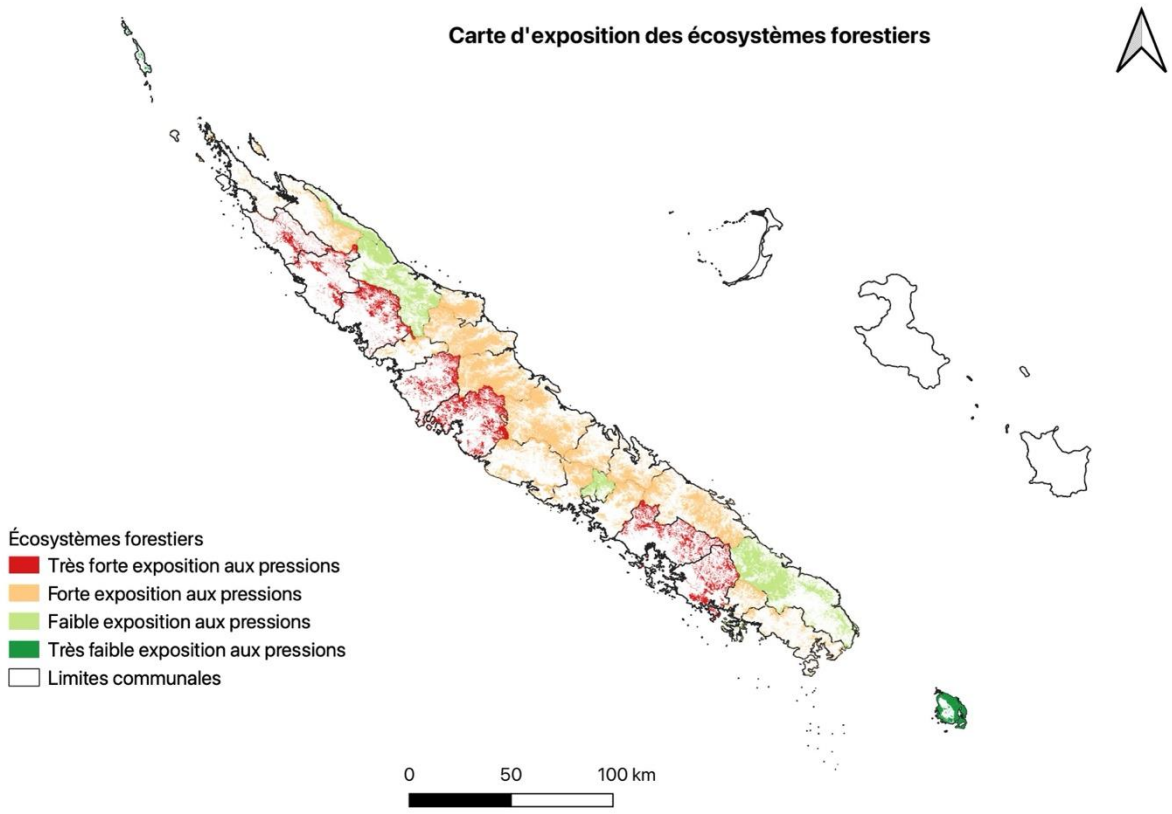


Figure 15: Summary map of the level of exposure of New Caledonia's forest ecosystems to climatic hazards and other anthropogenic threats

The level of exposure to pressures affecting secondary and anthropized terrestrial ecosystems is generally low to very low along the east coast, on the Isle of Pines and Bélep, as well as in the Loyalty Islands. Despite limited exposure to climate hazards, Païta and Boulouparis are the municipalities where these ecosystems face the highest-pressure levels. These two municipalities are particularly affected by agricultural and urban pressures, wildfire risk, and all the invasive alien species considered (deer, pigs, rabbits, and rhinoceros beetle).

Due to the lack of local data on forest ecosystems, all terrestrial ecosystems of the Loyalty Islands were included in this analysis.

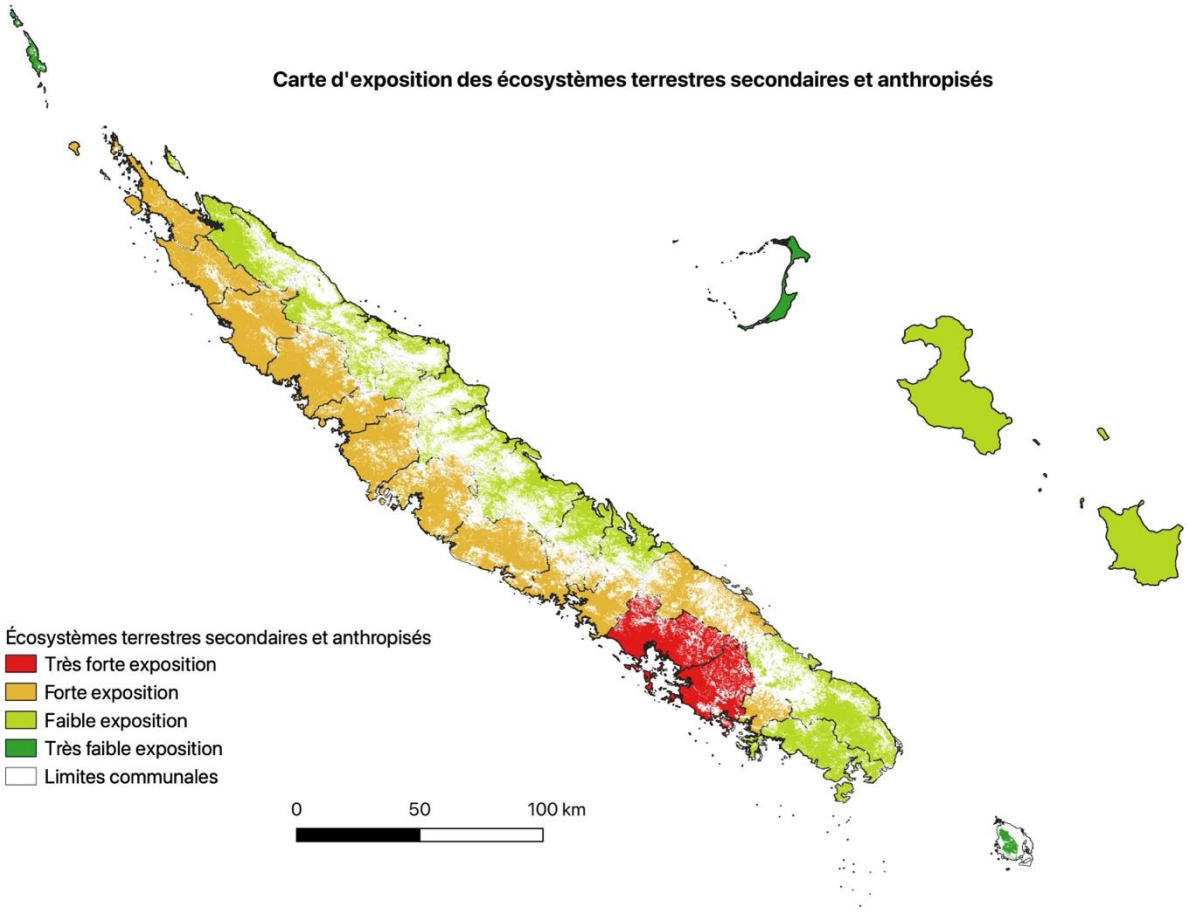


Figure 16 : Summary map of the level of exposure of New Caledonia's secondary and anthropogenic terrestrial ecosystems to climatic hazards and other anthropogenic threats

The level of exposure to pressures affecting freshwater ecosystems is low to very low on the Isle of Pines, Bélep, and in the Loyalty Islands, while it is generally high across most municipalities of Grande Terre. Despite limited exposure to climate hazards, Thio and Koumac are the

municipalities where freshwater ecosystems face the highest-pressure levels. These two municipalities are particularly affected by significant mining pressure, as well as high exposure to drought and wildfire risk.

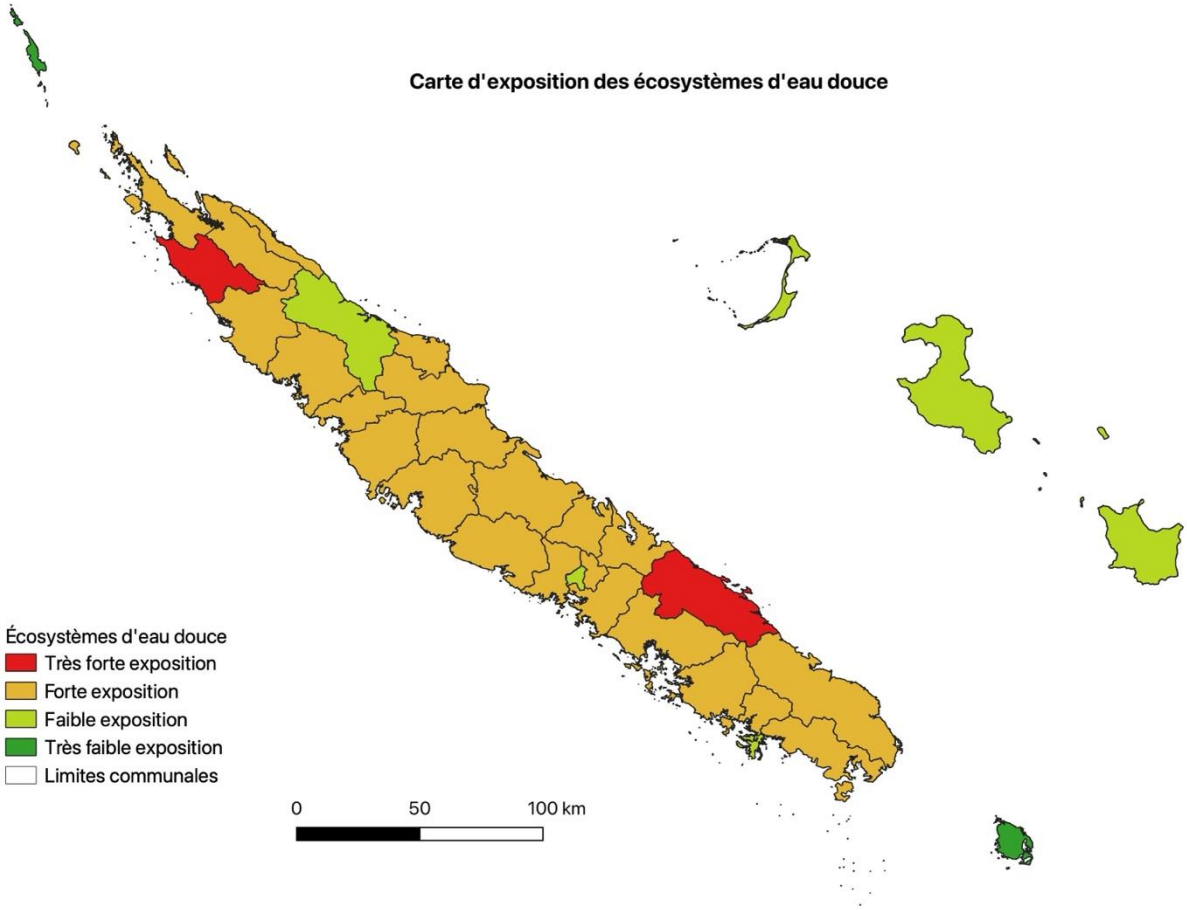


Figure 17 : Summary map of the level of exposure of New Caledonia's freshwater ecosystems to climatic hazards and other anthropogenic threats

Marine and coastal ecosystems in New Caledonia also show low to very low levels of exposure to pressures on the Isle of Pines, Bélep, in the Far North, and in the Loyalty Islands, while exposure is generally high off most municipalities of Grande Terre. The Mont-Dore lagoon is where marine ecosystems experience the highest level of pressure, due to the cumulative effects of anthropogenic threats such as mining and urban pressures, wildfire risk, pollution, and overfishing.

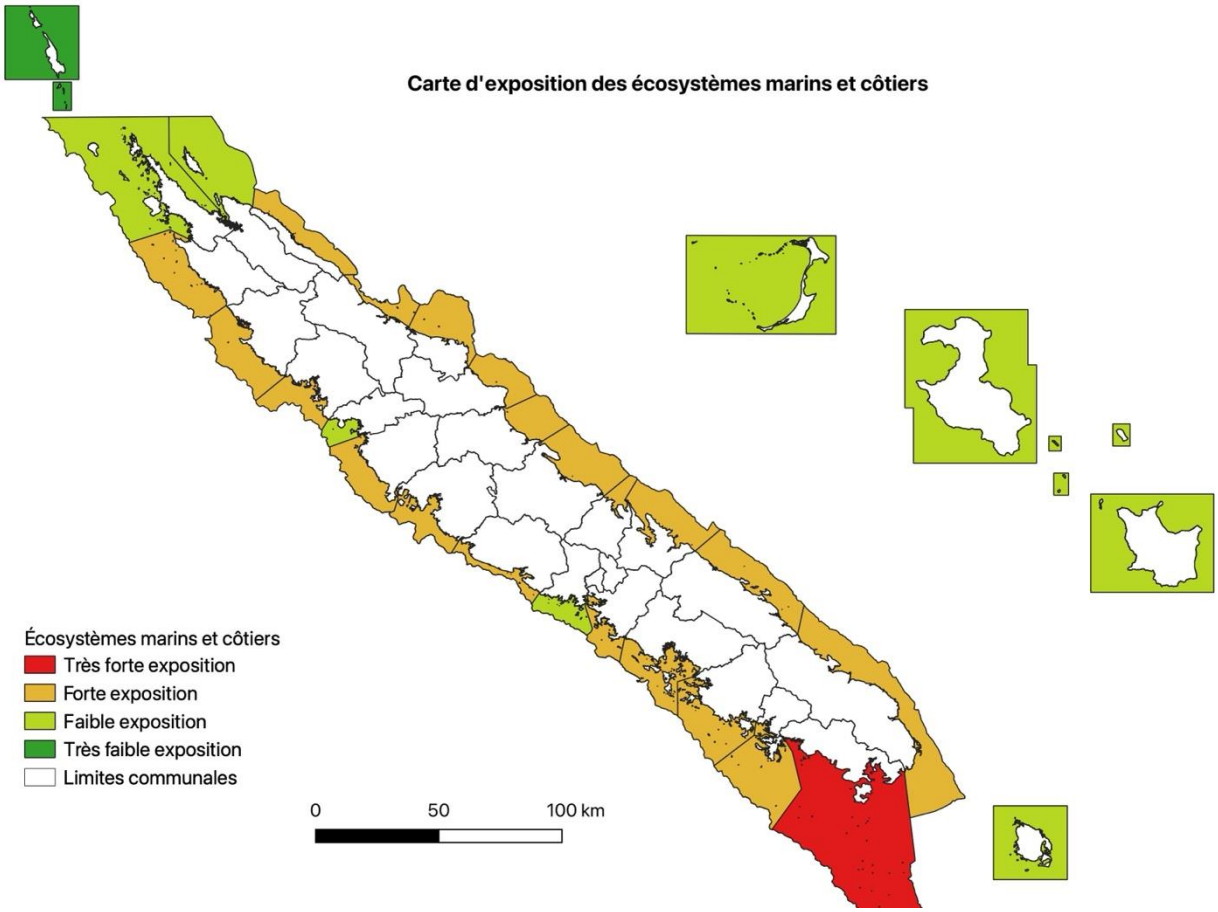


Figure 18 : Summary map of the level of exposure of New Caledonia's marine and coastal ecosystems to climatic hazards and other anthropogenic threats

3. Sensitivity of ecosystems

a. Indicators of ecosystem sensitivity to anthropogenic threats and climatic hazards

i. Edge effect

The edge effect, defined as the influence of open habitats on adjacent forest areas, represents a major sensitivity factor for New Caledonia's forest ecosystems. A high proportion of forest exposed to edges indicates a reduced distribution of interior habitats. The more fragmented a forest is, the greater its edge-exposed surface area, which reduces the extent of intact forest habitats required by species sensitive to light, heat, and human disturbances. In highly fragmented forests, ecological integrity is compromised because fragmentation intensifies the edge effect.

This effect results in changes to the abiotic environment, including increased temperature and light levels, reduced humidity, and alterations in soil chemical composition. The edge effect also disrupts biotic processes: it promotes the invasion of exotic plant and animal species, alters ecological interactions (predation, competition, etc.), and modifies forest regeneration dynamics.

The edge effect, therefore, serves as an indicator of the level of forest habitat degradation: a strong edge effect often reflects a loss of ecological connectivity, associated with reduced species movement and increased sensitivity to climate hazards and anthropogenic pressures.

The table below presents the scoring thresholds for the edge-effect indicator by municipality, and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Proportion of communal forest area located less than 100m from the forest edge**		
Source:	Birnbaum, P., Hequet, V., Ibanez, T., Eltabet, N., & Prior, J. (2024). Classification of New Caledonian Forests According to Edge and Elevation Effects (Version 2024) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.12739730		
Scoring rules and thresholds:			
1	2	3	4
> 50% selvedge	25 to 50% selvedge	5 to 25% selvedge	< 5% selvedge
Sensitivity weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
2	0	0	0

ii. Tree cover

The proportion of the tree layer is assessed outside forests (where the tree layer is dominant by default) and outside artificial environments (where it is not measured at the scale of the source data). It is a sensitivity factor for secondary and human-modified terrestrial ecosystems, including savannas, shrublands, and agro-pastoral environments. In these settings, even sparse tree cover contributes to microclimate regulation, soil protection against erosion, and ecological connectivity between fragmented forest habitats. A low proportion of tree cover often reflects

advanced ecological degradation, with reduced biodiversity, increased sensitivity to climate hazards, and disruption of biogeochemical cycles.

In New Caledonia, shrublands and savannas resulting from historical deforestation may retain tree patches that serve as refuge habitats for certain species and facilitate the natural recolonization of degraded areas. The loss of this woody vegetation outside forests significantly reduces the resilience of these environments to climate hazards and anthropogenic pressures. Thus, the proportion of tree cover is a direct indicator of the level of degradation and the restoration potential of secondary terrestrial ecosystems.

The table below presents the scoring thresholds for the tree cover indicator by municipality and the weighting coefficients applied to each major ecosystem type.

<table>
<tr><td>Indicator:</td><td colspan="4">Proportion of tree cover outside forests and artificial environments</td></tr>
<tr><td>Source:</td><td colspan="4">Land use (2014); Birnbaum, P., Hequet, V., Ibanez, T., Eltabet, N., & Prior, J. (2024). Classification of New Caledonian Forests According to Edge and Elevation Effects (Version 2024) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.12739730</td></tr>
<tr><td colspan="5">Scoring rules and thresholds:</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td colspan="2">4</td></tr>
<tr><td>< 10%</td><td>10 to 25%</td><td>25 to 50%</td><td colspan="2">> 50%</td></tr>
<tr><td colspan="5">Sensitivity weight, by ecosystem type:</td></tr>
<tr><td>Forest ecosystems</td><td>Secondary and anthropogenic terrestrial ecosystems</td><td>Freshwater ecosystems</td><td colspan="2">Marine and coastal ecosystems</td></tr>
<tr><td>0</td><td>2</td><td>0</td><td colspan="2">0</td></tr>
</table>

iii. Relative importance of mangroves along the municipal coastline

The proportion of coastal shoreline occupied by mangroves is a relevant sensitivity indicator for marine and coastal ecosystems, as mangroves play an essential ecological role at the land–sea interface. They act as a natural buffer against coastal erosion and marine flooding while providing nursery habitats for many species of fish and crustaceans.

In New Caledonia, mangroves are particularly sensitive to anthropogenic pressures related to coastal development, as well as to climate change impacts, notably sea-level rise and hydrological changes. The proportion of mangroves along the shoreline therefore represents the relative importance of this sensitive ecosystem, whose degradation would reduce its capacity to

absorb disturbances and maintain its ecological functions. However, mangroves represent only one of several habitats included within marine and coastal ecosystems, which justifies a moderate weighting.

The table below presents the scoring thresholds for the indicator of the relative importance of mangroves along the municipal coastline, as well as the weighting coefficients applied to each major ecosystem group.

Indicator:	**Proportion of municipal coastline occupied by mangroves**		
Source:	OBLIC		
Scoring rules and thresholds:			
1	2	3	4
> 50%	25 to 50%	> 0 to 25%	0%
Sensitivity weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
0	0	0	1

iv. Relative importance of coral reefs within the municipal lagoon

Similarly, the proportion of a municipal lagoon occupied by coral reefs is a complementary indicator of the sensitivity of marine and coastal ecosystems in New Caledonia. Coral reefs are highly sensitive to anthropogenic pressures such as terrigenous and chemical pollution and overfishing, as well as to climate change impacts, particularly marine heatwaves, ocean acidification, and the intensification of cyclones. A high coral cover also reflects a strong ecological dependence on reefs, which provide habitat for exceptional marine biodiversity and play a fundamental role in protecting coastlines from erosion, as well as a likely dependence of local economies and community well-being, particularly for fishing and tourism. Any degradation of reefs may therefore trigger cascading effects across the full range of ecosystem services associated with marine and coastal environments. Thus, the greater the proportion of reefs within a municipal lagoon, the higher the sensitivity level of this ecosystem.

The table below presents the scoring thresholds for the indicator of the relative importance of coral reefs within the municipal lagoon, as well as the weighting coefficients applied to each major ecosystem group.

<table>
<tr><td>Indicator:</td><td colspan="4">Proportion of the municipal lagoon area occupied by coral reefs</td></tr>
<tr><td>Source:</td><td colspan="4">Andréfouët S, Muller-Karger FE, Robinson JA, Kranenburg CJ, Torres-Pulliza D, Spraggins SA, Murch B (2006) Global assessment of modern coral reef extent and diversity for regional science and management applications: a view from space. 10th Int. Coral Reef Symposium 1: 1732-1745

Andréfouët S., Torres-Pulliza D, 2004, Atlas of the coral reefs of New Caledonia, IFRECOR New Caledonia, IRD, Nouméa, April 2004, 26 p + 22 plates</td></tr>
<tr><td colspan="5">Scoring rules and thresholds:</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td colspan="2">4</td></tr>
<tr><td>> 50%</td><td>25 to 50%</td><td>> 0 to 25%</td><td colspan="2">0%</td></tr>
<tr><td colspan="5">Sensitivity weight, by ecosystem type:</td></tr>
<tr><td>Forest ecosystems</td><td>Secondary and anthropogenic terrestrial ecosystems</td><td>Freshwater ecosystems</td><td colspan="2">Marine and coastal ecosystems</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td colspan="2">2</td></tr>
</table>

v. Forest biodiversity hotspots

The proportion of municipal area occupied by forest biodiversity hotspots is an important indicator of the sensitivity of forest ecosystems in New Caledonia. These hotspots correspond to areas with a high concentration of endemic species and rare or threatened natural habitats. They indicate a high sensitivity to disturbances such as deforestation, mining, wildfires, or invasive alien species.

However, while the presence of biodiversity hotspots increases the ecological value of the forests concerned, it also reflects a relatively high level of ecosystem integrity, and therefore a moderate sensitivity to climate hazards. The weighting applied to this indicator reflects its mainly localized influence on biotic processes.

The table below presents the scoring thresholds for the forest biodiversity hotspot indicator by municipality, as well as the weighting coefficients applied to each major ecosystem type.

Indicator:	**Proportion of municipal area occupied by forest biodiversity hotspots**		
Source:	Birnbaum, P. (2024). Forest Hotspots in the Biodiversity Hotspot of New Caledonia (Version 2024) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.12740617		
Scoring rules and thresholds:			
1	2	3	4
> 10%	5 to 10%	> 0 to 5%	0%
Sensitivity weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
1	0	0	0

vi. Priority dry forest sites

Dry forest is one of the most threatened ecosystems in the territory. Today it occupies only about 3% of its original extent, is highly fragmented, and its ecological condition is often degraded. These forest remnants host an exceptional endemic biodiversity, including many rare or critically endangered plant and animal species. Dry forest is also a strategic ecosystem for maintaining ecological processes underlying numerous forest ecosystem services, which may support adaptation to droughts and heatwaves across the territory.

The identification of around sixty priority sites by a working group coordinated by the New Caledonia Conservatory of Natural Areas (CEN) was based on an analysis combining 18 biological, management, and vulnerability criteria. The more priority dry forest sites a municipality contains, the more sensitive it is to disturbances and the higher the conservation stakes. This indicator is strongly weighted because it directly reflects the biological and ecological sensitivity of the forest ecosystem within the natural range of dry forests.

The table below presents the scoring thresholds for the priority dry forest sites indicator by municipality, as well as the weighting coefficients applied to each major ecosystem type.

Indicator:	**Number of priority dry forest sites in the municipality (within the natural distribution area of dry forests)**		
Source:	ANCB		
Scoring rules and thresholds:			
1	2	3	4
> 5	1 to 5	0	NA
Sensitivity weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
2	0	0	0

vii. Priority sites for the regulation of invasive ungulates (deer and pigs)

The presence of deer and feral pigs represents a major pressure on forest ecosystems in New Caledonia. These invasive alien species destroy forest understorey vegetation, disrupt the regeneration of various endemic plant species, alter floristic composition, and promote soil erosion.

The priority control sites identified by Conservation International and the New Caledonia Conservatory of Natural Areas (CEN) in 2016 are based on a spatial analysis combining 12 biological, management, and vulnerability criteria. They highlight areas where these species cause the most damage due to the presence of multiple environmental stakes. A high proportion of the municipal area affected by these priority sites, therefore, reflects a high sensitivity of forests to the impacts of these invasive ungulates.

In secondary and anthropized environments, deer and pigs are responsible—though to a lesser extent—for a degradation of certain biotic processes, particularly through their role in dispersing invasive plant species, competing for resources in grazing areas, and impacting some crops.

Similarly, freshwater ecosystems are indirectly affected by the excessive presence of deer and feral pigs, mainly through soil erosion and the degradation of riverbanks. These animals promote sedimentation in rivers and wetlands, altering water quality and affecting aquatic habitats. Priority control areas thus indicate a particular sensitivity of the concerned watercourses.

Marine and coastal ecosystems are only indirectly and diffusely impacted by the presence of deer and feral pigs, notably through increased sediment loads in rivers flowing into the lagoon. As this phenomenon is better captured by other indicators, the proportion of municipal area prioritized

for the control of these species is not considered a determining sensitivity factor for these environments.

The table below presents the scoring thresholds for the indicator of priority sites for deer and feral pig control by municipality, along with the weighting coefficients applied to each major ecosystem type.

Indicator:	**Proportion of the municipal area that is a priority for the regulation of deer and feral pigs, weighted by the number of priority sites affecting the municipality**		
Source:	ANCB, CI (2016)		
Scoring rules and thresholds:			
1	2	3	4
> 50	20 to <50	< 20	0
Sensitivity weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
2	1	1	0

viii. Important areas for seabirds

Important Bird Areas (IBAs) refer to key sites for the conservation of seabird populations in New Caledonia, particularly for nesting, feeding, and resting for many species, some of which are endemic or threatened. The presence of an IBA within a municipal lagoon indicates a specific ecological sensitivity of these environments to human and environmental pressures.

These birds act as bioindicators of the health of marine ecosystems; however, their vulnerability is localized, and marine ecosystems are not all directly affected by their decline. As a result, IBAs contribute moderately to the overall sensitivity score of marine and coastal ecosystems.

The table below presents the scoring thresholds for the indicator of Important Bird Areas at the municipal scale, along with the weighting coefficients applied to each major ecosystem type.

Indicator:	**Presence of an IBA in the communal lagoon**
Source:	SCO

Scoring rules and thresholds:			
1	2	3	4
	Attendance	Absence	
Sensitivity weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
0	0	0	1

ix. Reef health status

The health status of coral reefs, assessed in New Caledonia at around one hundred stations by the Coral Reef Observation Network (RORC), is an indicator of the sensitivity of marine and coastal ecosystems in New Caledonia. Reef health depends on various factors, including sedimentation associated with erosion processes linked to anthropogenic pressures and invasive ungulates, as well as the effects of climate change, such as bleaching caused by ocean warming and the physical impacts of strong swells during cyclonic events.

However, these degradations vary among sites, and New Caledonian reefs show a generally good capacity for regeneration: most monitored reefs are characterized by a medium-term trend toward improvement or stability in their health status rather than deterioration. Their sensitivity is therefore relatively limited, and reef health can only contribute to a limited extent to informing the overall sensitivity of these ecosystems.

The table below presents the scoring thresholds for the indicator of the RORC average health status at the municipal scale, along with the weighting coefficients applied to each major ecosystem type.

Indicator:	**Average score over the period 2023-2024 of the state of health of the reefs on all RORC stations in the communal lagoon**		
Source:	RORC		
Scoring rules and thresholds:			
1	2	3	4
Less than 1.5	1.5 to 2.4	2.5 to 3.4	3.5 and above
Sensitivity weight, by ecosystem type:			

Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
0	0	0	1

x. Marine biodiversity

The perceptions of local stakeholders (fishers, coastal residents, managers of marine protected areas, and scientists) constitute empirical knowledge, often derived from expertise developed through long-term observation and traditional knowledge, enabling the detection of degradation trends directly linked to the provision of essential ecosystem services for human populations.

A negative perception of the state of marine biodiversity generally reflects high sensitivity to various environmental and anthropogenic pressures, such as overexploitation of resources, coral reef degradation, marine pollution, and the effects of climate change. The perceptions of local stakeholders may also indirectly influence natural resource management, conservation practices, and policy decisions related to the preservation of marine environments.

The table below presents the scoring thresholds for the indicator of marine biodiversity status, along with the weighting coefficients applied to each major ecosystem type.

Indicator:	**Qualitative perception of the state of marine biodiversity by local stakeholders**		
Source:	Vulnerability map of the PacPath project in New Caledonia, supplemented by information gathered from experts (S. Job, L. Wantiez)		
Scoring rules and thresholds:			
1	2	3	4
Degraded biodiversity	Average biodiversity	Good biodiversity	Very good biodiversity
Sensitivity weight, by ecosystem type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
0	0	0	2

b. *Mapping result: sensitivity of ecosystems*

The maps below show the overall sensitivity score, calculated by municipality for each major ecosystem type based on all the indicators mentioned above and their respective weighting.

Due to the lack of local data on forest ecosystems, the Loyalty Islands were not included in the sensitivity analysis. Only the forests of the Isle of Pines show a very low level of sensitivity.

In the North Province, the municipalities whose forests are the most sensitive include Poya and Pouembout on the west coast, mainly because of the strong edge effect affecting highly fragmented local forests and the presence of numerous priority dry forest sites, as well as Ponérihouen and Hienghène on the east coast, due to the local importance of forest biodiversity hotspots and priority areas for regulating feral deer and pigs.

In the South Province, the forests of Dumbéa, Païta, Boulouparis, Thio, and Moindou are the most sensitive, primarily because of a pronounced edge effect linked to forest fragmentation and the importance of priority sites for managing invasive ungulates. Dumbéa also hosts a relatively large area of forest biodiversity hotspots, while many priority dry forest conservation sites are in Païta.

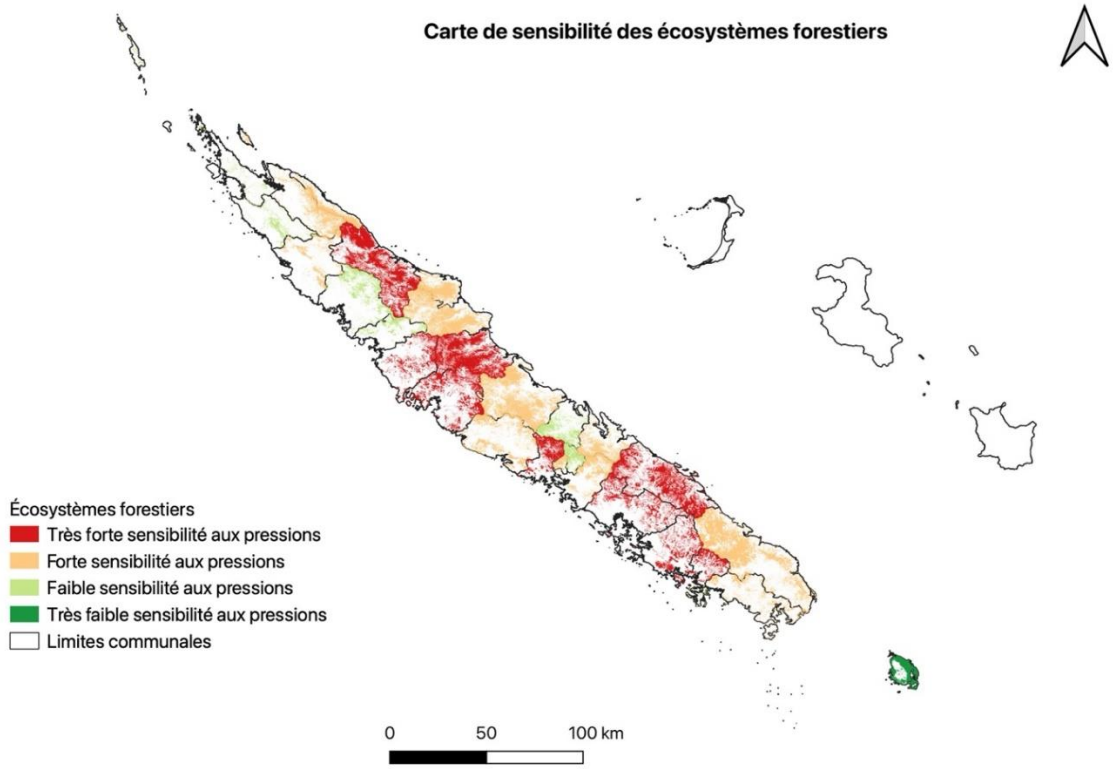


Figure 19 : Summary map of the level of sensitivity of New Caledonia's forest ecosystems to climatic hazards and other anthropogenic threats

Due to the lack of local data on forest ecosystems, this sensitivity analysis includes all terrestrial ecosystems of the Loyalty Islands, which exhibit a very low level of sensitivity to pressures.

In the South Province, only the secondary and anthropized terrestrial ecosystems of Nouméa and the Isle of Pines also show a very low level of sensitivity. All other municipalities in the province are characterized by very high sensitivity of secondary terrestrial ecosystems, as tree cover outside forested areas is very limited.

In the North Province, secondary terrestrial ecosystems are generally less sensitive, except the municipalities of Poya and Pouembout on the west coast, and Houailou, Ponérihouen, Hienghène, and Pouébo on the east coast, due to low tree cover outside forests and the significance of priority areas for regulating deer and pigs at the municipal scale.

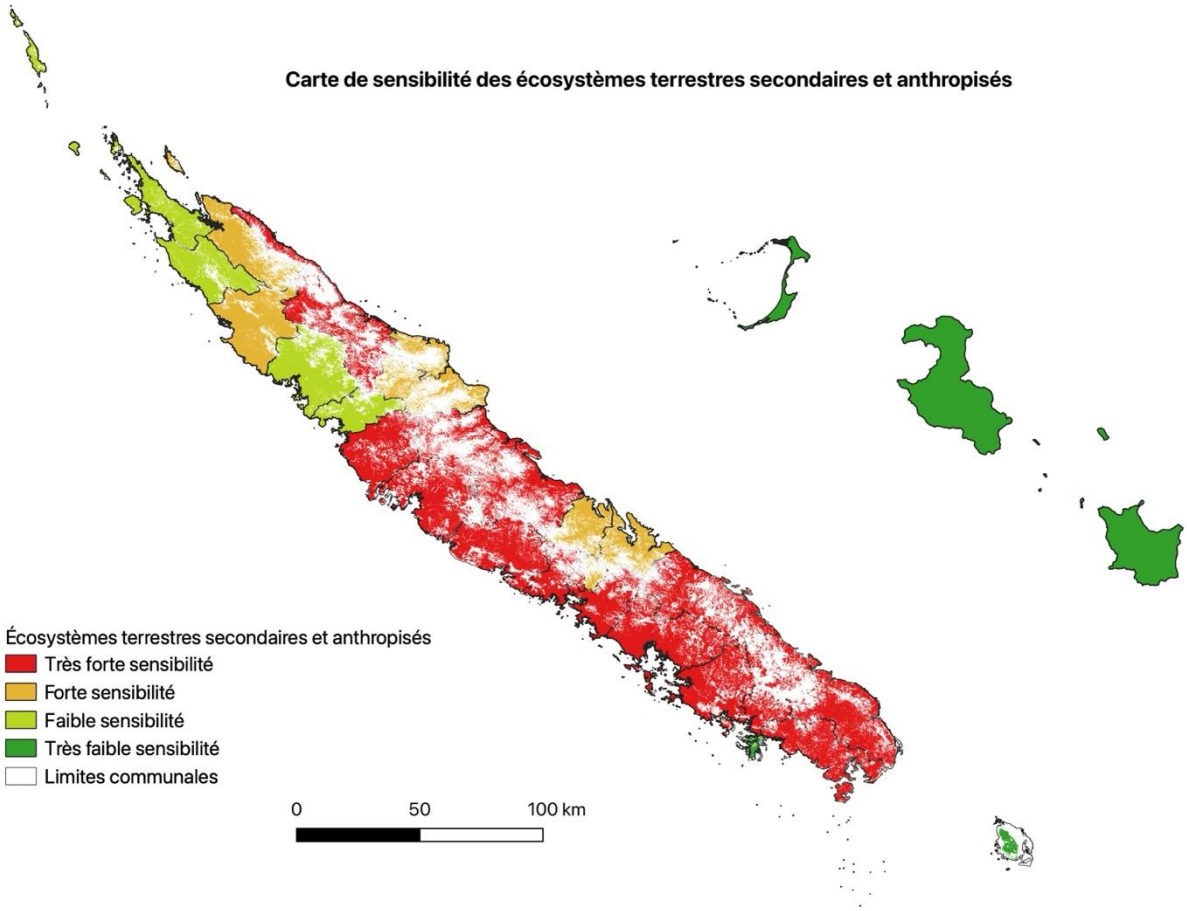


Figure 20 : Summary map of the level of sensitivity of New Caledonia's secondary and anthropogenic terrestrial ecosystems to climatic hazards and other anthropogenic threats

The sensitivity of freshwater ecosystems could only be assessed using a single indicator: the relative importance of priority areas for regulating deer and pigs at the municipal scale.

Based on this single indicator, the most sensitive freshwater ecosystems are those of Païta, Dumbéa, Boulouparis, Farino, and Moindou in the South Province, and those of Houailou, Ponérihouen, Hienghène, and Pouébo in the North Province.

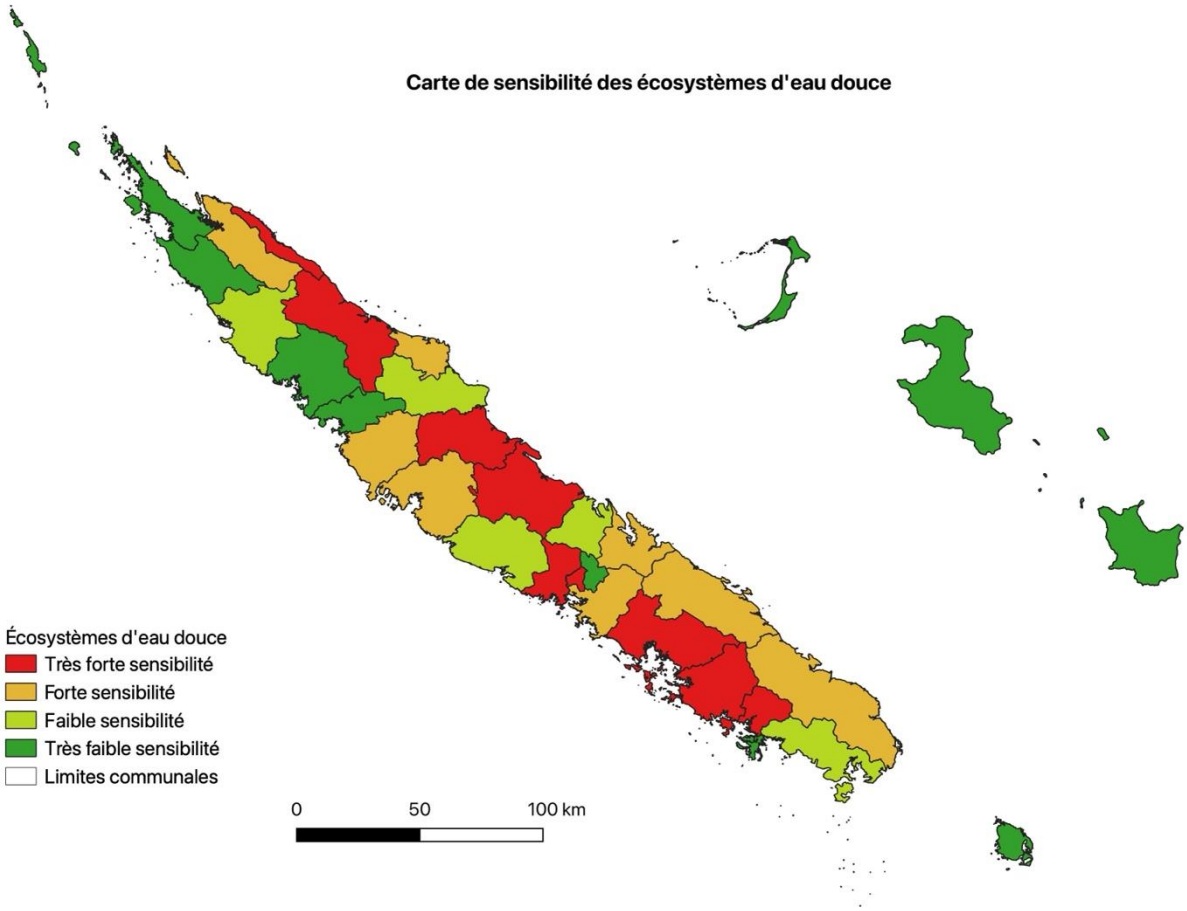


Figure 21 : Summary map of the level of sensitivity of New Caledonia's freshwater ecosystems to climatic hazards and other anthropogenic threats

The sensitivity of marine and coastal ecosystems, measured using five indicators, appears to be very low in the Loyalty Islands and in Bélep, and is also low in the Far North and Far South regions of the territory.

A relatively high sensitivity is observed along the coastal region of the west coast, from Païta to Kaala-Gomen, and along the east coast, from Houailou to Pouébo. This sensitivity is mainly

explained by the greater relative importance of sensitive ecosystems there, namely mangroves and coral reefs.

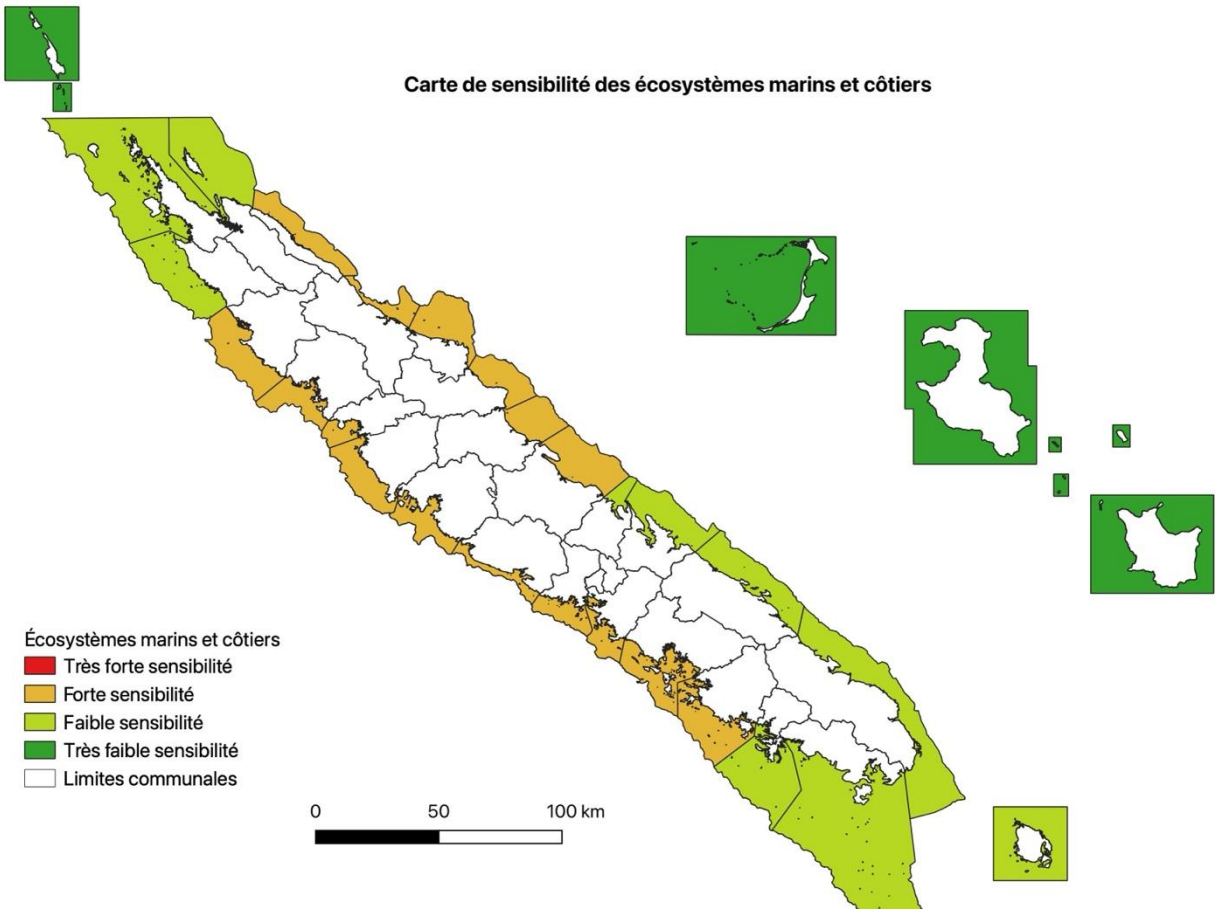


Figure 22 : Summary map of the level of sensitivity of New Caledonia's marine and coastal ecosystems to climatic hazards and other anthropogenic threats

4. Adaptive capacity: means of sustainable management of ecosystems

a. Indicators of adaptive capacity

The analysis of the adaptive capacity of New Caledonia's ecosystems is based on the assumption that the intrinsic resilience of ecosystems is weakened by the cumulative pressures they face. These pressures, already assessed in the Exposure component, reduce the ability of ecosystems to respond naturally to disturbances, particularly those related to climate change. Thus, the effectiveness of ecosystem adaptive capacity depends mainly on the sustainability of management measures dedicated to their conservation or restoration.

In this context, only long-term measures were retained as indicators of adaptive capacity. These include regulatory protections, ecological monitoring networks, and long-term management tools that promote a sustainable approach and multi-stakeholder mobilization for conservation. Conversely, short-term projects, although potentially beneficial, were not considered effective long-term levers in the absence of mechanisms ensuring continuity of funding and actions.

Depending on the ecosystem, a significant part of adaptive capacity to climate change effects may rely on their ability to migrate or expand naturally. However, this dimension was not included in the analysis for several reasons:

- For forests and other terrestrial ecosystems, migration needs mainly concern individual species rather than the ecosystem as a whole, except for cloud forests, which have almost no migration capacity due to their physical limitation by mountain altitude.
- For mangroves and freshwater ecosystems, potential barriers to migration are already accounted for through indicators of urban, agricultural, and aquaculture pressures.
- For seagrass meadows and coral reefs, no measurable barriers at the territorial scale were identified.

The selection of adaptive capacity indicators, therefore, focused on factors favourable to sustainable ecosystem management, which directly or indirectly contribute to their conservation and resilience to climate change impacts.

i. Ungulate regulation capacity in the municipality

The capacity to regulate invasive ungulates (deer and feral pigs) was assessed through the maximum hunting effort recorded within a municipal management unit during the "Mâchoires" operation (2008–2015).

Regulating deer and pig populations is essential to limit the pressure they exert on ecosystems through the various mechanisms previously described. The mobilization potential of hunters to implement effective regulation strategies represents an indicator of the human resources that can be deployed to significantly reduce the vulnerability of forest and freshwater ecosystems, and to a lesser extent, that of secondary terrestrial ecosystems and marine and coastal ecosystems.

The table below presents the scoring thresholds for the indicator of invasive ungulate regulation capacity within the municipality, and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Maximum hunting effort obtained in a MU of the municipality**		
Source:	Data from Operation Jaws 2008-2015 (ANCB, Rural Agency)		
Scoring rules and thresholds:			
1	2	3	4
< 80	80 to 228	228 to 860	>,860
Adaptive Capacity Component Weights by Ecosystem Type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
2	1	2	1

ii. Sustainable management of dry forests

The sustainable management of dry forests, a particularly threatened ecosystem in New Caledonia, is a key factor in their adaptive capacity to anthropogenic pressures and the effects of climate change.

The presence of sustainably managed sites within a municipality reflects the implementation of protection and restoration measures aimed at limiting degradation and promoting the resilience of these ecosystems. These actions include reducing pressures from invasive animal and plant species, preserving biodiversity core areas, active ecological restoration (planting), and engaging and raising awareness among local stakeholders. Through these efforts, sustainably managed dry forests have a greater capacity for regeneration and enhanced resilience to climate change.

However, these effects remain limited and locally concentrated within a few forest fragments of an ecosystem that is overall highly degraded. For this reason, the scoring rules applied do not allow for the assignment of extreme scores (high or low).

The table below presents the scoring thresholds for the indicator of sustainable dry forest management and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Sustainable management of dry forest sites within the natural range of dry forests**
Source:	ANCB
Scoring rules and thresholds:	

1	2	3	4
NA	No sustainably managed MSDS sites in the municipality	Sustainable management of at least 1 SF site in the municipality	NA
Adaptive Capacity Component Weights by Ecosystem Type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
2	0	0	0

iii. Master plans for the conservation of rare and threatened species

The mobilization of local stakeholders around a master conservation plan for rare and threatened species represents an important lever for strengthening the adaptive capacity of their habitats—namely forest ecosystems—facing anthropogenic pressures and the effects of climate change.

In New Caledonia, primary forests host exceptional biodiversity characterized by high endemism and strong vulnerability. The implementation of a conservation plan promotes coordinated and sustainable management, focused on the implementation of prioritized actions in consultation with local stakeholders. The more advanced the plan is in its development and implementation, the more it reflects the engagement of stakeholders and the potential for sustained involvement in ecosystem management.

The table below presents the scoring thresholds for the indicator of master plans for the conservation of rare and threatened species and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Status of the mobilization of local actors around a CDP**		
Source:	CBN-NC		
Scoring rules and thresholds:			
1	2	3	4
All other municipalities	PDC under development	PDC in the process of being finalized	PDC Validated or Finalized
Adaptive Capacity Component Weights by Ecosystem Type:			

Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
1	0	0	0

iv. Protected natural areas on land

The regulatory protection of terrestrial natural areas provides an institutional framework that supports ecosystem conservation, limits anthropogenic pressures, and maintains essential ecological processes.

Protected areas are a key tool for reducing forest fragmentation and degradation by prioritizing the regulation of invasive alien species and ecological restoration, while also restricting human access and activities. Awareness-raising among local stakeholders and the positive effects on forest biodiversity partly extend to anthropogenic areas, some of which may be included within protected areas. Terrestrial protected areas can also indirectly contribute to the protection of freshwater ecosystems, notably by limiting erosion, the runoff of chemical or terrigenous pollutants, and the destruction of wetlands.

However, the effectiveness of protected areas remains limited by the resources dedicated to the specific management of watersheds, which is why a moderate weighting was assigned to this indicator.

The table below presents the scoring thresholds for the indicator of protected terrestrial natural areas and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Number and type of terrestrial protected areas by municipality**		
Source:	North Province, South Province, and Terrestrial buffer zones of UNESCO World Heritage properties		
Scoring rules and thresholds:			
1	2	3	4
0	1	> 1	at least 1 strict nature reserve
Adaptive Capacity Component Weights by Ecosystem Type:			
Forest ecosystems	Secondary and anthropogenic	Freshwater ecosystems	Marine and coastal ecosystems

	terrestrial ecosystems		
1	1	1	0

v. Protected marine natural areas

Marine protected areas help strengthen the adaptive capacity of marine and coastal ecosystems in the face of anthropogenic pressures and the effects of climate change. They serve as a tool for the sustainable management of marine resources by promoting the protection of sensitive habitats and regulating human activities that impact these environments, such as fishing and recreational boating.

The establishment of a marine protected area therefore reduces pressure on marine biodiversity and supports the resilience of marine ecosystems, notably by maintaining healthy fish populations, protecting breeding areas, and minimizing disturbances.

The table below presents the scoring thresholds for the indicator of protected marine natural areas and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Number and type of marine protected areas by municipality**		
Source:	North Province, South Province, properties, and marine buffer zones of UNESCO World Heritage properties		
Scoring rules and thresholds:			
1	2	3	4
0 AMP	1 MPA	1 UNESCO property	At least 1 strict nature reserve
Adaptive Capacity Component Weights by Ecosystem Type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
0	0	0	2

vi. Water protection zones for drinking water supply

Water protection zones target natural areas that must be preserved to ensure the quality and availability of water resources. By limiting pollution sources (agricultural, urban and industrial effluents), reducing degradation risks linked to human activities, and constituting priority areas for managing threats such as invasive ungulates—sources of sediment pollution and pathogen contamination—these zones directly contribute to the adaptive capacity of freshwater ecosystems facing multiple pressures.

Forest ecosystems, whose good ecological condition is essential for maintaining an adequate supply of freshwater in both quantity and quality, are also directly concerned by the establishment of water protection zones and the management actions implemented within them.

However, as with protected areas, although the establishment of a regulatory perimeter is an undeniable lever for strengthening adaptive capacity, its effectiveness necessarily depends on the management resources associated with it.

The table below presents the scoring thresholds for the indicator of water protection zones for drinking water supply and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Proportion of the municipal area covered by PPE**		
Source:	DAVAR		
Scoring rules and thresholds:			
1	2	3	4
< 10%	10 to 25%	25 to 50%	> 50%
Adaptive Capacity Component Weights by Ecosystem Type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
1	0	2	0

vii. Monitoring the health of coral reefs

Participatory, scientific, industrial, and regulatory monitoring stations in the lagoon make it possible to collect data on the ecological status of coral reefs, water quality, changes in fish populations, and the dynamics of coastal ecosystems. This information is essential for adapting conservation strategies and assessing the effectiveness of management measures implemented, particularly in response to anthropogenic pressures and the effects of climate change. By

strengthening managers' ability to anticipate and respond to threats, this indicator is considered to contribute moderately to the adaptive capacity of marine ecosystems.

The table below presents the scoring thresholds for the coral reef health monitoring indicator and the weighting coefficients applied to each major ecosystem type.

Indicator:	**Number of participatory, scientific, industrial and regulatory monitoring stations present in the municipal lagoon**		
Source:	IFRECOR 2020		
Scoring rules and thresholds:			
1	2	3	4
0 stations	1 to 5 stations	6 to 10 stations	>10 stations
Adaptive Capacity Component Weights by Ecosystem Type:			
Forest ecosystems	Secondary and anthropogenic terrestrial ecosystems	Freshwater ecosystems	Marine and coastal ecosystems
0	0	0	1

b. Mapping result: capacity for sustainable management of ecosystems

The maps below show the overall ecosystem adaptive capacity score, calculated by municipality for each major ecosystem type based on all the sustainable management indicators and their weighting.

Due to the lack of local data relating to forest ecosystems, the Loyalty Islands were not included in the analysis of their adaptive capacity.

At the territorial scale, forests display an overall low adaptive capacity.

In the South Province, only the forests of Boulouparis, Sarraméa and Bourail show good adaptive capacity, mainly due to a relatively high capacity for ungulate regulation and the extent of protected natural areas or water protection perimeters.

In the North Province, the municipalities whose forests exhibit the best adaptive capacity are Poya and Pouembout, thanks to the mobilisation of local stakeholders around a master conservation plan for rare and threatened species (ERM), the sustainable management of priority dry forest sites, and a relatively high capacity for ungulate regulation.

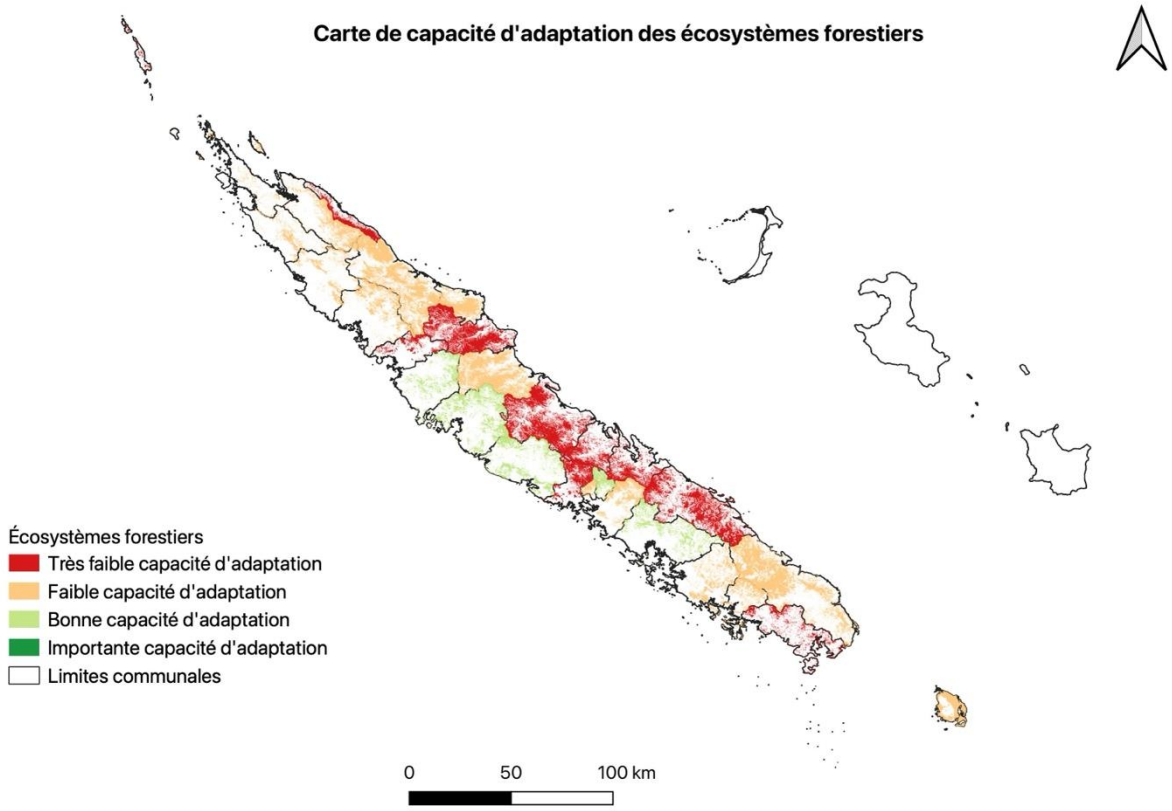


Figure 23 : Summary map of the relative capacity for adaptation through the sustainable management of New Caledonia's forest ecosystems

Due to the lack of local data on forest ecosystems, the assessment of the adaptive capacity of secondary and anthropised terrestrial ecosystems also includes all terrestrial ecosystems of the Loyalty Islands (except Ouvéa, for which no data were available). The terrestrial ecosystems of Lifou and Maré show a very low level of adaptive capacity to pressures.

Only the secondary and anthropised terrestrial ecosystems of Boulouparis and Bourail in the South Province, and Hienghène and Ouégoa in the North Province, display good adaptive capacity. In these municipalities, the results reflect a relatively high capacity for ungulate regulation and the significant area covered by protected natural spaces.

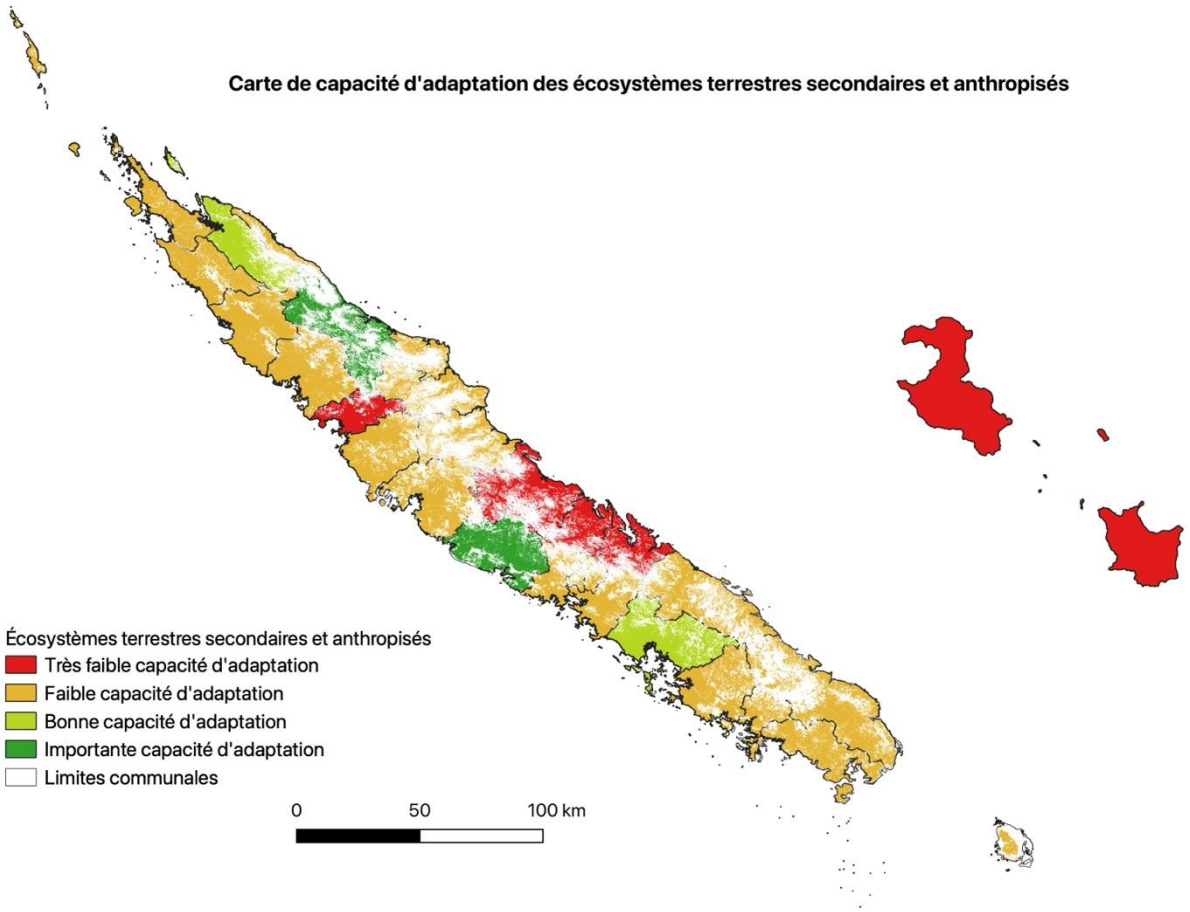


Figure 24 : Summary map of the relative capacity for adaptation through the sustainable management of secondary and anthropogenic terrestrial ecosystems in New Caledonia

At the territorial scale, as with terrestrial ecosystems, freshwater ecosystems show an overall low to very low adaptive capacity.

Based on the indicators considered, the municipalities with the strongest adaptive capacity for freshwater ecosystems are Dumbéa, Boulouparis, Farino, Sarraméa, and Bourail in the South Province, and Voh in the North Province. This is explained by a relatively high capacity for ungulate regulation and the significant area covered by water protection zones in these municipalities, as well as by the relative importance of protected natural areas in Dumbéa, Bourail, and Boulouparis.

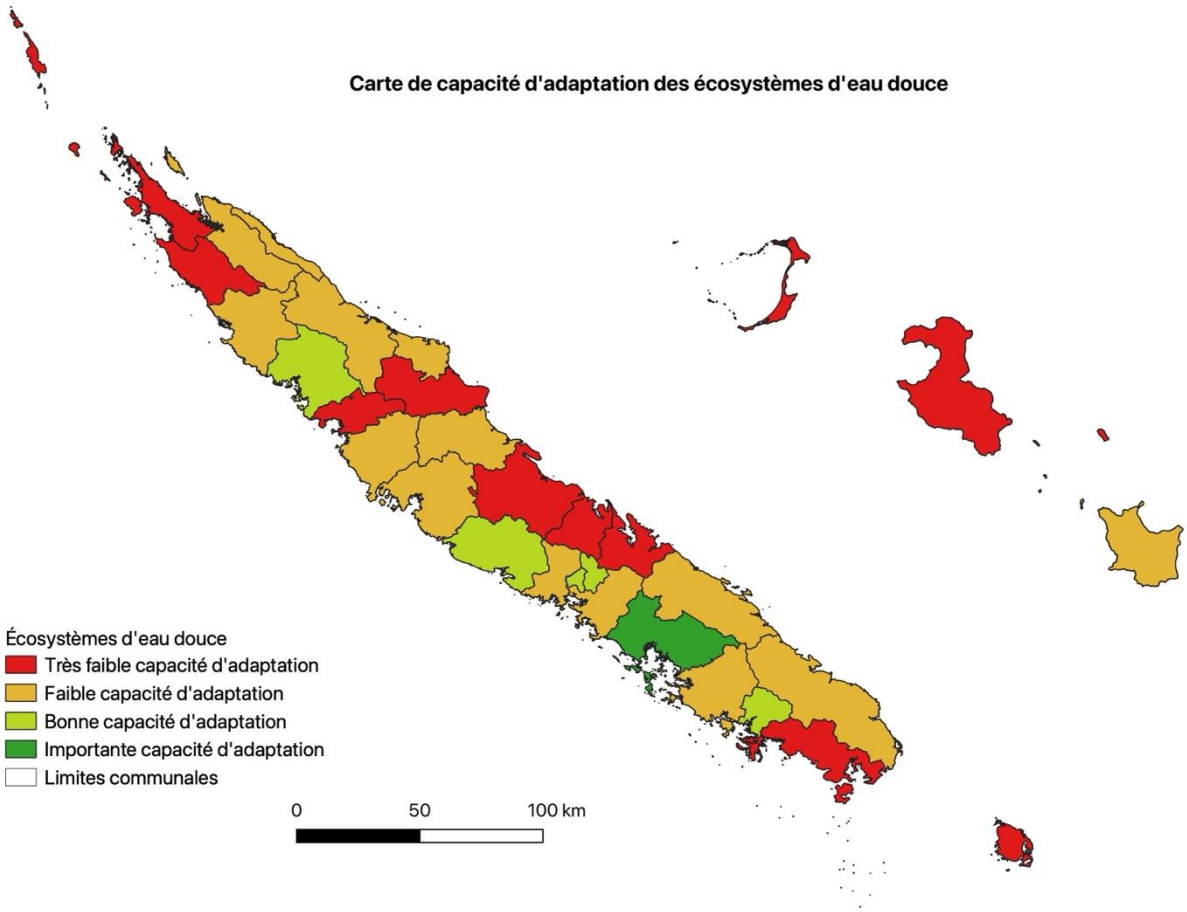


Figure 25 : Summary map of the relative capacity for adaptation through sustainable management of New Caledonia's freshwater ecosystems

Most municipalities in New Caledonia have a relatively high adaptive capacity for marine and coastal ecosystems.

Based on the indicators considered, a very low adaptive capacity of marine ecosystems is observed only off the municipalities of Dumbéa and Païta in the South Province, and Canala, Kouaoua, and Ponérihouen in the North Province. These municipalities lack marine protected areas, the number of coral reef monitoring stations is zero or low, and the capacity to regulate deer and feral pigs is very limited.

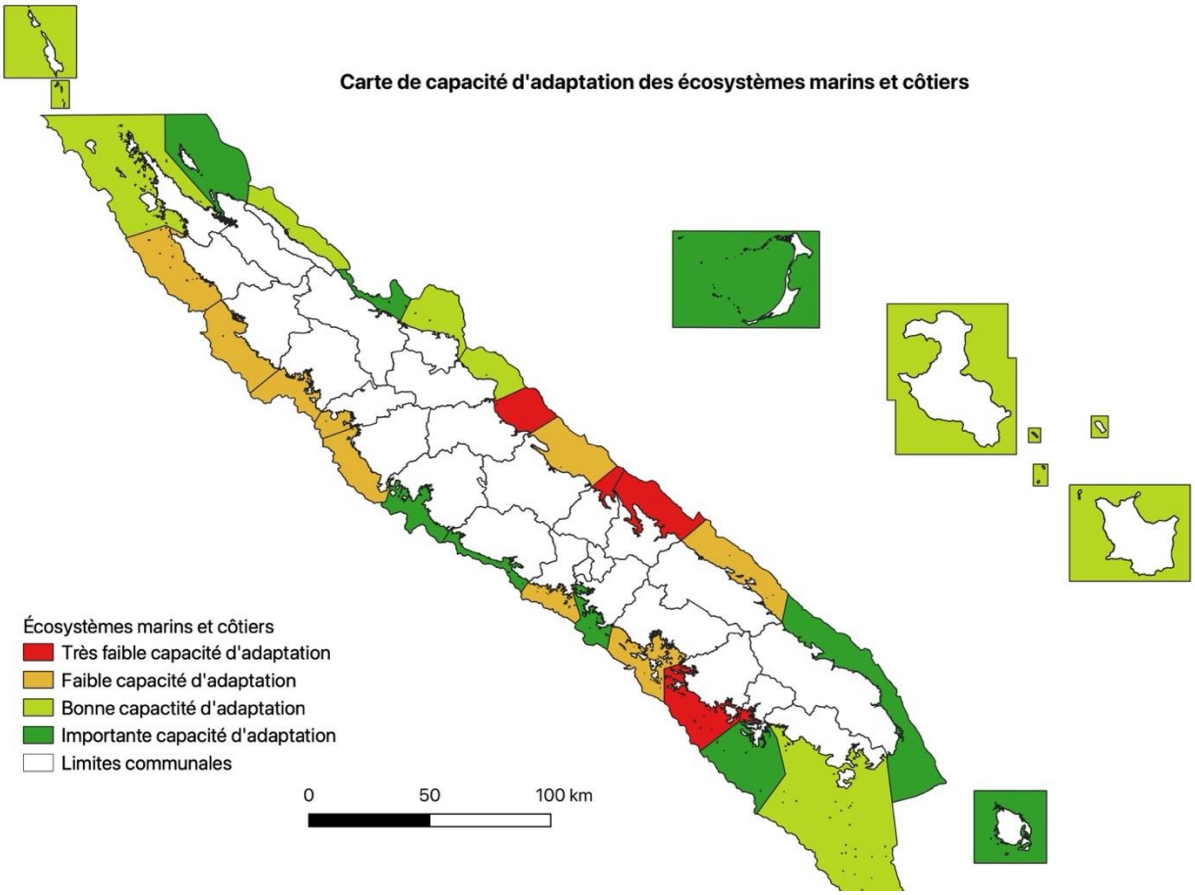


Figure 26 : Synthesis map of the relative capacity for adaptation through sustainable management of New Caledonia's marine and coastal ecosystems

5. Ecosystem resilience mapping

The maps below show the overall ecosystem resilience score, calculated by aggregating exposure, sensitivity, and adaptive capacity scores by municipality for each major ecosystem type.

Due to the lack of local data on forest ecosystems, no resilience score could be assigned to forests in the Loyalty Islands.

At the territorial scale, the resilience of forest ecosystems is generally low to very low. Only the forests of Île des Pins, Bélep, and Sarraméa can be considered as having a good level of resilience concerning all the pressures considered.

Païta and Thio in the South Province, and Canala and Houailou in the North Province, are the municipalities where forest ecosystems are the least resilient. These municipalities are particularly vulnerable to mining pressure and wildfires, and to varying degrees to ungulate pressure and forest fragmentation. These elements should be considered to appropriately guide management measures aimed at strengthening forest resilience in these areas.

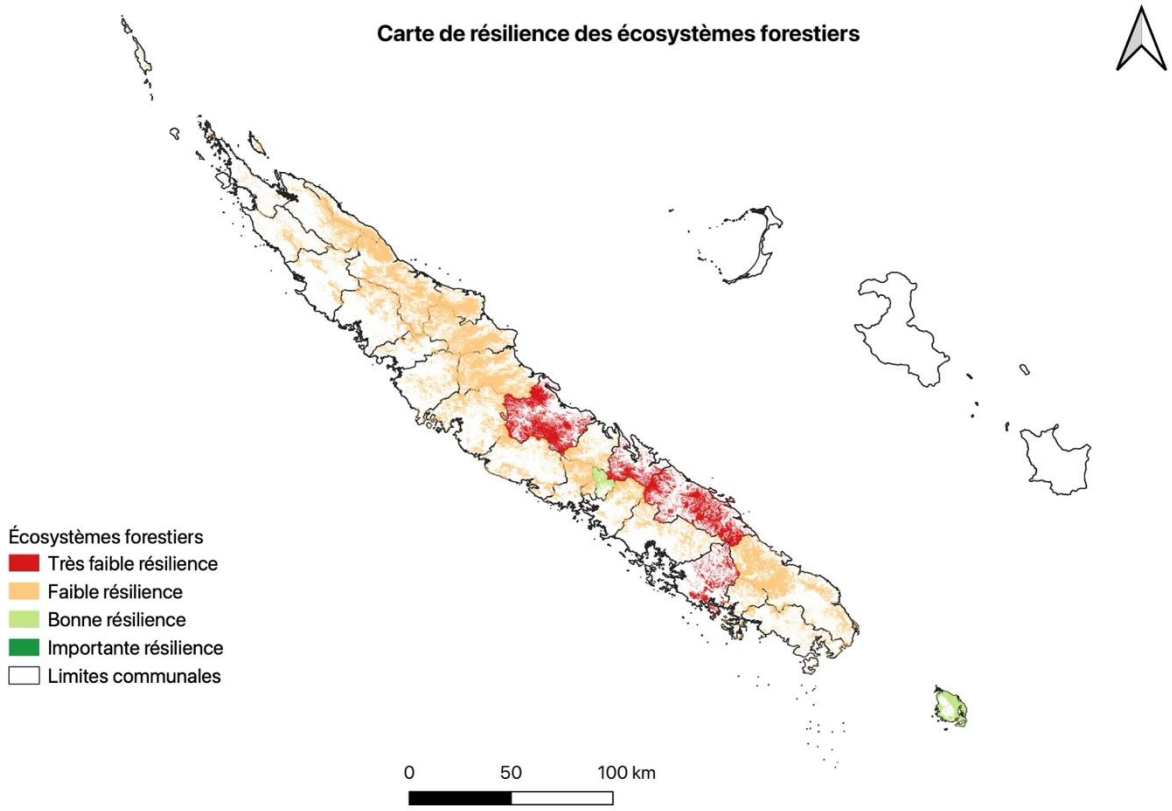


Figure 27 : Summary map of the level of resilience of New Caledonia's forest ecosystems

Due to the lack of local data on forest ecosystems, all terrestrial ecosystems of the Loyalty Islands are included in the resilience analysis of secondary and anthropised terrestrial ecosystems in New Caledonia. The resilience of terrestrial ecosystems appears to be good in Lifou and Maré, and even higher in Ouvéa. However, these results rely on very partial data compared with those included in the analysis for the other two provinces and would therefore need further investigation.

In the North and South Provinces, the resilience of secondary and anthropised terrestrial ecosystems is low in most municipalities. These ecosystems appear particularly vulnerable in two municipalities: Païta in the South Province and Houailou in the North Province.

In Païta, this is explained by the combination of urban and agricultural pressures, wildfire risk, and several invasive alien species, together with a high level of sensitivity to these pressures.

In Houailou, this result is mainly due to the high pressure from wildfires and invasive ungulates, to which these ecosystems are highly sensitive, and for which management capacity is low.

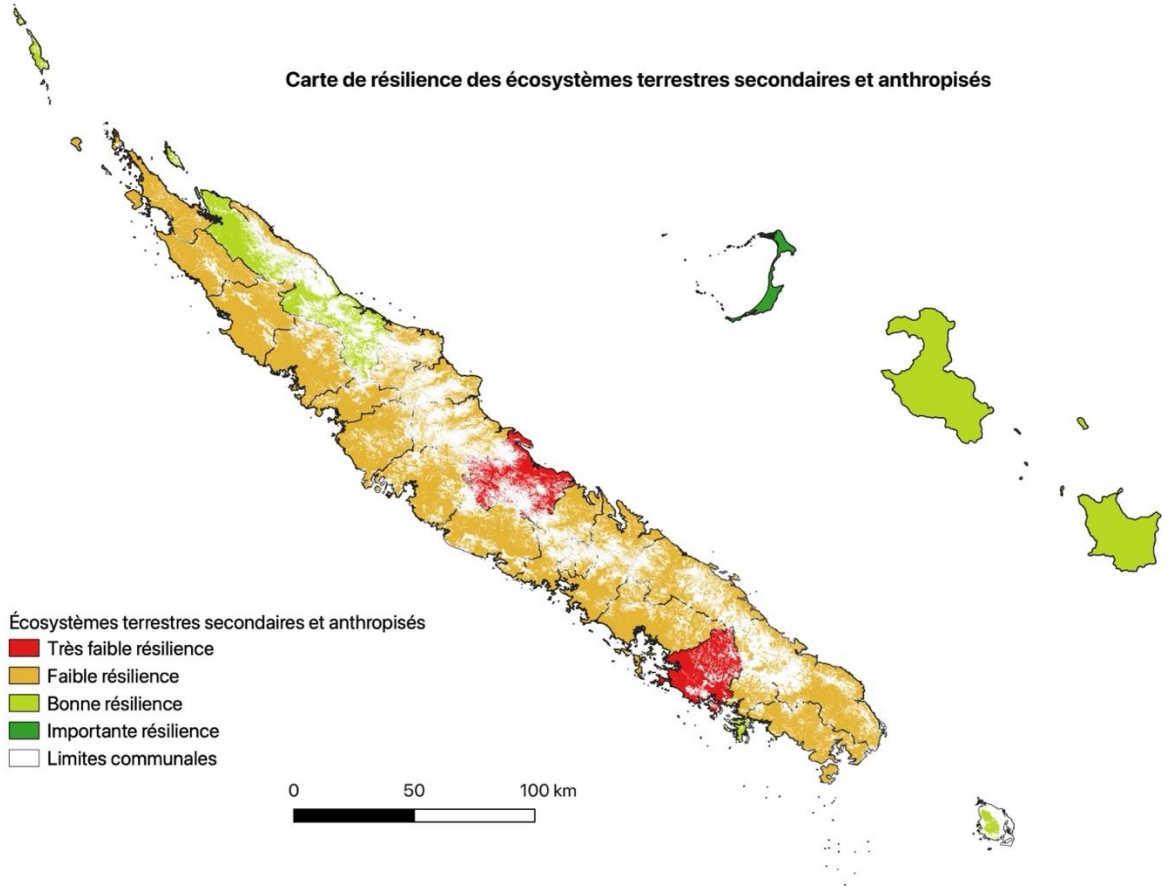


Figure 28 : Summary map of the level of resilience of secondary and anthropogenic terrestrial ecosystems in New Caledonia

The distribution of resilience levels for freshwater ecosystems is broadly similar to that of terrestrial ecosystems. The municipalities where freshwater ecosystems appear most vulnerable are Païta, Canala and Houailou.

Canala is the municipality in the territory with the lowest adaptive capacity across all ecosystems and indicators combined. The exposure and sensitivity of its waterways to pressures from mining, wildfires, and invasive ungulates are therefore not offset by any of the long-term management measures considered in the analysis.

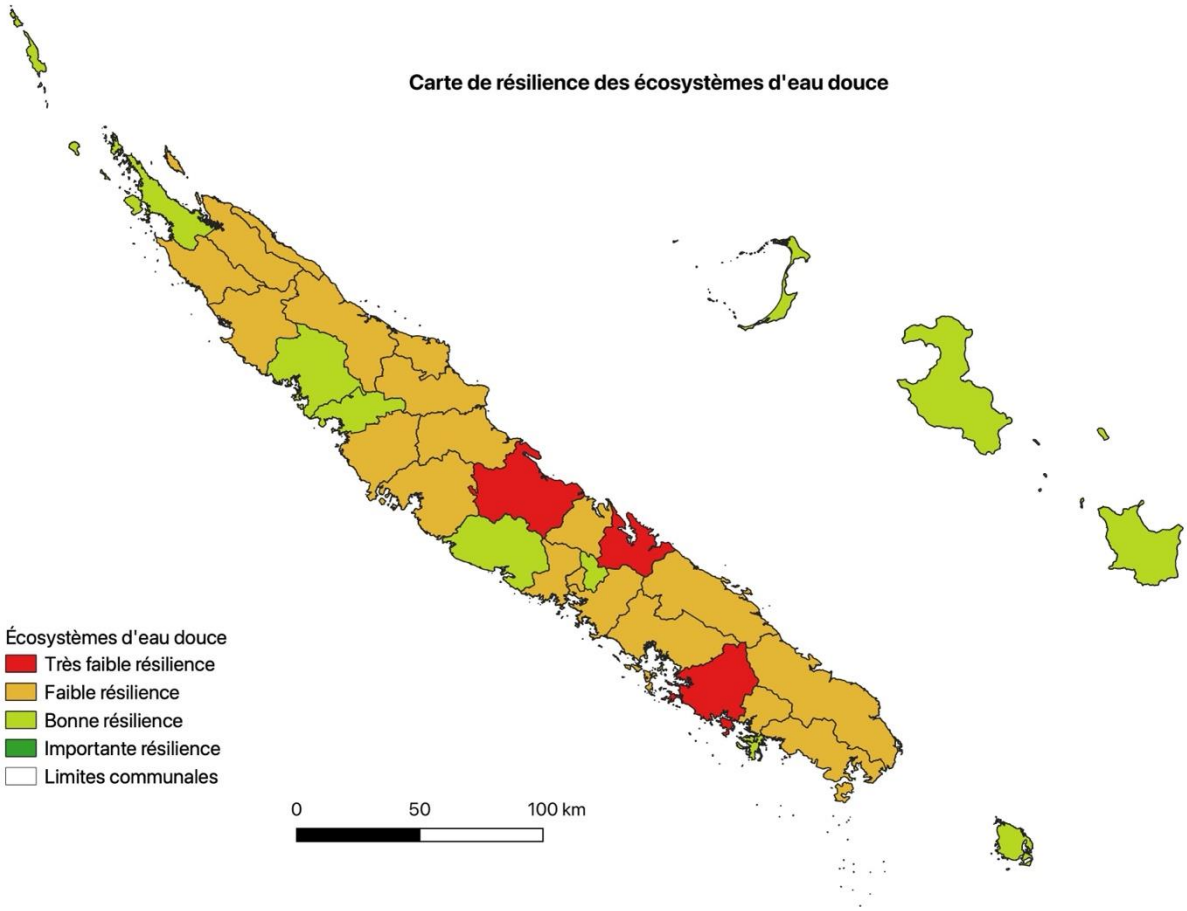


Figure 29 : Summary map of the level of resilience of New Caledonia's freshwater ecosystems

Finally, marine and coastal ecosystems are the most resilient in New Caledonia. Although exposed to various pressures, these remain sufficiently limited so as not to alarmingly affect the ecological condition of these ecosystems and are partly offset by a range of management measures that support their adaptive capacity.

More generally, any actions aimed at reducing the vulnerability of terrestrial and freshwater ecosystems will also benefit marine ecosystems, which therefore do not appear to be a priority target for specific interventions.

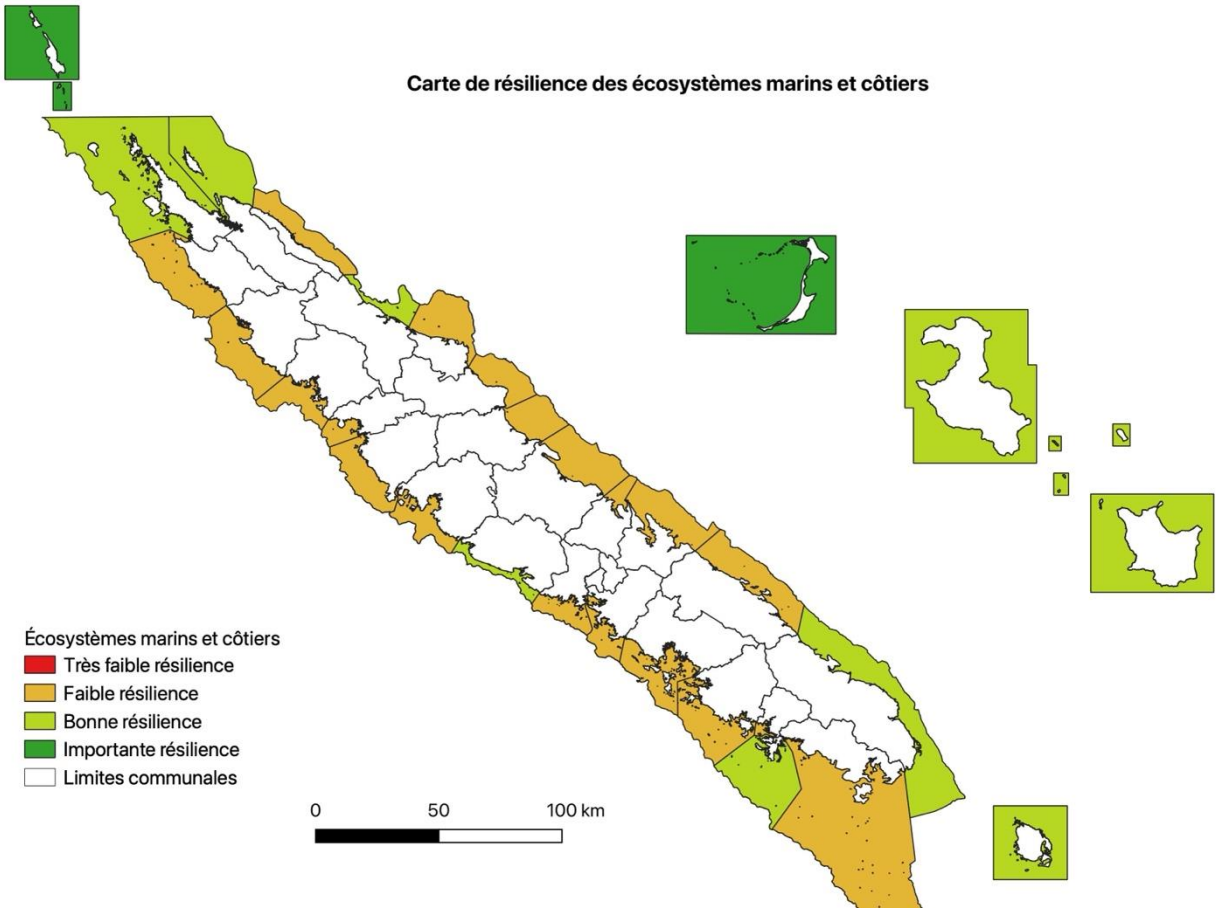


Figure 30 : Summary map of the level of resilience of New Caledonia's marine and coastal ecosystems

D. Analysis and mapping of socio-economic resilience in New Caledonia

1. Cross-analysis of the importance of issues within each province

a. South Province

According to the weighting assigned by representatives of the operational departments of the local authority, professional agriculture is identified in South Province as the main issue, followed by tourism and the mining and quarrying sector. Livestock farming and forestry are also considered major issues.

Among infrastructures, drinking water supply networks appear to be the most critical. Finally, concerning human well-being, food and water security is perceived as the priority issue.

Répartir 100 points selon l'importance stratégique de chaque enjeu socio-économique dans votre province.	
Enjeux économiques	
Agriculture professionnelle	11
Tourisme	10
Mines et carrières	10
Élevage	9
Sylviculture	9
Agriculture d'autosubsistance	5
Pêche professionnelle	3
Pêche de loisir et d'autosubsistance	2
Aquaculture	2
Energies renouvelables	1
Transports	1
Enjeux infrastructurels	
Infrastructures routières	2
Réseaux AEP, captages et PPE	7
Ports et aéroports	1
Bâtiments	1
Réseaux de télécommunication	1
Réseau électrique	1
Enjeux de bien-être humain	
Santé publique	6
Sécurité alimentaire et en eau	15
Éducation, transmission des savoirs	3
Total	100

b. North Province

Répartir 100 points selon l'importance stratégique de chaque enjeu socio-économique dans votre province.	Province Nord
Agriculture professionnelle	8
Agriculture d'autosubsistance	8
Élevage	3
Pêche professionnelle	4
Pêche de loisir et d'autosubsistance	4
Aquaculture	2
Sylviculture	3
Tourisme	2
Energies renouvelables	4
Mines et carrières	2
Transports	3
Infrastructures routières	6
Ports et aéroports	4
Bâtiments	2
Réseaux AEP, captages et PPE	13
Réseaux de télécommunication	2
Réseau électrique	2
Santé publique	7
Sécurité alimentaire et en eau	9
Éducation, transmission des savoirs	13
Total	100

In North Province, the main issues identified are agriculture (both commercial and subsistence), followed by fisheries and renewable energy. Regarding infrastructure, drinking water supply networks (DWS) and water protection perimeters (WPP) are considered essential, as in South Province. To a lesser extent, road infrastructure also represents an important issue. Finally, in terms of human well-being, education and knowledge transmission emerge as the major priorities. However, all issues within this category received a high overall assessment.

2. Analysis and mapping of the resilience of economic activities

This analysis was carried out at the municipal level for three categories of socio-economic issues:

- **Economic activities**, including agriculture, livestock farming and forestry, fisheries and aquaculture, tourism, and mining/quarrying activities. The energy and transport sectors were examined from the perspective of their infrastructure.
- **Infrastructure**, including main roads, ports and airports, healthcare facilities, drinking water supply networks (DWS), and electricity networks.
- **Well-being**, encompassing public health, food security, and water security. Education and knowledge transmission were incorporated under adaptive capacity rather than as a vulnerability to climate change.

a. Agriculture, livestock farming, forestry

i. Overview and importance of the sector

Here, the focus is specifically on professional activities related to these sectors, excluding subsistence agriculture and livestock farming, which were incorporated into the analysis of food security under the well-being category.

In 2022, at the scale of New Caledonia, the agricultural sector accounted for 2.2% of value added and 2.6% of salaried employment, representing 1,762 employees. Among the 7,117 primary-sector holdings recorded by SRIDET, 77% are primarily dedicated to crop production, fishing and hunting activities, while 1.3% focus on forestry and logging. As shown in the figure below, crop production is dominated by fruits and vegetables, far ahead of cereals, vanilla, coffee, and sandalwood, for example, while animal production is mainly structured around the poultry, cattle, and pig sectors.

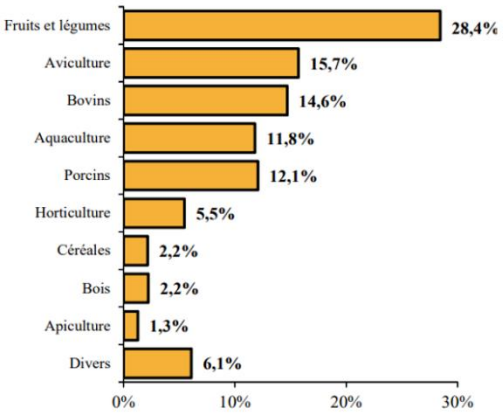
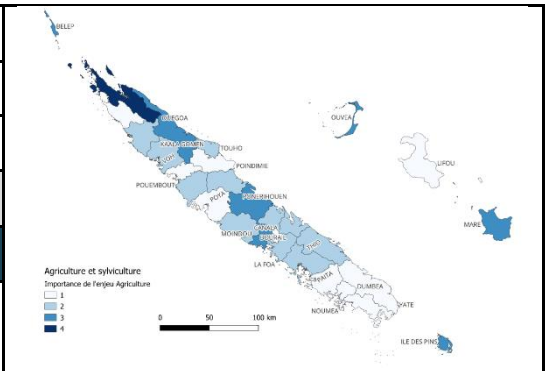


Figure 31. Relative share of rural sector sectors in value (Government of New Caledonia, 2023)

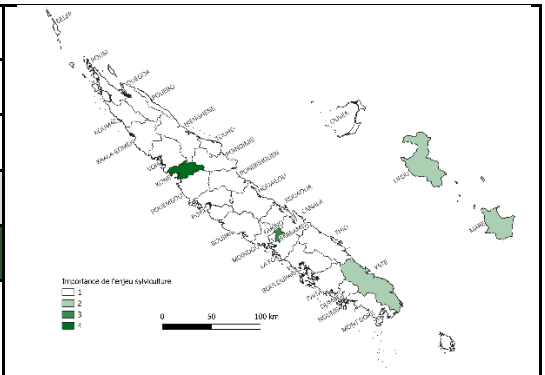
Although agriculture, livestock farming, and—more markedly—forestry occupy a modest position compared with sectors such as the nickel industry or tourism, they play an essential role in the local economy, particularly in terms of rural employment and the sustainable management of natural resources.

The importance of this issue across municipalities was assessed using the indicators presented in the tables below.

Issue	**Agriculture/livestock**		
Indicator:	Share of farmers in the population		
Source:	ISEE		
Scoring rules and thresholds:			
Low	Moderate	High	Very high
0 to 2.5%	2.5 to 5%	5% to 10%	> 10%
Most agricultural communes: **Poum (14.2%), Ouegoa (11.1%), Belep (8.5%), Ouvéa (7.8%)**			



Issue	**Forestry**		
Indicator:	Number of silviculture sites		
Source:	IEOM, 2023		
Scoring rules and thresholds:			
Low	Moderate	High	Very high
No site in the town	1 site in the town	2 sites in the town	More than 2 sites in the town
Important silvicultural challenge for: **Koné (5 sites), Yate and Sarramea (3 sites), Lifou and Mare (2 sites)**			



The results of the workshops on the importance of the agriculture, livestock, and forestry sectors (scored from 1 to 4) are presented in the table below.

Table 2: Rating of the importance of the agriculture, livestock, and forestry sectors according to experts

	South Province	**North Province**	**Loyalty Islands**
Professional farming	Very high	High	No rating yet
Ageing	High	Low	No rating yet
Forestry	Low	Low	No rating yet

ii. Main hazards and their impacts on the sector

The climatic hazards impacting the agricultural sector analysed in this study are summarised in the table below.

Table 3: Climatic hazards impacting the agricultural sector

		Climatic hazards							Other pressures	
CHALLENGE		**Flooding**	**Submersion**	**Heavy rain**	**Drought**	**Cyclone**	**Heatwave**	**Marine Heatwave**	**Wildfires**	**Invasive species**
Economic activity	Professional farming	x		x	x	x	x		x	x
	Livestock farming	x		x	x	x	x		x	x
	Forestry			x	x	x	x		x	x

Agriculture in New Caledonia is subject to several climate hazards that can affect agricultural production. The intensification of drought events (El Niño) and heavy rainfall (La Niña) lead to more frequent and severe droughts and floods. Rising temperatures and humidity promote the spread of pests that were previously less present in the territory. In addition, saltwater intrusion resulting from sea-level rise threatens the fertility of certain soils. Increasing temperatures also affect some climate-sensitive agricultural productions. Furthermore, invasive species and forest fires represent additional threats that may impact agricultural outputs.

The figure below presents the cumulative exposure of the agriculture/livestock/forestry sector to the various climate hazards to which it is vulnerable. Overall, this sector shows exposure levels ranging from moderate to very high, with the municipalities of Thio, La Foa, Poindimié, Moindou, and Kouaoua experiencing very high exposure, while Nouméa, Ouvéa, and the Isle of Pines display moderate levels of exposure to these hazards for this sector.

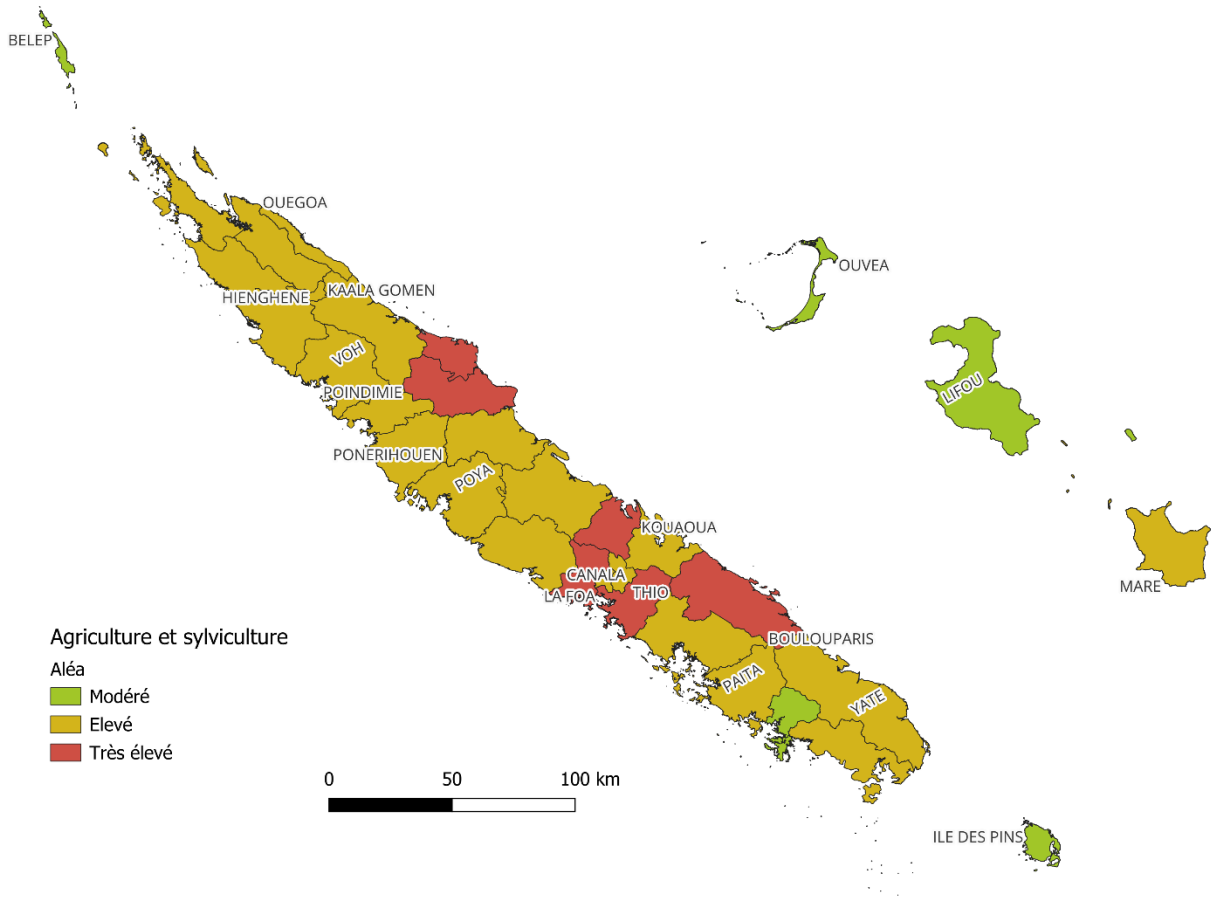


Figure 32. Exposure of the territory to hazards likely to impact the agriculture/livestock and forestry sectors

Agriculture and livestock farming are constrained by the limited availability of arable land, with only 12% of land suitable for agricultural use. This constraint is compounded by uneven soil quality, requiring adapted practices to maintain fertility. In addition, access to land is a challenge due to the complexity of the customary land tenure system, which restricts the establishment and expansion of agricultural holdings.

Water is another critical factor. The scarcity of water resources, exacerbated by increasingly frequent climate hazards, represents a major obstacle to agricultural development and livestock productivity. Moreover, the distance between production areas and consumption centres, particularly Nouméa, leads to high logistical costs and affects the profitability of agricultural and livestock sectors. Finally, the agricultural sector has suffered significantly in recent years due to weather conditions, especially the "La Niña" phenomenon, which brought exceptional rainfall (IEOM, 2023).

Regarding forestry, the main threat is the high risk of wildfires. When forest formations are destroyed by fire, they are often replaced by secondary vegetation (savanna, maquis), which promotes recurring fires and creates a vicious cycle that is difficult to break.

The strong sensitivity of this sector to climate change was also highlighted by the experts consulted, as reflected in the sensitivity scores presented in the table below.

Table 4: Rating of the sensitivity of the sector according to experts

	South Province	North Province	Loyalty Islands
Agriculture	Very high	Very high	Not Rated
Livestock Farming	Very high	Very high	Not Rated
Forestry	Very high	Very high	Not Rated

Concerning the sector's capacity to adapt, several structural constraints—such as the narrowness of the market, rural exodus particularly affecting the Loyalty Islands, as well as an aging farming population and the abandonment of the sector by young people—significantly reduce the sector's ability to cope with deteriorating climatic conditions.

In response to these challenges, several adaptation strategies are being implemented to strengthen the resilience of these sectors. Land tenure, a particularly sensitive issue, is at the heart of concerns. The Rural Development and Agricultural Land Management Agency (ADRAF) play a key role by mediating land conflicts, thereby stabilizing access to agricultural land and encouraging its development (Sénat, 2019). The archipelago also has a well-structured professional agricultural sector, with production chains inspired by Western models and an organized commercial sector ensuring efficient product marketing (Sénat, 2019). In terms of livestock production, New Caledonian breeders have developed considerable expertise, notably through genetic crossbreeding with species adapted to the local climate, and benefit from strong technical and commercial exchanges with countries such as India, New Zealand, and Australia (Sénat, 2019).

Innovation and research play an essential role in the sector's adaptation. Various actors such as the New Caledonian Agronomic Institute (IAC), ADECAL, the chambers of agriculture, and the interprovincial association managing agricultural centers work to improve production, particularly in animal and plant genetics (Sénat, 2019). Moreover, several innovative projects are emerging to strengthen the sustainability of the New Caledonian agricultural model. Among these, methanization units—which convert organic waste into energy—and, above all, alternatives to plant-protection products are central to efforts toward more environmentally friendly agriculture (Sénat, 2019). The Biofabrique of Port-Laguerre illustrates this dynamic by providing fruit and vegetable producers with beneficial insects, such as ladybirds, to combat pests while reducing

pesticide use. The development of the weevil is also being studied as a natural means of controlling the spread of water hyacinths, an invasive species harmful to aquatic environments and crops (Sénat, 2019).

Finally, resource management is a key issue in ensuring the sustainability and productivity of New Caledonian agriculture. Conditions for sustainable agricultural development are in place but require increased investment and better control of available land to realize the territory's many projects and potential. In addition, growing awareness of water management is reflected in initiatives to optimize irrigation and preserve this essential resource in a context of climate change (Sénat, 2019). These adaptations, combined with the territory's structural strengths, enable New Caledonia to strengthen the resilience of its agriculture and livestock farming in the face of environmental and economic challenges.

In the forestry sector, several measures have been implemented to guide forest management in response to fire risk. "Massif plans" have been developed for the Northern and Southern Provinces to structure prevention and response to forest fires. However, their effectiveness sometimes remains limited, as illustrated by the situation of the Tango massif in the Northern Province, which continues to be regularly affected by fires despite these measures. In the Southern Province, silvicultural experiments are underway to introduce endemic species believed to be less flammable, intending to reduce fire spread and strengthen forest resilience to climatic hazards.

At the same time, fire management relies on several levels of intervention. At the territorial scale, the forecasting tool Prévifeu[2], developed in partnership with Civil Security and Météo-France, enables residents to monitor fire alert levels in real time, adopt appropriate behaviour, and report an outbreak via their smartphone's geolocation. On the ground, firefighting mobilizes local solidarity, the gendarmerie, and the civil security directorate, which can deploy water-bombing helicopters, if necessary, as well as state military resources in emergencies.

Furthermore, sandalwood production—mainly located in the islands—is subject to highly regulated, customary, and sustainable management. This sector, which relies on a balance between exploitation and resource preservation, is strictly regulated to ensure the sustainability of sandalwood while respecting traditional practices and customary uses (Sénat, 2019).

[2] www.meteo.nc/nouvelle-caledonie/risque-feu

The expert-based assessment of the adaptive capacity of the agriculture, livestock, and forestry sectors is presented in the table below.

Table 5: Expert Adaptive Capacity Rating (including responsive adaptability, existing "guardrails", and transformational adaptability of the sector)

	South Province	North Province	Loyalty Islands
Agriculture	Moderate	Moderate	Not Rated
Livestock Farming	Moderate	Moderate	Not Rated
Forestry	Very high	Moderate	Not Rated

iv. Vulnerability and resilience

The map below shows the level of resilience attributed to each municipality, combining information on hazard, sensitivity, and adaptive capacity.

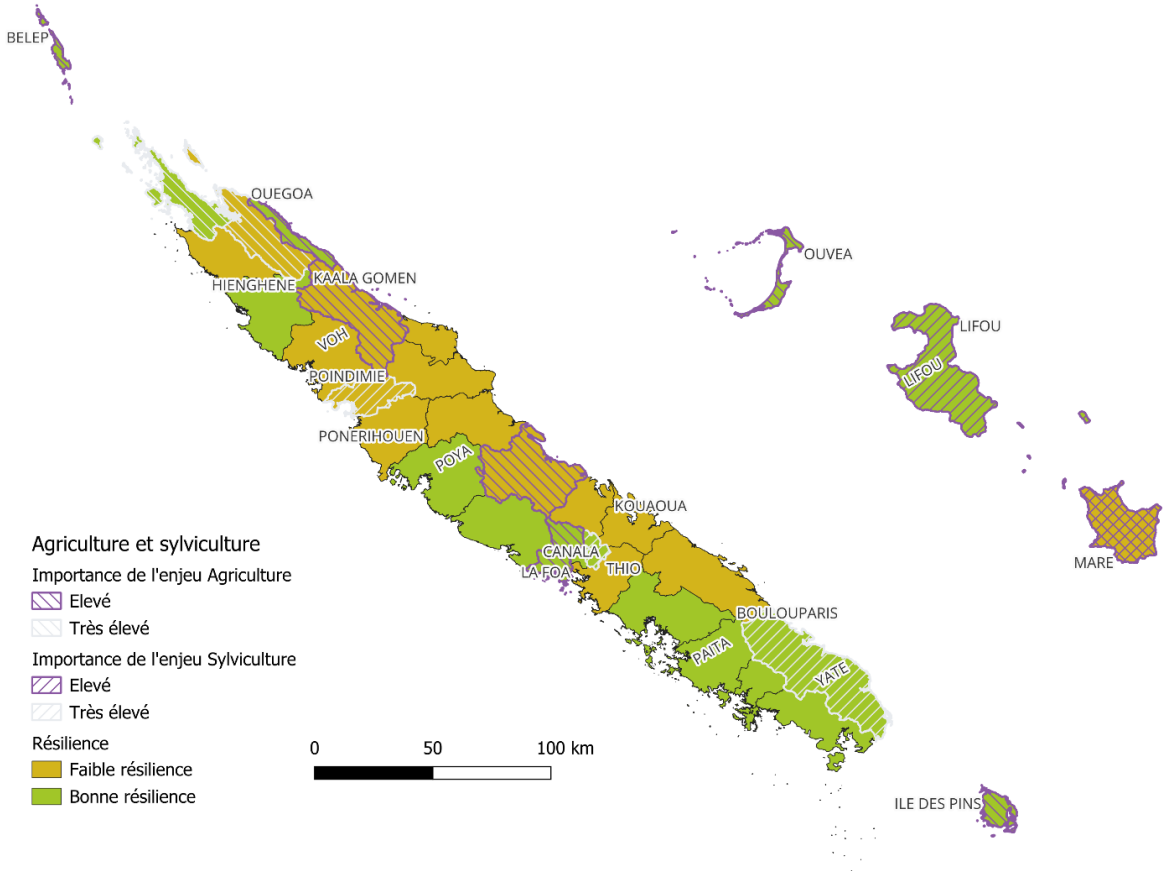


Figure 33. Resilience of the agriculture/livestock and forestry sectors to current climatic conditions

Resilience levels are low (municipalities in pink) to moderate (municipalities in orange) across the entire territory, with very little variability from one municipality to another (scores between 1.6 and 2.1).

By cross-referencing the information on "resilience level" and "importance of the sector" (hatched on the map), several hotspots can be identified: **first Koné and Poum** (very important sector and low resilience); **but also, Hienghène, Houaïlou, and Maré** (high sector importance and low resilience), **as well as Yaté** (important sector and moderate resilience).

b. Aquaculture/fisheries

i. Overview and importance of the issue

Although it generates only a small share of New Caledonia's wealth (0.1% in value and 1% of salaried employment in 2010), **fishing occupies a central place in the territory's social, cultural, and economic fabric**. While recreational fishing is mainly concentrated around Nouméa, professional fishing takes place more in the north of the main island.

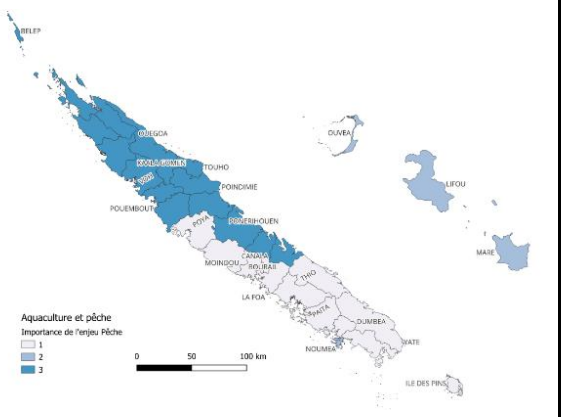
- Offshore fishing accounts for between 2,500 and 3,000 tonnes of fish caught, about 30% of which is exported.
- Coastal fishing, carried out by multipurpose vessels outside the lagoon, supplies the local market.
- Lagoon fishing is primarily for subsistence. What is not consumed is redistributed within families, and any surplus is sold. It reports an annual production of around 500 tonnes, of which 78% is self-consumed.
- In addition to fishing activity, three main processing facilities operate in the market. These facilities handle fish packaging and cutting, followed by marketing. Other smaller workshops are also present across the territory.

Non-professional fishing exceeds professional fishing in terms of catch volumes. Various studies on this topic estimate a ratio of 5:1 between volumes taken by non-professional fishing and those of professional fishing. Subsistence fishing within tribes is estimated to represent more than 3,700 tonnes across all products. This category is discussed in more detail in the section "well-being – food security."

The weight of the aquaculture sector (mainly shrimp) in the economy also remains modest (about 0.1% of GDP and 0.5% of private-sector employment). However, it represents a means of diversifying the economy, strengthening food self-sufficiency, and rebalancing activity toward the Northern Province (the west coast of the Northern Province has strong potential natural seaside sites suitable for the establishment of farming ponds). It is also New Caledonia's second-largest export activity. On average over the last ten years, shrimp production has fluctuated around 1,500 tonnes, with cultivated areas remaining stable at about 650 hectares and production deliberately limited to a single summer cycle.

Aquaculture has diversified in recent years with new productions such as oyster farming and fish farming. Aquaculture farms are spread along the west coast from Tontouta to the Ouazangou farm near Kaala-Gomen. The four hatcheries are located along the east coast: Montagnes in Païta, Mara in La Foa, Eori in Bourail, and Nord in Koné.

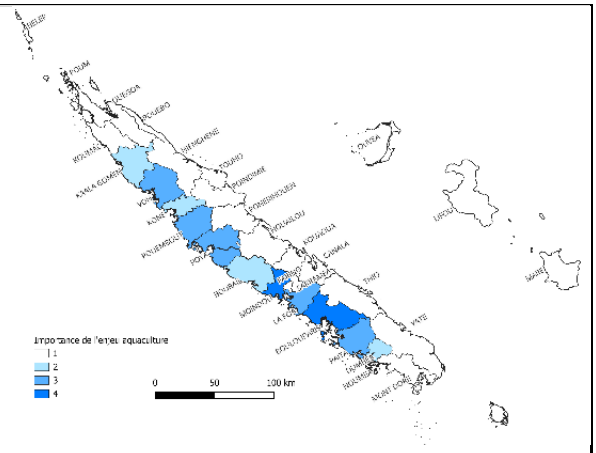
The importance of this sector at the municipal level was assessed using the indicators presented in the tables below.

<table>
<tr><td>Issue</td><td colspan="4">Professional fishing</td><td rowspan="3"> 
</td></tr>
<tr><td>Indicator:</td><td colspan="4">Number of professional inshore fishing authorizations issued by the province per 1000 inhabitants.</td></tr>
<tr><td>Source:</td><td colspan="4">Coastal Fisheries Observatory: Statistical report on New Caledonia's professional coastal fishing (2022)[3]</td></tr>
<tr><td colspan="5">Scoring rules and thresholds:</td></tr>
<tr><td>Low</td><td>Moderate</td><td>High</td><td>Very high</td><td></td></tr>
<tr><td>< 1‰</td><td>1 to 5‰</td><td>5 to 10‰</td><td>10‰</td><td></td></tr>
<tr><td colspan="5">The North Province, with several authorizations of almost 7‰ (315 authorizations issued in 2020), is much more present in the professional fishing sector than the Province of the Loyalty Islands (2‰ with 48 authorizations) and the South Province (0.6‰ with 156 authorizations).</td></tr>
</table>

Issue	**Aquaculture**	
Indicator :	Number of farms per municipality	
Source:	IEOM, 2023	

[3] Fabry, L. and Laplante, J.-F. (2022). Annual Statistical Report on Professional Coastal Fisheries of New Caledonia, Year 2020. Coastal Fisheries Observatory of New Caledonia, Adecal Technopole, Nouméa, New Caledonia. 36 pages.

Scoring rules and thresholds:			
Low	Moderate	High	Very high
No farms in the municipality	1 farm in the municipality	2 to 5 farms in the municipality	6 farms or more in the municipality



Aquaculture activity is present only on the west coast of the territory, with Moindou and Boulouparis (8 and 6 farms) as major hubs of this activity, but also Poya (5 farms), La Foa (4 farms), and Voh and Païta (3 farms respectively).

The results of the workshops on the importance of the "fishing and aquaculture" sectors at the provincial level, scaled from 1 to 4, are presented in the table below, assigning low importance to this sector:

Table 6: Importance of the fishing and aquaculture sectors of activity according to the provinces

	South Province	**North Province**	**Loyalty Islands**
Professional fishing	1	2	No rating yet
Aquaculture	1	1	No rating yet

ii. Climate hazards and main impacts of climate change

Climate change and its consequences (rising temperatures and acidification, changes in thermohaline circulation, degradation of certain functional habitats, etc.) are affecting marine biodiversity—particularly exploited marine species—as well as aquaculture production. These impacts include shifts in the distribution ranges of certain target species (habitat displacement or contraction), reduced abundance of some species (lower primary productivity due to water stratification and impacts on individual growth), increased fluctuations in abundance, predation phenomena, and the emergence of new species (PNACC, 2023).

In Nouméa, for example, residents who depend on fishing are already observing a deterioration of the marine environment and, consequently, of their activities. "Dempsey, a recreational fisherman, notes a decrease in the number of fish. Joseph T., a fish vendor since the market

opened in 1991, reports the same observation: he now sells only 500 kilograms of fish per week, whereas he previously sold up to 800 kilograms" (epop, 2018).

In New Caledonia, climate change is expected to have a very strong impact on coral reef ecosystems and may exacerbate existing local pressures on coral reefs and associated ecosystems (mangroves, seagrass beds), as well as intertidal zones. The result would be a reduction in the quality and extent of all associated habitats, linked to sea-level rise and the progressive salinization of coastal areas. Ongoing climate change also favours the development of planktonic microalgae. Consequently, climate change is expected to lead to a gradual decline in coastal fishing productivity (due to reduced resources) and aquaculture, while an increasing trend in offshore resources (tuna) may be observed (CRESICA, 2021).

The hazards considered in this study for the professional fishing and aquaculture sectors are presented in the table below.

Table 7: Climatic hazards impacting the fisheries/aquaculture sector

	Climatic hazards							Other pressures	
CHALLENGE	**Flooding**	**Submersion**	**Heavy rain**	**Drought**	**Cyclone**	**Heatwave**	**Marine Heatwave**	**Wildfires**	**Deer and pigs**
Professional fishing	x	x	x		x		x		
Aquaculture	x	x	x		x		x		

The sector's level of exposure to current climatic conditions is shown on the map below.

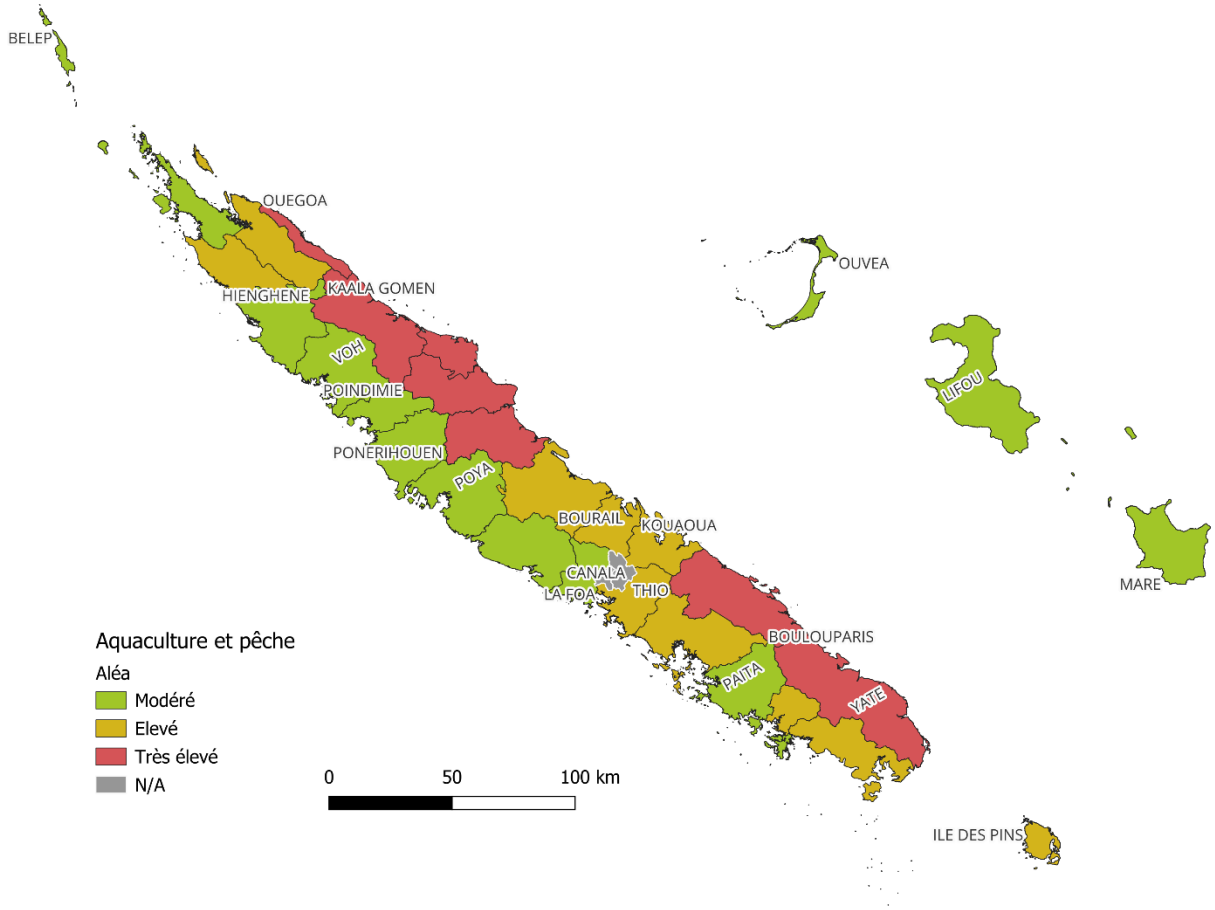


Figure 34. Exposure of the territory to climatic hazards likely to impact the aquaculture and fisheries sector

Exposure of the territory to the various hazards affecting this sector is very high in Poindimié, Yaté, Touho, Thio, Ponérihouen, and Pouébo, and moderate in Poum, Pouembout, and Bélep.

iii. Sensitivity and adaptive capacity of the sector

The two tables below present the expert-based assessment of the sectors' sensitivity and adaptive capacity.

Table 8: Rating of the sensitivity of the fisheries and aquaculture sector according to experts

	South Province	North Province	Loyalty Islands
Fishing	Very high	Very high	Very high
Aquaculture	Very high	Very high	Very high

Table 9: Ratings of the adaptive capacity of the fisheries/aquaculture sector according to experts including the reactive adaptive capacity (existing safeguards) and the transformational adaptive capacity of the sector

	South Province	North Province	Loyalty Islands
Fishing	Moderate	Moderate	Not Rated
Aquaculture	High	Moderate	Not Rated

The fishing and aquaculture sector in New Caledonia is highly dependent on natural resources, both for the supply of raw materials used in aquaculture feed and for maintaining the productivity and proper functioning of coastal and marine ecosystems. This dependence makes these activities particularly vulnerable to the effects of climate change, which affects the availability of fishery resources, water quality, and marine habitats essential for species reproduction (SPC, 2023). At the same time, several environmental degradation factors are increasing pressure on marine and coastal ecosystems, including overexploitation of resources, pollution from various sources, coastal and estuarine artificialization, as well as the spread of invasive species and marine plastic pollution (Nouvelle-Calédonie.gouv.fr, 2021).

On the aquaculture side, the sector faces several structural challenges, such as high production costs, a production chain that is still imperfectly structured, and the emergence of diseases likely to affect certain farmed species—particularly the blue shrimp, on which a large part of the sector depends (ISEE, 2016). In addition, illegal fishing by foreign vessels represents an additional threat, especially for prized species such as albacore tuna, skipjack tuna, and sea cucumbers. Attracted by the abundance of stocks in New Caledonian waters, this practice could intensify with the degradation of fishery resources in the South Pacific, further increasing pressure on local stocks and making the implementation of strengthened and sustainable fisheries management even more crucial (Sénat, 2019).

Adaptation in the fishing sector involves, among other measures, support for and implementation of participatory and integrated fisheries resource management to ensure the sustainability of marine resources and the preservation of their habitats—such as the creation of the New Caledonia Coastal Fisheries Observatory in 2020 under the PROTEGE project (SPC, 2023), the identification of marine ecosystem protection needs (coral reefs, seagrass beds, mangroves) through the establishment of Marine Protected Areas, and coral reef restoration. Unlike fishing, human intervention is present throughout the entire life cycle of aquaculture production, which

should enable adaptation to climate change through stakeholder action, provided adequate funding and resources are available. The resilience of aquaculture to unexpected shocks has already been demonstrated. For example, much of Asia was able to switch shrimp species in a short time when one species was severely affected by a virus, and some countries impacted by devastating climatic events rapidly returned to production levels close to previous ones. Actions that could support aquaculture adaptation include species selection and the development of farming practices suited to future climatic conditions.

iv. Sector resilience

The map below shows the level of resilience attributed to each municipality by combining hazard, sensitivity, and adaptive capacity scores.

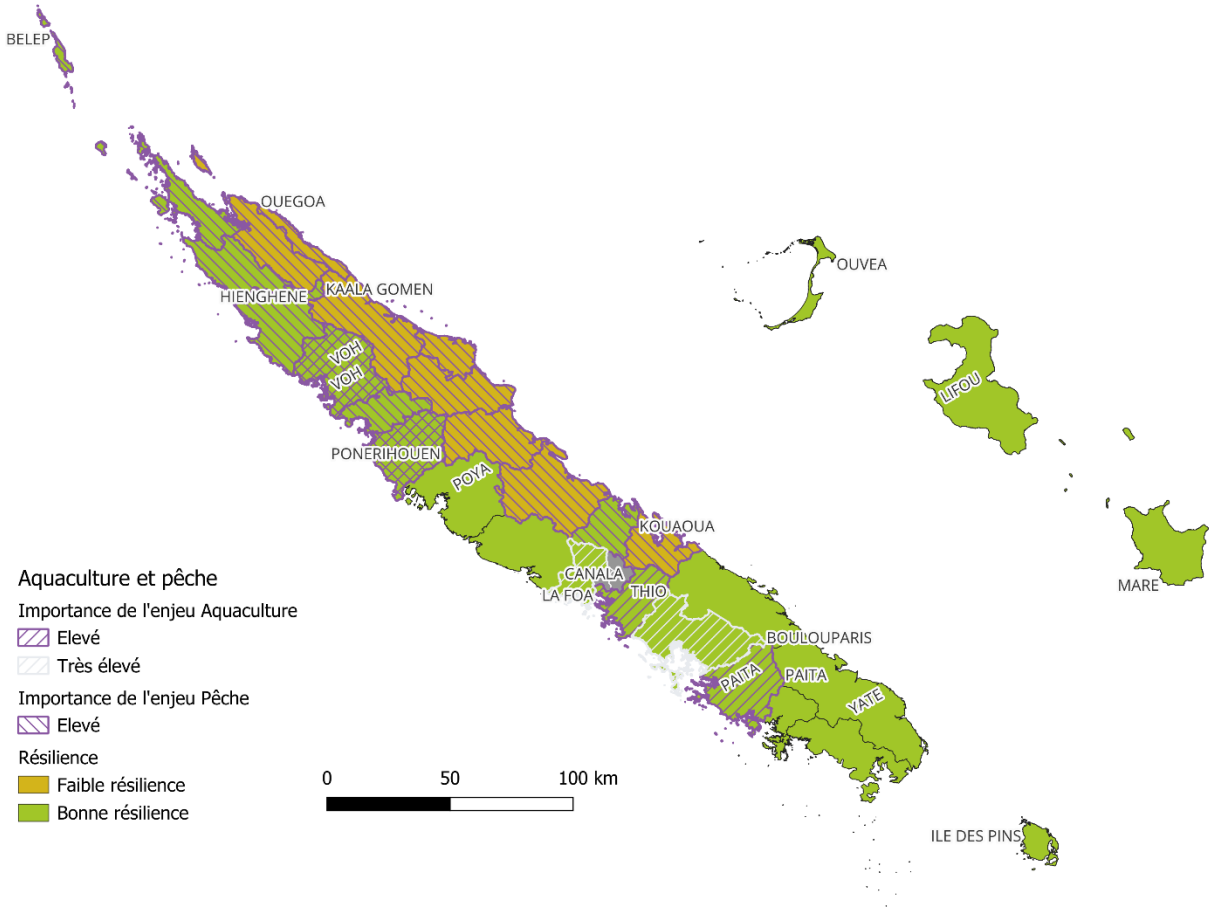


Figure 35. Resilience of the aquaculture and fisheries sectors to current climatic conditions

The level of resilience of the fisheries and aquaculture sectors is low to moderate for the entire territory. It is the municipalities on the West Coast of the North Province that are awarded the lowest scores.

By cross-referencing information on the level of resilience with information on the importance of the sector of activity for the municipality (hatched on the map), we identify several priority areas in terms of adaptation, in the North Province, but also in Boulouparis in the South Province.

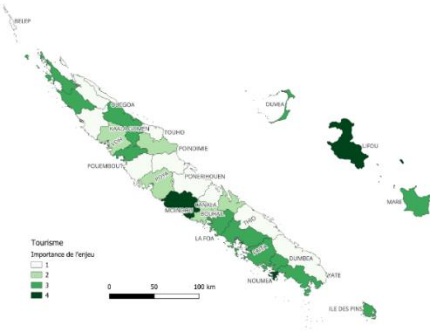
c. Tourism

i. Overview and importance of the sector

Although it represents a development axis for New Caledonia's economy, the tourism sector remains relatively modest, with an estimated contribution of 4% of GDP and 7% of private-sector employment in 2023. The sector includes 1,263 businesses (RIDET, ISEE), with 75% located in the Southern Province, 17% in the Northern Province, and 8% in the Loyalty Islands Province (IEOM, 2023).

New Caledonia offers a rich and diverse tourism supply largely based on its environmental wealth: seaside and nautical tourism centred on its beaches and lagoons listed as a UNESCO World Heritage Site, and the richness of its seabed; hiking and ecotourism (mountains, tropical forests, and wild landscapes, unique natural ecosystems, and tropical fauna and flora). Tourism is mainly developed along the coastline and much less in inland areas.

The importance of tourism activity was assessed through the presence of accommodation facilities within each municipality.

<table>
<tr><td>Issue</td><td colspan="3">Tourism</td><td rowspan="3">  </td></tr>
<tr><td>Indicator</td><td colspan="3">Number of accommodation facilities per municipality</td></tr>
<tr><td>Source</td><td colspan="3">IEOM, 2023</td></tr>
<tr><td colspan="4">Scoring rules and thresholds</td></tr>
<tr><td>Low</td><td>Moderate</td><td>High</td><td>Very high</td></tr>
<tr><td>0 to 3</td><td>4 to 10</td><td>11 to 20</td><td>More than 20</td></tr>
<tr><td colspan="5">In 2023, the territory has a total of 347 accommodation facilities, of which 53% are in the Southern Province, 30% in the Northern Province, and 17% in the Loyalty Islands Province (IEOM, 2023). Nouméa, Bourail, and Boulouparis are major tourism hubs, as well as Lifou in the Loyalty Islands Province. The municipalities of Hienghène, Koné, and Koumac in the Northern Province, Mont-Dore in the Southern Province, and Ouvéa and Maré in the Loyalty Islands also have a significant number of accommodation establishments.</td></tr>
</table>

The results are consistent with feedback from the workshops on the relative importance of the tourism sector between the Northern Province and the Southern Province (see table below).

Table 10: Rating of the importance of the tourism sector according to experts reduced to 4 classes

	South Province	North Province	Loyalty Islands
Tourism	Very high	Low	No rating yet

ii. Main hazards and impacts of climate change on the sector

The table below presents the hazards selected for the analysis of the tourism sector's resilience..

Table 11: Climatic hazards impacting the tourism sector selected for this study

	Climatic hazards								Other pressures
CHALLENGE	**Flooding**	**Submersion**	**Heavy rain**	**Drought**	**Cyclone**	**Heatwave**	**Marine Heatwave**	**Wildfires**	**Invasive species**
Tourism	X	X	X	X	X	X	X	X	X

Among the main hazards likely to affect the tourism sector are cyclones, which can cause significant damage to tourism infrastructure, disrupt transport, and deter visitors. Sea-level rise worsens coastal erosion and threatens beaches and coastal facilities—key elements of the archipelago's tourism appeal. In addition, the increasing frequency and intensity of extreme weather events, such as heavy rainfall and heatwaves, can disrupt tourism activities and reduce visitor comfort, leading to decreased attendance. Finally, biodiversity loss, exacerbated by these multiple climatic factors, represents another major challenge for tourism in New Caledonia.

The map below summarizes the combined hazard levels across the different municipalities. It highlights varying **exposure to climate-related hazards** that may affect tourism depending on the region.

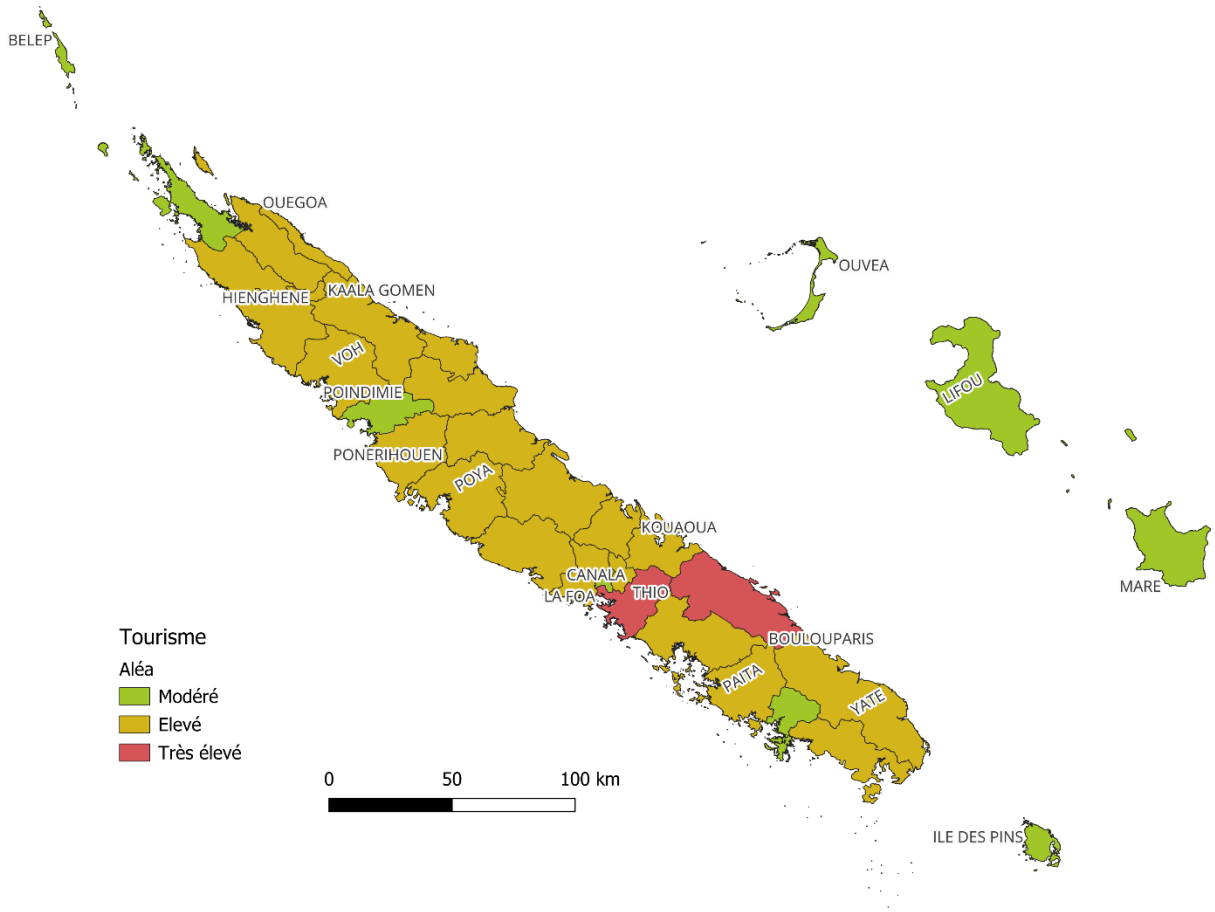


Figure 36. Exposure of the territory to climatic hazards likely to impact the tourism sector

Some municipalities, such as **Thio** (where all hazards are rated high to very high except marine heatwaves and the deer and pig threat) **and La Foa** (very high levels except for heavy rainfall, heatwaves, and marine heatwaves), show **high exposure** (>3.3). Conversely, areas such as **Bélep, Ouvéa, Nouméa, Dumbéa, Lifou, and the Isle of Pines** display **lower exposure** (<2.5), potentially reducing direct impacts on tourism.

However, most of the territory faces **moderate to high exposure**, meaning that the tourism sector remains widely affected by climate conditions. Their deterioration—particularly sea-level rise and the increasing frequency of extreme events—could heighten risks and affect tourist attendance, especially in the most exposed areas.

iii. Sensitivity and adaptive capacity

The two tables below present the expert-based assessment of the tourism sector's sensitivity and adaptive capacity.

Table 12: Rating of the sensitivity of the tourism sector according to experts

	South Province	North Province	Loyalty Islands
Tourism	High	High	Very high

Table 13: Expert ratings of the tourism sector's adaptive capacity (including responsive adaptive capacity – existing "guardrails" – and transformational adaptive capacity of the sector)

	South Province	North Province	Loyalty Islands
Tourism	Moderate	High	Not Rated

The main factors of sensitivity of the tourism sector to climate change include:

- **Strong dependence on climatic conditions:** most activities offered are outdoor activities, whether in the lagoon or in the mountain range. Favourable weather conditions are essential for attracting tourists, as they strongly influence destination choice.
- **Dependence on ecosystems:** New Caledonia's unique biodiversity—particularly its coral reefs and marine ecosystems—is central to its image as a tourist destination. The decline of this biodiversity, caused by ocean warming and pollution, could reduce the island's tourism appeal.
- **Concentration of infrastructure in coastal areas:** the seaside location of a large share of tourism infrastructure (hotels, resorts, restaurants, and tourism complexes—especially on islands and popular beaches—as well as marinas and yacht harbours) makes the sector particularly sensitive to sea-level rise.
- **Insular nature and strong dependence on international tourism:** this makes the sector especially vulnerable to any disruptions in transport (air and maritime).
- **Dependence on natural resources and the primary sector,** which play a key role in supplying local products to tourism (water, fruits, vegetables, seafood, and fish).

To mitigate these impacts, adaptation strategies are needed to preserve the sector's long-term competitiveness: sustainable coastal zone management and coral reef protection, rehabilitation of tourism infrastructure, beach erosion control, promotion of domestic tourism and non-coastal activities, and the development of sustainable tourism, among others.

Positive progress has been made (establishment of marine protected areas, coral reef restoration projects, dune rehabilitation and coastal vegetation planting, promotion of ecotourism, etc.), but

much remains to be done. Among the obstacles to adaptation, adaptation costs may be high—potentially unaffordable for small tourism businesses, particularly those located in highly vulnerable areas. Stronger commitment, increased funding, and close coordination among public, private, and international stakeholders will be necessary to raise the level of adaptation in New Caledonia's tourism sector.

iv. Resilience

The map below shows the level of resilience attributed to each municipality by combining hazard, sensitivity, and adaptive capacity information.

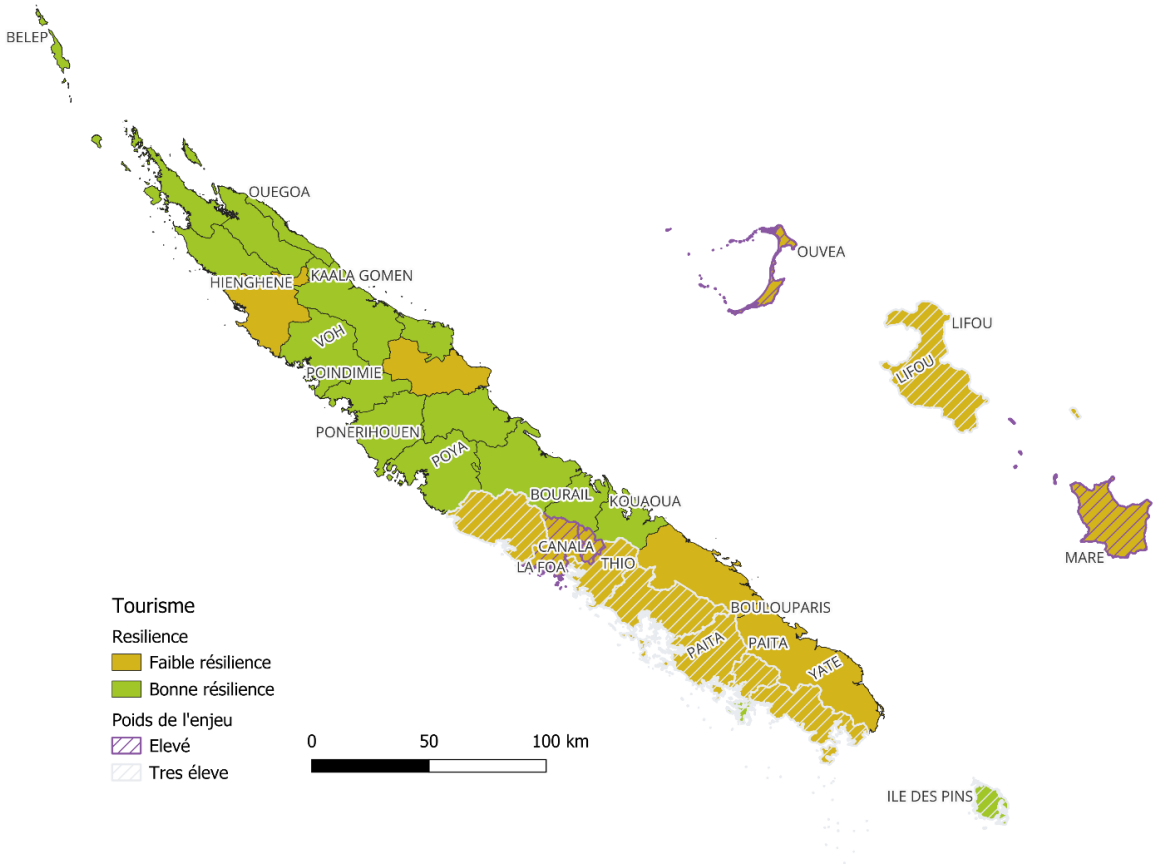


Figure 37. Resilience of the tourism sector to current climate conditions

Resilience levels are moderate across the entire territory (scores between 1.8 and 2.5). However, the municipalities of Thio, Maré, and La Foa show lower scores (close to the threshold of the "low" class), while Bélep, Koné, and Poum have scores close to or equal to 2.5 (the upper limit of the "high" class).

By cross-referencing resilience levels with the importance of the sector for each municipality (hatched on the map), several priority areas can be identified where very high sector importance coincides with lower resilience—particularly along the east coast of the Southern Province and in the Loyalty Islands.

d. Mines and quarries

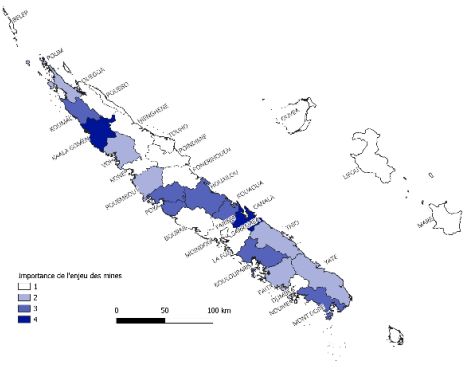
i. Overview and importance of the sector in New Caledonia

In 2022, the nickel sector accounted for 14% of New Caledonia's GDP. However, its economic impact goes far beyond the wealth created by its direct actors. Through strong spillover effects, it generates significant indirect employment and stimulates consumption. At the end of 2019, the sector employed 9% of private-sector workers (around 5,900 people), but its overall impact on salaried employment was estimated at 15,600 jobs—about a quarter of private-sector employment (IEOM, 2023). It is also a pillar of exports, representing 90% of international sales.

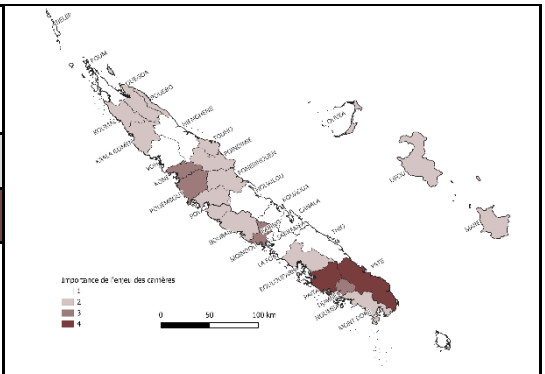
Alongside this dominant industry, the quarrying sector—although important—plays a more modest economic role. Nevertheless, it remains essential for infrastructure development and the construction sector, contributing to territorial planning and local growth.

The importance of the mining and quarrying sector at the municipal level was assessed using two indicators presented in the tables below.

Issue	**Mining**			
Indicator	Number of mining sites and metallurgical plants by municipality			
Source	Mines and Quarries Service of DIMENC, data updated annually (downloaded from the Georep platform)			
Scoring rules and thresholds				
Low	Moderate	High	Very high	
No site	1 to 2 sites	3 to 4 sites	5 to 6 sites	
The municipalities where mining activity is most significant are Kaala-Gomen with 6 sites, Canala with 5 sites, and Kouaoua and Koumac with 4 sites.				



Issue	**Careers**
Indicator	Maximum volume allowed in quarries

Source	DIMENC Mines and Quarries Service, 2020 (downloaded from the georep platform)			
Scoring rules and thresholds:				
Low	Moderate	High	Very high	
0	< 95000 m3	From 95000 to 175000 m3	> 175,000 m3	
Yate 8 million^{m3}, Paita 7.4 million m3, Dumbéa 5 million m3, Kone 3 million, Moindou 2.7 million m3, Poembout 1.6 million^{m3}.				

In addition, the results of the workshops on the importance of the mining and quarrying sector by province (scaled from 1 to 4) are presented in the table below:

Table 14: Importance of the Mining/Quarrying sectors of activity according to the provinces

	South Province	**North Province**	**Loyalty Islands**
Mining/Quarrying	Very high	Low	No rating yet

ii. Climate hazards and main impacts of climate change on the sector

There are currently few studies on the impacts of climate change across the entire life cycle of mining projects. Overall, companies in the mining industry primarily perceive climate change as a logistical risk, particularly due to water shortages and flooding that threaten their facilities. The main impacts of climatic conditions on this sector in New Caledonia are listed below:

- **Heavy rainfall** can cause flooding, cutting off access roads to mining sites and reducing site accessibility for workers. It can also lead to failures in water treatment and management structures. Flooding may further cause ground instability, reducing on-site safety conditions. Finally, the transport of sediments into rivers and lagoons poses a risk of contamination of surrounding water bodies.
- **Cyclones** can also damage mining infrastructure (processing facilities, warehouses, access roads) and disrupt operations.
- **Wildfires** may damage mining facilities and equipment.
- **Drought** periods can affect the availability of water resources required for industrial processes and may also compromise revegetation efforts at mining sites after exploitation.
- **Heatwaves** can reduce working conditions, thereby lowering workforce efficiency.

- Mining sites located near the coast could be affected by sea-level rise and increased coastal erosion risk.

These various impacts could lead to increased operating, transport, and decommissioning costs.

The climate hazards considered in this study are summarized in the table below.

Table 15: Climatic hazards impacting mining activity

	Climatic hazards								Other pressures
CHALLENGE	**Flooding**	**Submersion**	**Heavy rain**	**Drought**	**Cyclone**	**Heatwave**	**Marine Heatwave**	**Wildfires**	**EEA**
Mining and quarrying	X	X	X	X	X	X		X	

Hazard levels are very high for Yaté, Thio, Poindimié, and La Foa (> 3.25). They are moderate for Ouvéa, Lifou, and Bélep (between 1.75 and 2.5), and high for the other municipalities (see figure below).

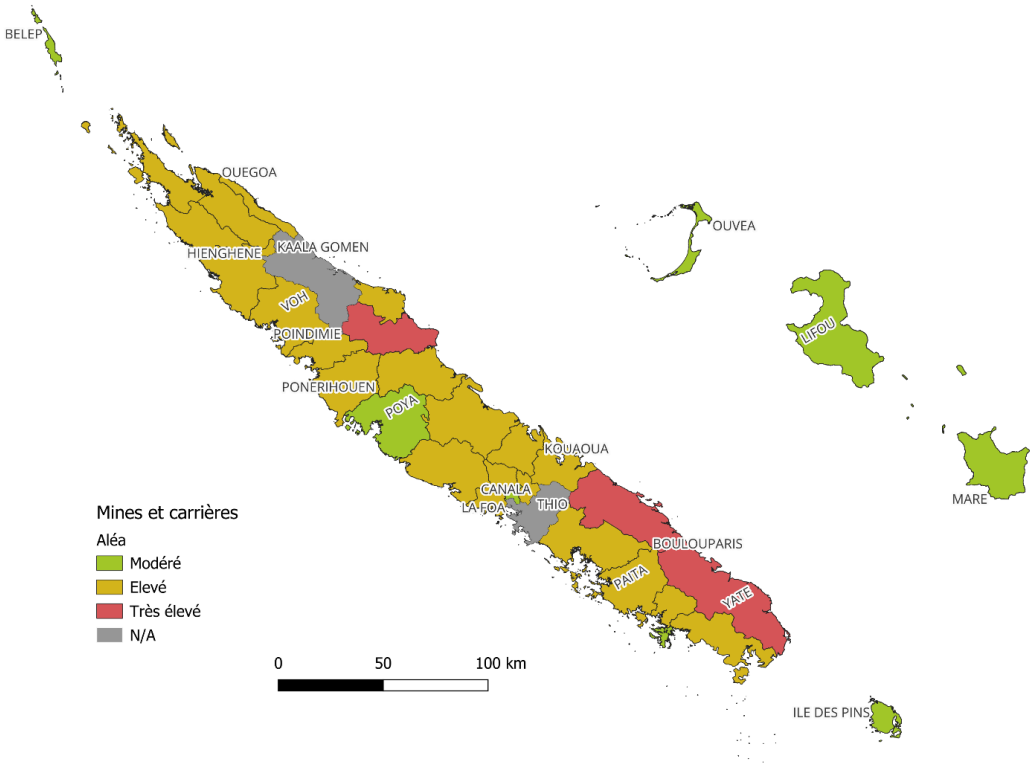


Figure 38. Exposure of the territory to climatic hazards likely to impact the mining/quarrying sector

iii. Sensitivity and adaptive capacity

The influence of weather conditions on the sector's productivity highlights its high sensitivity to climatic conditions. For example, 2023—characterized by significantly lower rainfall than in 2021 and 2022 (La Niña years)—was a record year in terms of mining production (IEOM, 2023).

Among the main sensitivity factors is the sector's dependence on water and energy resources for its operations: electricity consumption by mining sites and metallurgical industries accounts for between two-thirds and three-quarters of final consumption across the archipelago. The sector also relies heavily on road and maritime transport infrastructure to move minerals extracted from mining sites and metallurgical plants to their destinations, as well as to ensure logistical transport of incoming goods, including personnel.

While nickel is a source of wealth, the archipelago's dependence on this activity also represents a vulnerability in the context of globalization due to price volatility. The collapse in nickel prices—halving between 2011 and 2016—and the emergence of producers with lower production costs (Indonesia, the Philippines, Brazil) have increased pressure on local production.

The environmental and social impacts of the sector contribute to its low acceptance among local communities. Events such as the 2018 blockade of the Méa mining site (Kouaoua), organized to protest the ecological consequences of mining and the planned opening of three new deposits, illustrate these tensions (Reporterre, 2018).

Overall, awareness among sector stakeholders of the risks associated with climate change remains limited. Mining companies worldwide operate in a complex environment with many challenges to address; however, they are increasingly integrating climate risk management into their strategic planning.

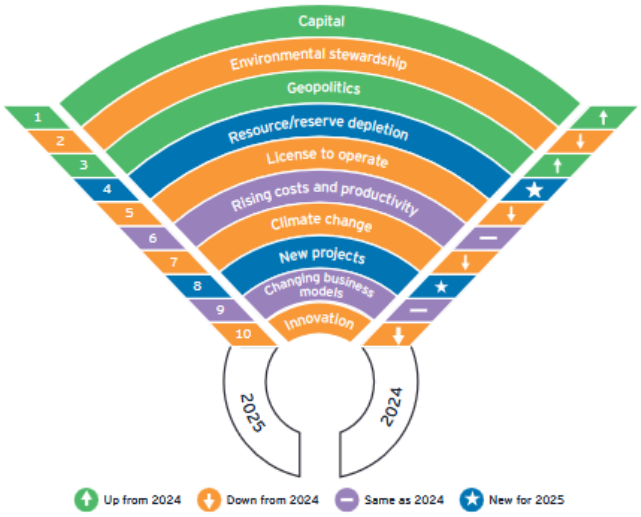


Figure 39. Top ten risks and opportunities in the mining and metals sector in 2025 (source: EY, 2024)

We do not have an expert-based assessment of the sector's sensitivity. However, considering the information presented, the sector's sensitivity in New Caledonia can be considered high.

The table below presents the expert-based assessment of adaptive capacity, which is considered moderate for this sector.

Table 16: Expert ratings of the resilience of the mining/quarrying sector including the reactive adaptability (existing guardrails) and the transformational adaptability of the sector

	South Province	North Province	Loyalty Islands
Mining/Quarrying	Moderate	Moderate	Not Rated

iv. Resilience

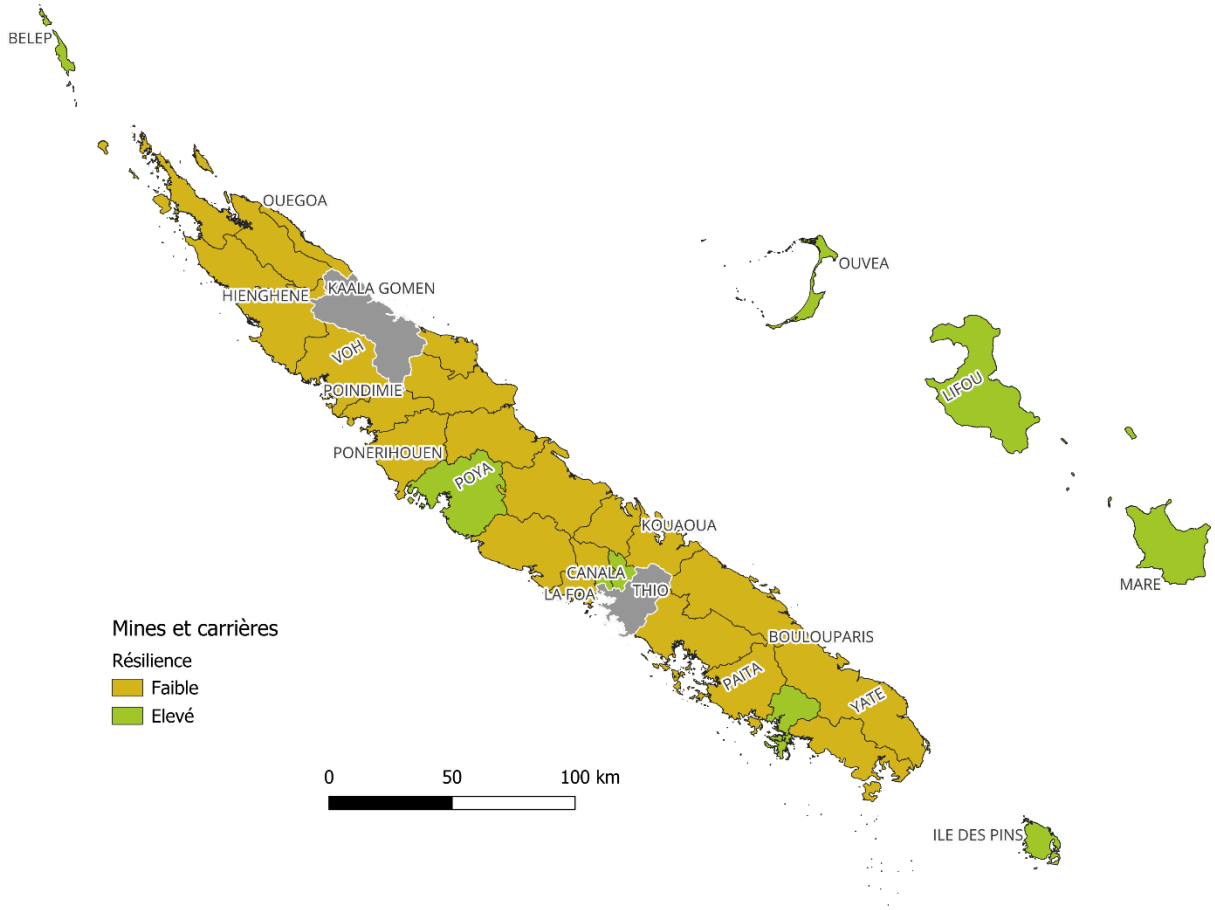


Figure 40. Resilience of the mining and quarrying sector to current climatic conditions

Resilience levels are low to moderate and fairly homogeneous across the territory (slightly lower in municipalities along the East Coast). Hotspots, therefore, mainly correspond to municipalities where the sector is most developed.

3. Analysis and mapping of the resilience of infrastructure issues

Assessing infrastructure resilience is a complex task requiring a detailed analysis of its physical and functional sensitivity to different climate hazards. The resilience of a port, road, power plant, etc., does not rely on the same criteria. As a detailed study of each infrastructure is beyond the scope of this work, we propose an analysis of resilience based on mapping the asset and examining hazard and adaptive capacity components (expert-based). Since no data could be obtained on sensitivity, this component was not included in our analysis. Given the lack of detailed information and the broad level of assessment, no overall resilience map of infrastructures could be produced.

a. Overview and importance of the issue

The analysis of infrastructure resilience to climate change includes infrastructure essential to the country's economic development (see figure below): roads, ports, airports, and electricity production sites. The map also presents drinking water supply areas and healthcare centres.

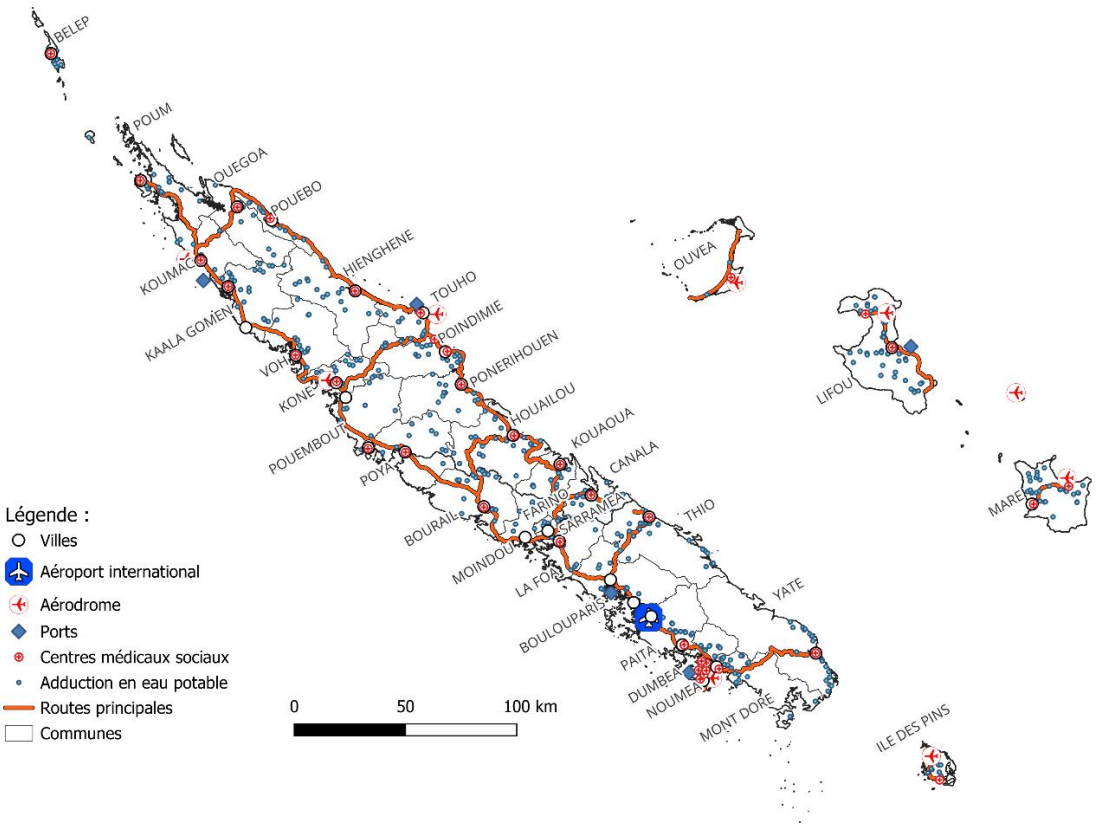


Figure 41 : Map of the main infrastructures in New Caledonia

i. Transport Infrastructure

As an island territory, New Caledonia maintains numerous exchanges with the outside world, carried out by sea (mainly for goods) or by air (primarily for passengers). Connectivity and access to the islands are ensured by plane or boat. With dispersed settlement patterns and concentrated economic activity centres, land transport (private and public) is also essential.

The road network open to public traffic in New Caledonia extends over approximately 5,600 km, with 46% in the Northern Province, 40% in the Southern Province, and 14% in the Loyalty Islands. The road system consists of municipal roads, provincial roads, and territorial roads. About 50% of the network is paved, mainly around Nouméa and along the southern coast. Roads leading to tourist sites and major industrial areas are also often paved. The remaining 50% is unpaved, primarily in rural and more isolated areas (notably inland and mountainous zones, but also in some coastal regions and the Loyalty Islands). These roads are often dirt, gravel, or built with less durable materials.

While most municipalities have sea access and varying levels of maritime infrastructure (boat ramps, pontoons, or wharves), there are relatively few actual ports in New Caledonia. Two public ports are grouped under the Autonomous Port of New Caledonia (Nouméa and Wé), alongside three private industrial ports dedicated to freight transport for industrial purposes: the port of Népoui in the municipality of Poya, used for shipping nickel ore and unloading hydrocarbons for Enercal's gas-fired power plant; Vavouto in the municipality of Voh, serving the Koniambo plant; and the port of Prony, located between Mont-Dore and Yaté, which also serves major metallurgical industrial facilities. These infrastructures are fundamental for the nickel industry, the development of cruise tourism, and the import of raw materials necessary to ensure the population's food security.

In terms of airport infrastructure, New Caledonia includes:

- 1 international airport located 50 km north of Nouméa.
- 3 main aerodromes: Nouméa-Magenta, located within the Nouméa urban area and handling domestic traffic between the three provinces; Koné, the main airport in the Northern Province; and Lifou.
- 10 provincial aerodromes (3 in the Southern Province, 4 in the Northern Province, and 3 in the Loyalty Islands Province).

ii. Energy production infrastructure

Electricity generation sites are shown in the figure below. The electricity mix is composed of 77.5% thermal energy and 22.5% renewable energy. In 2021, 65.0% of renewable energy production in the territory came from hydropower, 6.3% from wind, and 28.7% from solar power.

In terms of transmission, a high-voltage electricity network (lines above 33 kV) exists only on the main island (Grande Terre). The islands (Bélep, the Loyalty Islands, and the Isle of Pines) rely solely on autonomous electricity networks.

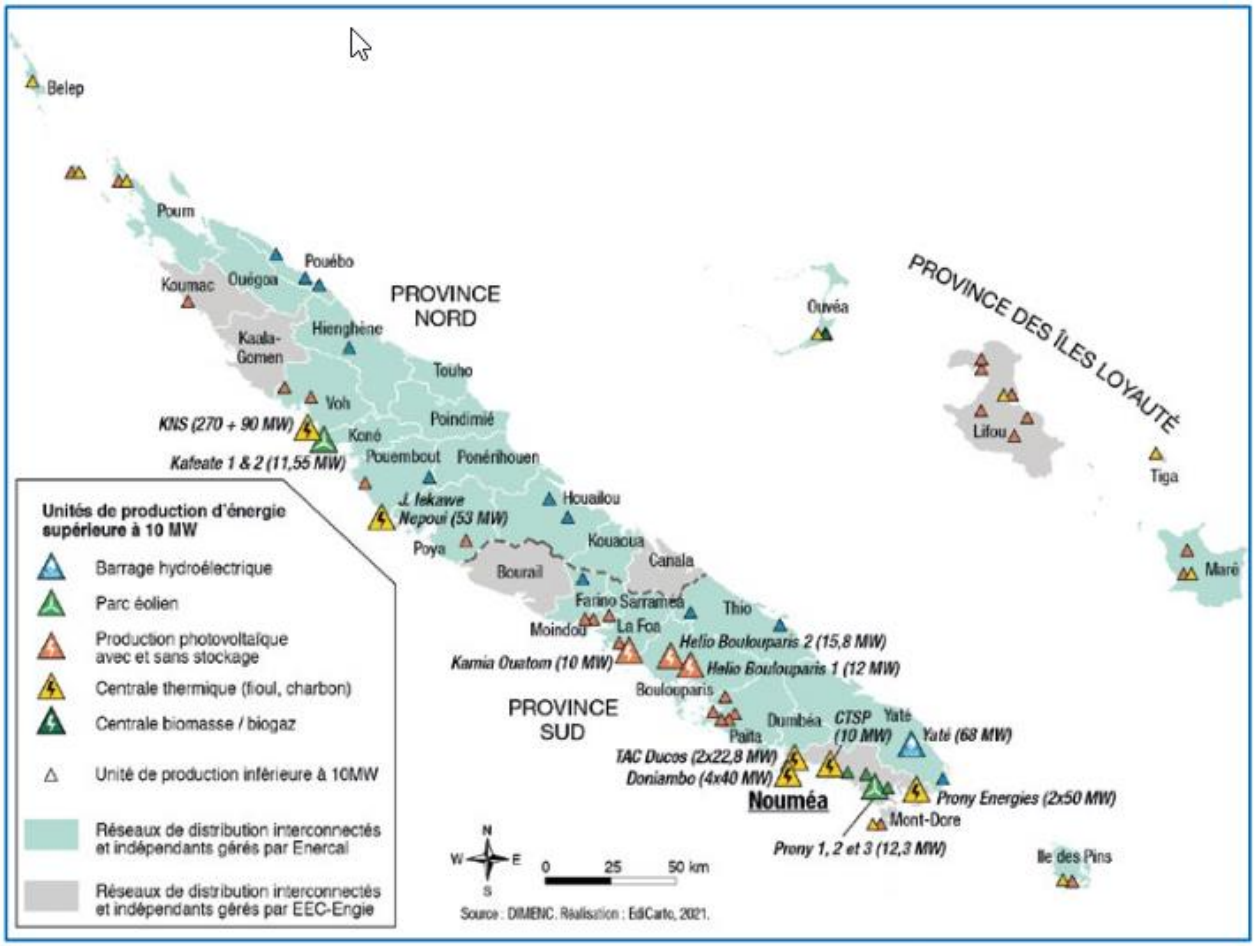


Figure 42 : Map of the distribution of electricity production units in New Caledonia in 2020

The results of the workshops on the importance of different types of infrastructure are presented in the table below:

Table 17: Importance of the different types of infrastructure according to the provinces:

	South Province	North Province	Loyalty Islands
Road infrastructure	1	2	No rating yet
Ports and airports	1	2	No rating yet
Buildings	1	1	No rating yet
Water supply networks, catchments and PPE	3	4	No rating yet
Electricity and telecommunications network	1	1	No rating yet

b. Climate hazards and main impacts

The infrastructure sector is exposed to various climate hazards:

- Sea-level rise, flooding risk, and coastal erosion threaten coastal infrastructure, particularly port facilities, but also roads, airports, and buildings located near the shoreline.
- Cyclones and intense rainfall can cause major damage through flooding, strong winds, and landslides, affecting paved and unpaved roads, bridges, and other infrastructure (buildings, water supply, energy systems, etc.).
- Periods of severe drought may affect pavement stability through shrink–swell processes in clay soils, leading to cracks and deformations.
- Wildfires also represent a significant risk for all types of infrastructure.
- Reduced efficiency of thermal power plants due to rising temperatures.
- Deterioration of comfort and safety conditions for occupants and risk of equipment damage in buildings as temperatures increase.

Infrastructure damage can result not only in substantial repair and rehabilitation costs (physical impacts) but also in loss of efficiency and additional costs linked to disruptions in the services provided by infrastructure (functional impacts).

The climate hazards considered in the infrastructure resilience study are summarized in the table below.

Table 18: Climate hazards impacting infrastructural issues

	Climatic hazards								Other pressures
CHALLENGE	**Flooding**	**Submersion**	**Heavy rain**	**Drought**	**Cyclone**	**Heatwave**	**Marine Heatwave**	**Wildfires**	**EEA**
Road infrastructure	X	X	X	X	X	X		X	
Buildings	X	X	X	X	X	X		X	
AEP Networks	X		X	X	X	X			
Electricity and telecom network	X	X			X	X		X	

c. Sensitivity and adaptive capacity

Infrastructure in New Caledonia displays several sensitivity factors related to its location, condition, and design. **Topography** plays an important role in this vulnerability: roads built in rugged terrain are generally more sensitive than those on flat ground. Slopes, water drainage, and soil stability create technical challenges that increase the risk of deterioration or failure.

In addition, **a large share of infrastructure is in coastal areas where density is high**. This location increases exposure to climate hazards, marine erosion, and sea-level rise. These coastal zones therefore concentrate higher risks, particularly with the intensification of extreme events linked to climate change.

The **aging of infrastructure** is also a concern. Some roads and engineering structures built several decades ago are now in poor condition. The New Caledonia Road Transport Companies Union (SETRNC) and the Mining Contractors Union (Contrakmine) have highlighted the urgency of the situation, warning about the aging of several major bridges—such as those at Tontouta, Ouenghi, Moindah, and Ponérihouen—which date back to 1945 and already show signs of cracking.

Regarding structural design, road drainage systems were developed at a time when climate change impacts were not considered. Many of these infrastructures, **built in the 1970s and 1980s**, may not withstand the increasing frequency and intensity of rainfall or the resulting flooding.

Maintenance of the network is another critical issue. While roads in Nouméa and its surroundings are generally in good condition—paved or concreted and regularly maintained—the situation is different in rural or less-travelled areas. These suffer from chronic maintenance shortages, particularly unpaved roads, which accelerate their degradation.

Infrastructure sensitivity could not be assessed through expert judgment. The expert-based evaluation of adaptive capacity is presented below.

Table 19: Expert ratings of infrastructure adaptability, including reactive adaptive capacity (existing guardrails) and transformational adaptability of the sector

	South Province	North Province	Loyalty Islands
Road infrastructure	Moderate	Moderate	No rating yet
Ports and airports	High	Moderate	No rating yet
Buildings	High	Moderate	No rating yet
Water supply networks, catchments and PPE	Low	Moderate	No rating yet
Electricity and telecommunications network	Very high	High	No rating yet

4. Analysis and mapping of the resilience of human well-being issues

The resilience of the human well-being category was assessed for public health, food security and water security.

a. Public Health

i. Overview of the issue

In this section, we do not address issues related to food security and water security, which are covered in the following sections, nor risks to health infrastructure, which were discussed in the previous section.

The **New Caledonia Adult Health Barometer 2021–2022** provides a detailed picture of the health status of adults aged 18 to 64, highlighting key trends and challenges in well-being and prevention. The data below comes from the Government of New Caledonia and dates from 2022.

Perceived health status in New Caledonia is generally positive, with 70% of adults reporting good or very good health. However, the study shows that about 22% of the population suffers from a chronic disease, a figure rising to 37% among those aged 45–64. These conditions include cardiovascular and respiratory diseases as well as metabolic disorders such as diabetes, representing major public health concerns.

Access to healthcare is also a concern, with 20% of New Caledonians reporting difficulties obtaining a medical consultation. The main obstacles mentioned are long waiting times for

appointments and limited availability of certain specialists, particularly in rural areas and the Loyalty Islands.

Obesity and overweight represent a major public health issue, affecting 66% of adults (28% overweight and 38% obese). Prevalence increases with age, reaching 47% among those aged 45–64, and is higher among women (42%) than men (34%). Abdominal obesity, a cardiovascular risk factor, affects 49% of adults, with a strong gender disparity (66% of women versus 32% of men). These trends are linked to **unbalanced diets**—low consumption of fruit (24%) and vegetables (38%)—and **high levels of sedentary behaviour**, contributing to the rise in metabolic diseases such as diabetes and cardiovascular disorders. **Hypertension** affects 29% of adults, while 10.8% have been diagnosed with diabetes and 5.7% are in a prediabetic state. **High cholesterol** concerns 20.5% of adults, and 7.8% suffer from anaemia. **Chronic kidney disease** affects 5.4% of the population, often linked to hypertension and diabetes. Overall, 33% of adults face a moderate to **high cardiovascular risk**, highlighting the importance of prevention, improved medical follow-up, and greater awareness of healthy lifestyles to curb chronic disease progression in New Caledonia.

Screening for **women's cancers** shows mixed results: 66% of women have had a cervical smear within the past three years, indicating awareness of cervical cancer prevention. Regarding breast cancer screening, 54% of women have had a mammogram in the past two years, consistent with recommendations but still improvable to ensure optimal coverage of at-risk populations.

Smoking remains a major issue, with a high prevalence of 42.5% daily smokers, particularly among young adults aged 18–44. **Alcohol consumption** is also widespread: nearly 60% of adults report drinking alcohol, usually occasionally (51% drink two to three times per month), though 8% consume alcohol daily, increasing the risk of dependence and long-term health complications. **Cannabis use** is another concern, with 13% of adults reporting consumption (8.5% occasional and 4.5% daily), more common among men (18%) than women (8%).

In terms of **mental health**, the study highlights a notable prevalence of depressive disorders. Nine percent of individuals aged 18–60 experienced a major depressive episode at the time of the survey, with significantly higher rates among women (14%) than men (4%). These findings underscore the need to strengthen psychological support systems and improve access to mental health care in New Caledonia.

The study also addresses violence experienced by adults, particularly **physical and sexual violence**. Although detailed figures are not provided here, such experiences represent aggravating factors for both mental and physical health and call for strengthened prevention and support measures.

Beyond the health issues identified by the Adult Health Barometer, it is important to consider environmental risks specific to New Caledonia, particularly those linked to mining activity. As one of the world's largest nickel producers, the territory faces indirect but significant health challenges related to mining, including **soil, water, and air pollution**. The dispersion of **heavy**

metals from mining sites—reaching rivers and lagoon waters—can directly affect population health as well as environmental quality on which many communities depend for food and livelihoods (Bodrati, 2024). A notable incident occurred in 2014, when a toxic leak from a nickel plant severely polluted a local river, affecting fishing activities and posing an immediate health risk to surrounding communities. Beyond active sites, abandoned mines also represent a persistent environmental threat through poorly contained toxic residues that continue to contaminate natural environments. These risks particularly affect Kanak populations, often living near mining areas and heavily reliant on natural resources for subsistence (Bodrati, 2024).

Overall, the public health sector in New Caledonia reflects a dual reality: modern medical infrastructure and a robust social protection system coexist with structural fragilities and growing challenges linked to demographic changes, territorial inequalities, and climate-related risks.

ii. Strengths of the healthcare system

New Caledonia benefits from a healthcare system structured around recent and high-performing hospital facilities. Since 2018, the territory has had five public hospital centres:

- The Médipôle of Koutio, located in the near suburbs of Nouméa, which serves as the territory's main reference hospital
- The Albert-Bousquet Specialized Hospital Centre (CHS), in Nouméa
- The Northern Hospital Centre (CHN), located in Koné, which strengthens hospital services in the Northern Province.

Healthcare provision has developed rapidly in recent years with the opening of the Médipôle and the Nouville Clinic in the Southern Province, as well as the Koné Hospital Centre in the Northern Province. However, only one private clinic remains in the territory today, located in Nouméa, which limits access to specialized care in certain areas (Government of New Caledonia, 2016).

In addition, the territory has an autonomous social protection system administered by CAFAT. It manages the Unified Health and Maternity Insurance Scheme (RUAMM), which covers most of the population, as well as the prevention of occupational accidents and diseases. The Health, Social, and Family Action Fund (FASSF) also provides funding for targeted assistance (Government of New Caledonia, 2016).

iii. Weaknesses and vulnerabilities of the healthcare sector

Despite these strengths, New Caledonia's healthcare system faces several fragilities that call into question its capacity to adapt.

A system under pressure in the face of demographic and epidemiological changes

The New Caledonian population is gradually aging, increasing demand for specialized medical care. Between 2010 and 2018, the crude mortality rate rose from 4.8% to 5.6%, reflecting both population aging and the rise in chronic diseases (Government of New Caledonia, 2018). The

main causes of death are tumours (27.2%), diseases of the circulatory system (24.5%), and external causes, particularly transport accidents (13.2%).

The growing burden of chronic diseases such as diabetes and cardiovascular conditions is driving up healthcare expenditures and threatening the sustainability of the RUAMM, whose financial balance is weakened by rising treatment costs (Government of New Caledonia, 2016).

Marked territorial inequalities and the persistence of "medical deserts."

Although hospital services have improved, they remain unevenly distributed across the territory. Many rural and remote municipalities suffer from a shortage of doctors and healthcare staff, forcing residents to travel to Nouméa or other well-equipped urban centers to access care (Inspection générale des affaires sociales, 2018). These inequalities worsened following the May 2024 riots, which increased population movements toward areas with better healthcare infrastructure. Mayors of Bourail, Poindimié, and Koumac reported a significant rise in attendance at their medical and social centers (CMS) by residents from the East Coast or the far North, where healthcare provision is particularly limited (Cour des comptes, 2021).

Governance and system management challenges

Gaps in the organization, regulation, and governance of the healthcare system have been identified, limiting the effectiveness of reforms. The lack of up-to-date health data makes it difficult to adapt healthcare provision to the population's actual needs (Cour des comptes, 2021).

The results regarding the importance of the public health issue are presented in the table below:

Table 20: Importance of the public health issue according to the provinces:

	South Province	North Province	Loyalty Islands
Public Health	2	3	No rating yet

iv. Hazards and impacts

Climate change represents a **growing and multidimensional threat to public health** in New Caledonia, exacerbating existing vulnerabilities and introducing new health risks. Among the most concerning effects are rising **temperatures, changing rainfall patterns, the increasing frequency of extreme events**, and their direct and indirect health consequences.

Extreme **climate events**—such as **cyclones, floods, heatwaves, and wildfires**—are expected to become more frequent and intense. These hazards can cause **physical injuries, loss of life**, and **psychological trauma**, particularly in the form of post-traumatic stress. They also weaken healthcare infrastructure, complicating access to care at times when needs are most urgent.

Heatwaves, which are becoming more frequent and intense both day and night, particularly expose older people and those with chronic illnesses—especially individuals with diabetes—to heatstroke risks. They also increase cooling needs in buildings and have already led to a near doubling of energy consumption over the past 50 years. These effects are especially pronounced along the west coast, notably in Nouméa, Bourail, and the La Tontouta region.

Flooding linked to heavy tropical rainfall and cyclones is another major hazard. It can cause sudden river overflows, particularly in valleys and urban areas near waterways, leading to significant material damage, loss of life, and contamination **of drinking water sources**. This context favours the **resurgence of epidemics** such as **cholera** and **leptospirosis** and increases **mosquito proliferation**, which can transmit diseases like dengue. Dengue, already an endemic epidemic, could become fully endemic by 2050 according to local climate models. Warmer and more humid conditions create an environment favourable to mosquito multiplication, increasing the risk of **dengue transmission** (notably serotype 2) as well as **leptospirosis**, especially during the rainy season. New Caledonia has experienced several dengue **outbreaks** in recent years, with hundreds of cases reported annually (Bodrati, 2024). Examples from neighbouring islands such as Kiribati, where previously absent vector-borne diseases have rapidly emerged with climate warming, confirm this regional trend.

Bushfires, increasingly frequent during drought periods, also have serious health consequences. Fuelled by heat, winds, and dry vegetation, these fires destroy fragile ecosystems (dry forests, mining scrub) as well as human settlements and rural infrastructure. **Toxic smoke** emissions worsen **respiratory diseases**, particularly among already vulnerable populations. These fires also contribute to the loss of agricultural land and livestock, undermining local food security.

Finally, climate change increases the **risk of water- and food-borne diseases**. Temperature fluctuations and irregular rainfall affect water and food quality, exposing populations—especially children and the elderly—to **gastrointestinal infections**, often aggravated by inadequate sanitary conditions (Bodrati, 2024).

v. Sensitivity and adaptive capacity

The public health sector is particularly vulnerable to climate risks and social inequalities, which directly influence the quality of care and access to health services. The main sensitivity factors include:

- **Strong dependence on climatic conditions**: air quality, access to drinking water, food production, and housing safety are directly affected by climate change. In addition, rising temperatures promote the spread of vector-borne diseases such as dengue (Government of New Caledonia, 2022).
- **Presence of vulnerable populations**: older adults and children are especially exposed to health risks and chronic diseases (Cour des comptes, 2021). Population aging in New

Caledonia represents a major medical challenge. Since 1989, the number of people aged over 60 has doubled, and by 2030 this group is expected to represent more than one-fifth of the population (Government of New Caledonia, 2021).

- **Exacerbated territorial inequalities**: medical deserts in some remote municipalities force part of the population to travel long distances to access care, increasing health access inequalities (Inspection générale des affaires sociales, 2018).

The public health sector in New Caledonia has several levers to adapt to climate change, although these still need to be strengthened to fully address growing risks. In terms of **awareness**, authorities have incorporated climate-related health issues into several strategic frameworks. The **New Caledonia Climate Change Strategy (2022)** acknowledges the health impacts of warming, including the spread of vector-borne diseases, increased heatstroke risk, flood-related hazards, and declining air quality. This awareness is also reflected in the **"Do Kamo – Être épanoui" health plan** adopted in 2016, which proposes a comprehensive reform of the healthcare system while accounting for demographic, health, and environmental vulnerabilities (Government of New Caledonia, 2016; 2022).

Organisational **capacities** have been mobilized to respond to certain specific hazards. In response to increasing **heatwaves**, the territory has implemented a **"High Heat" plan**[4], automatically activated each year between November 15 and April 30. This scheme relies on seasonal monitoring, a **surveillance system** combining meteorological and health indicators, **targeted prevention campaigns**, and **crisis management** measures tailored to at-risk populations (older adults, people with chronic illnesses, and children). The plan also helps test the effectiveness of alert systems and the **identification of vulnerable individuals** (Government of New Caledonia, 2022).

[4] https://dass.gouv.nc/sites/default/files/atoms/files/plan_fc_061118.pdf

The management of **climate-sensitive epidemics** also illustrates a certain adaptive capacity. Faced with repeated **dengue outbreaks**, New Caledonia has implemented several **public health information campaigns** to raise awareness about transmission modes, symptoms, and appropriate actions in case of infection (see Figure 43). At the same time, an innovative research program, **"World Mosquito,"** was launched in 2018. It is based on the introduction of mosquitoes infected with the **Wolbachia** bacterium—a biological control method that helps reduce dengue virus transmission (Government of New Caledonia, 2022). This type of initiative demonstrates a genuine commitment to prevention and epidemiological resilience.

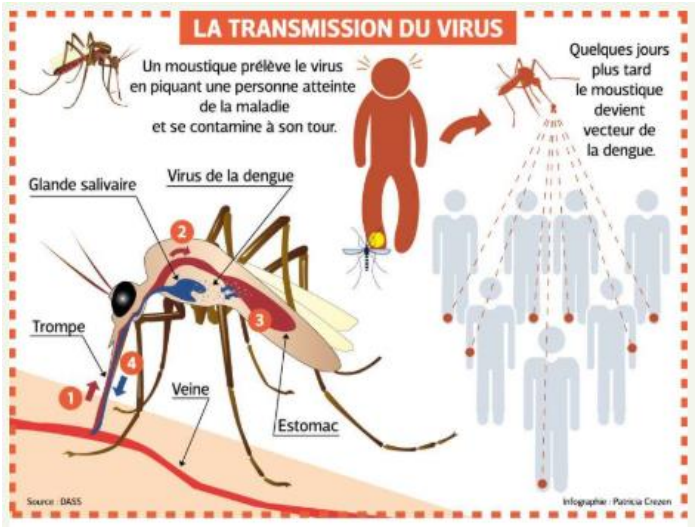


Figure 43. Transmission of the dengue virus. Infographic: Patricia Crezen (Bodrati, 2024)

From a **technological** perspective, the territory benefits from modern medical equipment, notably through reference hospital infrastructure such as the Médipôle of Koutio, as well as digital tools supporting risk management. The **GeoRep.nc software**, for example, enables visualization of **flood-prone areas**: in Dumbéa, some zones could be submerged by more than 1.5 meters for a 100-year return period. Such tools are essential for anticipating risks, adapting health-related urban planning, and protecting critical infrastructure (GeoRep.nc, 2023).

However, **financial capacities** remain limited. The **Unified Health and Maternity Insurance Scheme (RUAMM)** is structurally in deficit, restricting budgetary flexibility in the event of health or climate crises. This imbalance is exacerbated by the rise in chronic diseases, population aging, and the absence of dedicated funding for climate adaptation in the health sector (Cour des comptes, 2023). Moreover, despite institutional autonomy, **health governance** faces dysfunctions. The General Inspectorate of Social Affairs (IGAS) and the Court of Auditors have highlighted persistent weaknesses in the organization, steering, and regulation of the health system, as well as insufficient consolidated health data to inform decision-making (IGAS, 2018; Cour des comptes, 2023).

In summary, although New Caledonia has laid the foundations for a health system resilient to climate change—through targeted prevention plans, digital tools, and innovative disease-control programs—**financial and institutional capacities still need strengthening**. More integrated governance, increased resources, and stronger territorial anchoring of health policies will be essential to anticipate and effectively respond to climate-amplified health risks.

The sensitivity of the public health issue was rated 4 out of 4 by the DASS across all provinces.

Table 21: Rating of public health sensitivity according to experts

	South Province	North Province	Loyalty Islands
Public Health	Very high	Very high	Very high

Adaptive capacity was assessed as moderate by the South Province and the North Province.

Table 22: Ratings of public health's adaptive capacity according to experts including reactive adaptive capacity (existing guardrails) and transformational adaptive capacity of the sector

	South Province	North Province	Loyalty Islands
Public Health	Moderate	Moderate	Not Rated

	South Province	North Province	Loyalty Islands
Food safety	Moderate	Moderate	Not Rated

b. Food security

Food security is a concept defined by the World Bank at the 1996 World Food Summit. It "exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life." It therefore encompasses individuals' diets, the nutritional and sanitary quality of food, as well as people's physical, economic, and cognitive access to food. Food security rests on four pillars:

- The physical availability of food within the territory
- Economic and physical access of the population to that food
- Food utilization

Stability of the first three dimensions over time, considering external variables (social, economic, and political context, as well as climatic conditions). This temporal dimension is important as it aligns with the United Nations Sustainable Development Goals (SDGs), particularly Goal 2, which aims to "end hunger and ensure food security."

The resilience analysis of food security was conducted based on the first three pillars. The fourth pillar was not addressed due to a lack of data and contextual perspective. The present ESRAM analysis cannot exhaustively address food security, a dense and complex topic that would require a dedicated in-depth study to reach a finer level of detail than the provincial scale. Nevertheless, it enabled an assessment of population dependence on ecosystems for food purposes across the six zones defined for the field survey. This provides insight into self-consumption practices,

although no precise correlation could be established with the other food security pillars for each zone.

The following sections therefore, present the importance of the issue for the territory, the hazards to which it is exposed, and its sensitivity and adaptive capacity.

vi. Importance of the issue

A report prepared under the PROTEGE program in February 2022 highlighted the following food security challenges at the scale of New Caledonia:

Sustainability Axis	Issues
1. Food and nutritional security	Current dietary practices have negative impacts on the health of New Caledonians. Public health issues have been exacerbated by the COVID-19 crisis.
	Local production is very expensive, which limits access to healthy food, particularly for low-income populations whose available food budget is limited.
	Local production represents a very low level of coverage.
	Social perceptions surrounding food do not encourage a balanced diet or changes in practices.

The three pillars clearly emerge as major issues at the territorial scale and can be detailed as follows:

Physical and economic access: local production is costly, and coverage is uneven across the territory

At the sub-territorial level, access to a diverse commercial food supply is generally easy in Greater Nouméa and in larger rural towns such as Boulouparis, La Foa, Bourail, VKP, and Poindimié. In these areas, the food offer is diversified, combining supermarkets, small shops and service-station stores, and markets with relatively affordable prices.

By contrast, food availability is very limited in the rest of the territory—particularly in the islands and rural areas—where short supply chains are poorly developed. Products are scarce and sold at high prices, especially fresh produce such as fruits and vegetables, leading many small shops to focus mainly on dry goods. Nevertheless, along the East Coast and in the central mountain range, informal roadside stalls selling surplus agricultural production at attractive prices can be found, although their availability is not guaranteed. In these areas where transport costs are high, self-consumption is therefore very common to offset **geographic inequalities** (PROTEGE, 2021).

Compared with other uses, food supply appears highly dependent on resources harvested directly from ecosystems across New Caledonia. According to the socio-economic survey, food use has a generally high level of importance. When broken down by zone, food use received a score of 3

(high importance) in all zones except Greater Nouméa, which scored 2. This can be explained by the largely urban character of Greater Nouméa and the presence of numerous retail outlets, confirming the observations above.

Currently, food accounts for around 20% of household budgets in New Caledonia (a figure close to mainland France's 22% in 2024 according to INSEE). However, this expenditure share is much higher for lower socio-professional categories and thus represents a greater financial burden. Unlike mainland France, the economic advantage tends to favour producers rather than consumers. To address high prices, a Price Quality Shield mechanism was introduced in 2019, yet the high cost of living remains a major issue. Purchasing cheaper, often processed and less nutritious products is one coping strategy; self-consumption is another. Its importance varies by household income: it represents 30% of consumption value for the lowest income quintile and 38% among Kanak households (ISEE, 2021). At the territorial level, self-consumption accounts for about 22% of food volume and 15% of its average value. Self-consumption also has a strong cultural dimension centred on specific products, notably fishing, tropical root crops, and deer meat from hunting, products for which self-produced values may exceed commercial ones. It partly reflects **economic inequalities** in access to certain types of food. Food sharing and gifting among relatives, neighbours, or within customary practices are also very common, though difficult to quantify. Purchasing cooperatives and food aid associations help mitigate these economic access inequalities to some extent.

Fishing provides a clear illustration of subsistence production. Often informal in New Caledonia, it involves an estimated 50,000 participants, with 6,000 tonnes caught (six times more than professional coastal fishing) and representing 41% of the value of self-consumption. In a territory where seafood accounts for more than 40% of dietary protein intake, dominated by lagoon fish, **supply through informal channels plays a major role in strengthening food security**.

To illustrate subsistence production, three maps were produced showing the importance of livestock farming, fishing, and agricultural production for tribal communities. Municipalities with the highest importance are mainly located in rural areas of the Northern Province and in the islands, including Hienghène, Touho, Poindimié, Ponérihouen, Lifou, as well as Ouvéa, Kaala-Gomen, Koumac, Ouégoa, Pouébo, Poum, and Bélep. Tribes in these areas therefore appear highly dependent on the health of the ecosystems from which they harvest and produce their food.

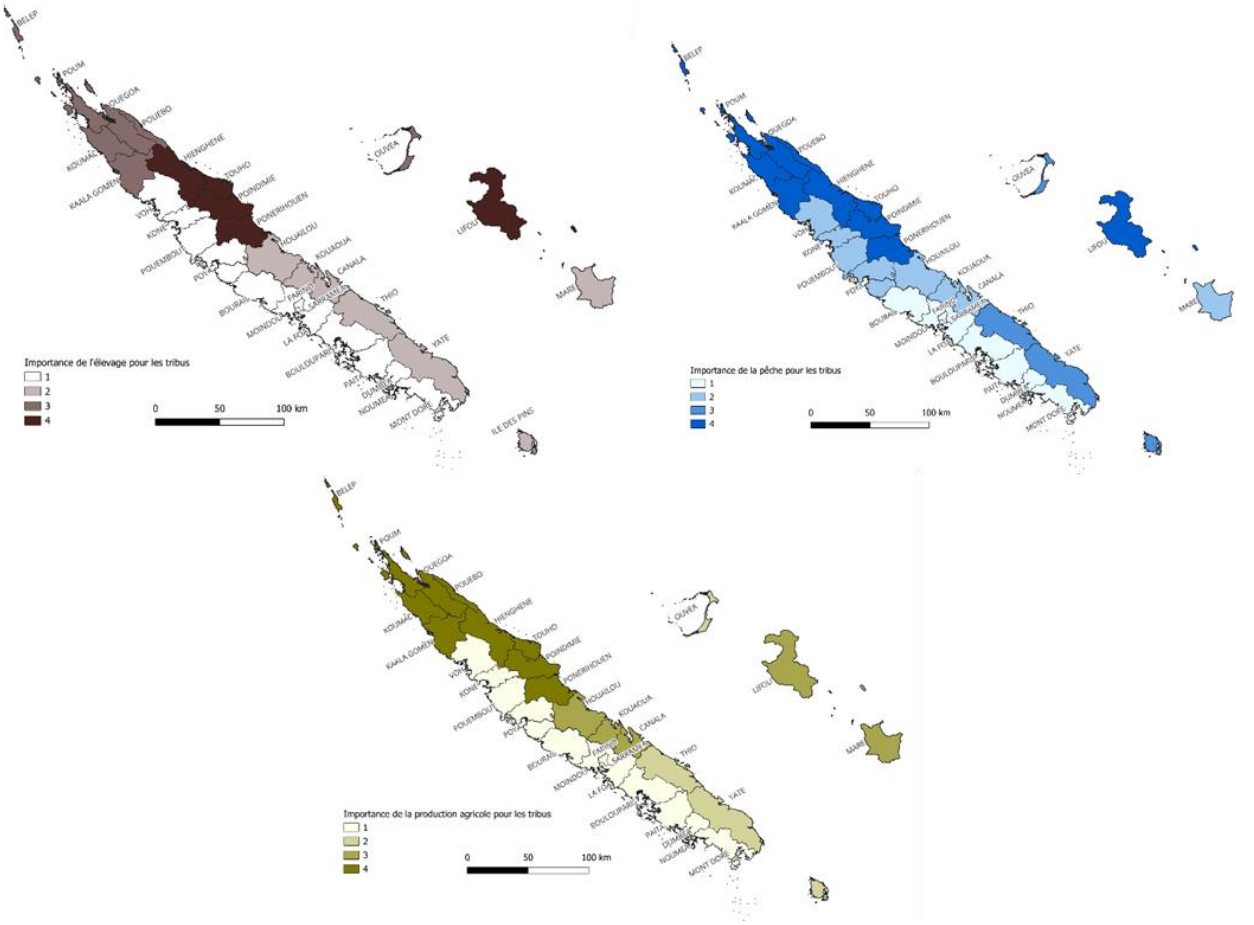


Figure 44 : Maps showing the distribution of the relative importance of tribal livestock farming (brown), fishing (blue), and agricultural production (khaki) by commune.

Availability: insularity makes the territory highly dependent on imports, and there are generational renewal challenges in agriculture and professional fishing

From a broader perspective, food security in New Caledonia raises major issues in terms of availability. The territory is highly dependent on food imports due to its insular nature and insufficient local production of certain products, notably cereals, dairy products, and fruits and vegetables depending on the season (PROTEGE, 2021). When both food imports and production inputs are considered, New Caledonia depends on external markets for 83% of its food needs. More than half of these imports come from Europe, significantly affecting both food prices and the carbon footprint of food products. As a result, the issue of food sovereignty frequently returns to public debate, intending to diversify local production.

In 2018, New Caledonia imported 40,000 tonnes of cereals annually, covering 90% of its needs, while the livestock sector was locally supplied at around 70% and fresh fruit and vegetable production at 80%. By 2025, targets have been set to reach 13,000 tonnes of maize, 7,500

tonnes of wheat, and 3,000 tonnes of rice, compared with only 10,000 tonnes of maize produced in 2018.

The local production coverage rate was estimated at 41% in 2021, including the value of self-consumption. Although some products are difficult to produce locally due to climatic requirements (cold and temperate crops), they are not the majority, and local production could increase significantly given the territory's climatic potential.

Professional agriculture and fishing sectors are also affected by an aging workforce, creating a strong need for generational renewal. However, these professions are becoming less attractive to young people, often perceived as physically demanding, poorly paid, and difficult to enter without a family background in the sector.

Food utilisation: a major health issue and a trend toward alignment with supermarket standards

The New Caledonian population is generally in poor health due to dietary patterns, with a large share of the population overweight or obese. The cost of long-term illnesses, particularly diabetes, amounts to 40 billion FCFP annually for the health system. Encouraging healthier diets could potentially reduce healthcare expenditures by 40% (PROTEGE, 2021).

Health challenges disproportionately affect more vulnerable populations and stem from limited physical and economic access to healthy food. Lack of access to balanced diets leads some individuals to consume inexpensive, processed foods high in sugar and salt, contributing to overweight and obesity (see public health section). Portion sizes are often excessive relative to average physical activity levels, and consumption of fresh fruits and vegetables remains low.

Food utilization is also influenced by cultural perceptions. Traditional representations valued abundance, and modernization—with the rise of consumerism—has partly weakened the link between food production and society. At the same time, the easy availability of rich and sugary foods intersects with cultural values associated with abundance, potentially encouraging high consumption of these products (PROTEGE, 2021).

vii. Hazards and impacts

All the hazards examined in this study may affect food security (see table below), as they threaten both land-based and marine production. For example, marine heatwaves can decimate marine fauna, which constitutes a significant share of the local diet.

Table 23: Climatic hazards impacting food security

	Climatic hazards								Other pressures
CHALLENGE	**Flooding**	**Submersion**	**Heavy rain**	**Drought**	**Cyclone**	**Heatwave**	**Marine Heatwave**	**Wildfires**	**EEA**
Food safety	X	X	X	X	X	X	X	X	X

For a detailed analysis, refer to:

- The agriculture, fisheries, and forestry section for climate hazards and how they may affect agricultural production, fishing, and hunting.
- The infrastructure section for hazards and how they may disrupt distribution chains

viii. Sensitivity and adaptive capacity

DAVAR assigned a 4 out of 4 sensitivity score to this issue regarding climate change across all provinces. This result reflects, on the one hand, the population's strong dependence on food for basic needs and, on the other, reliance on transport infrastructure for food imports and distribution. In addition to these factors, there is also a health risk of heavy metal contamination in food, particularly in plants grown in soils naturally rich in minerals and metals across New Caledonia.

Table 24: Rating of food safety sensitivity according to experts

	South Province	**North Province**	**Loyalty Islands**
Food security	Very high	Very high	Very high

Adaptive capacity was assessed as low by the Southern Province and moderate by the Northern Province. This may be explained by the fact that the Southern Province relies heavily on external imports, making it somewhat dependent on external supply chains, whereas the Northern Province is characterized more by limited access to a diverse range of food products and has already had to develop local or regional strategies to partially address this constraint.

Table 25: Ratings of the adaptive capacity of food security according to experts including the reactive adaptive capacity (existing guardrails) and the transformational adaptive capacity of the sector

	South Province	North Province	Loyalty Islands
Food security	Low	Moderate	Not Rated

Several projects are currently underway on the topic of food security. Among them:

- PACPATH, involving SPC, IRD, the Belmont Forum, and other partners, brings together scientific experts to better understand the impacts of climate change on the Pacific Ocean. Project workshops have addressed various themes, from sea-level rise to food security.
- FALAH, an innovative project in Oceania, focuses on family farming in the face of urban challenges, climate change, and evolving diets. By analysing agricultural practices, food security, and health impacts, it aims to promote sustainable lifestyles. The integration of traditional and scientific knowledge guides food education for balanced, environmentally respectful family farming, with both local and global relevance.

Several major institutional actors have also launched initiatives. The New Caledonia Chamber of Agriculture and Fisheries has addressed the issue through its O2P plan, which aims, among other goals, to develop short supply chains and local markets to structure the territory's food supply. The Rural Agency has launched a call for projects on edible plants as well as a diversification program with IAC and ADECAL.

Some initiatives appear easier to implement depending on the food security dimension considered, even though the topic remains broadly consensual. School catering is one promising lever, still relatively underdeveloped despite some initiatives promoting local product consumption—such as at the La Foa boarding school—and raising awareness from an early age through the Pacific Food Lab.

Overall, there is clear interest from public actors and the research community in addressing food security, as its challenges increasingly affect the New Caledonian population, particularly the most vulnerable. The key challenge now lies in better coordinating these initiatives and continuously assessing strengths and weaknesses through relevant indicators, with particular attention to governance, since food security depends on a broad ecosystem of actors whose dialogue and coordination are essential.

c. Water security

Water security is a major issue across New Caledonia. Also referred to as hydric security, it encompasses continuous access to drinking water in terms of both quantity and quality to meet essential needs. The World Water Council defines water security as the availability of sufficient

and good-quality water to support socio-economic development, livelihoods, health, and ecosystems.

Most of the data used here come from New Caledonia's Shared Water Policy (PEP), developed in 2019. This policy provided a territorial diagnosis and clarified key water security challenges. The consultation process with the population resulted in six strategic objectives, five cross-cutting objectives, and more than 700 actions.

The existence of this policy explains why no specific mapping was produced for this issue in the ESRAM analysis. Although the PEP diagnosis is comprehensive, it lacks sufficiently detailed data for mapping, and a single map would not capture the complexity and cross-cutting nature of water security issues. Instead, elements of the diagnosis are presented to provide an overview of water security across the territory, particularly by province and within the six hydrological zones defined by the PEP, which correspond to those used for the socio-economic field survey.

i. Overview and importance of the issue

Water security is a major concern across the territory. The PEP diagnosis justifies the implementation of a dedicated policy and the consideration of water security as a key cross-cutting issue.

Regarding access to water, ISEE data from 2019 show that household **connection to the drinking water network** (AEP) did not significantly improve compared with 2009, except in the municipalities of Bélep and Ouvéa, where connection rates increased dramatically—from 21% to 99% and from 7% to 74%, respectively. During this period, ISEE also revised its categories to reflect evolving access conditions.

Most New Caledonians are now connected to the network, although disparities remain between municipalities. The lowest connection rates are observed in Poum (67.2% of the population connected), Ouvéa (74.2%), and, to a lesser extent, Kaala-Gomen (87.6%)—all below the 90% threshold. These municipalities, located in the Northern Province and the Loyalty Islands Province, therefore face ongoing water supply challenges.

Tableau 3
Pourcentages de population n'ayant pas accès à l'eau courante et à de l'eau potabilisée

Bassins typologiques	% de population sans eau traitée
Sud-Est	39 %
Nord-Est	29 %
Nord-Ouest	20 %
Bassins insulaires	17 %
Sud-Ouest	5 %
Zone VKP	5 %
Grand Nouméa	4 %
Total général NC	**9 %**

Bassins typologiques	% de population sans eau courante
Bassins insulaires	18 %
Nord-Ouest	12 %
Sud-Est	11 %
Nord-Est	7 %
Sud-Ouest	7 %
Zone VKP	5 %
Grand Nouméa	2 %
Total général NC	**5 %**

Although connection rates may appear encouraging, they mask a still concerning reality: more than 7 out of 100 households do not have access to water. Moreover, while most New Caledonians have access to drinking water in urban areas, this is not necessarily the case in rural zones. Several indicators highlight insufficient network coverage and the risk of water shortages even where connections exist.

Being connected to the network does not necessarily mean that households receive safe, treated drinking water at home. While the proportion of people without running water is decreasing, the share without treated water remains significant and is mainly concentrated along the East Coast. The table below shows that the typological basins concerned differ, with the Greater Nouméa urban area being the least affected in both cases.

Some areas are particularly exposed to water scarcity risks, especially in the North, West, and the Islands. These shortages may also be aggravated by conflicts over water allocation, with pressure heightened in mining zones and areas of strong agricultural activity.

Water quality must also be considered, as it is intrinsically linked to availability: poor-quality water reduces the amount of potable water. Of the 413 water intake points in New Caledonia, 24% are in mining areas, and 33% have vulnerable catchment basins. Only 54% benefit from water protection perimeters (PPE), and 31% produce untreated water, increasing contamination risks. This risk is further heightened by the fact that two-thirds of municipalities have intake points and boreholes without quality control, and nearly 30% of distribution units lack adequate treatment capacity.

Because water is a cross-cutting issue, both its availability and quality depend on numerous variables affecting water security. The PEP has highlighted several of these—such as agricultural land area and population density—to establish profiles for each of the six hydrological regions identified below:

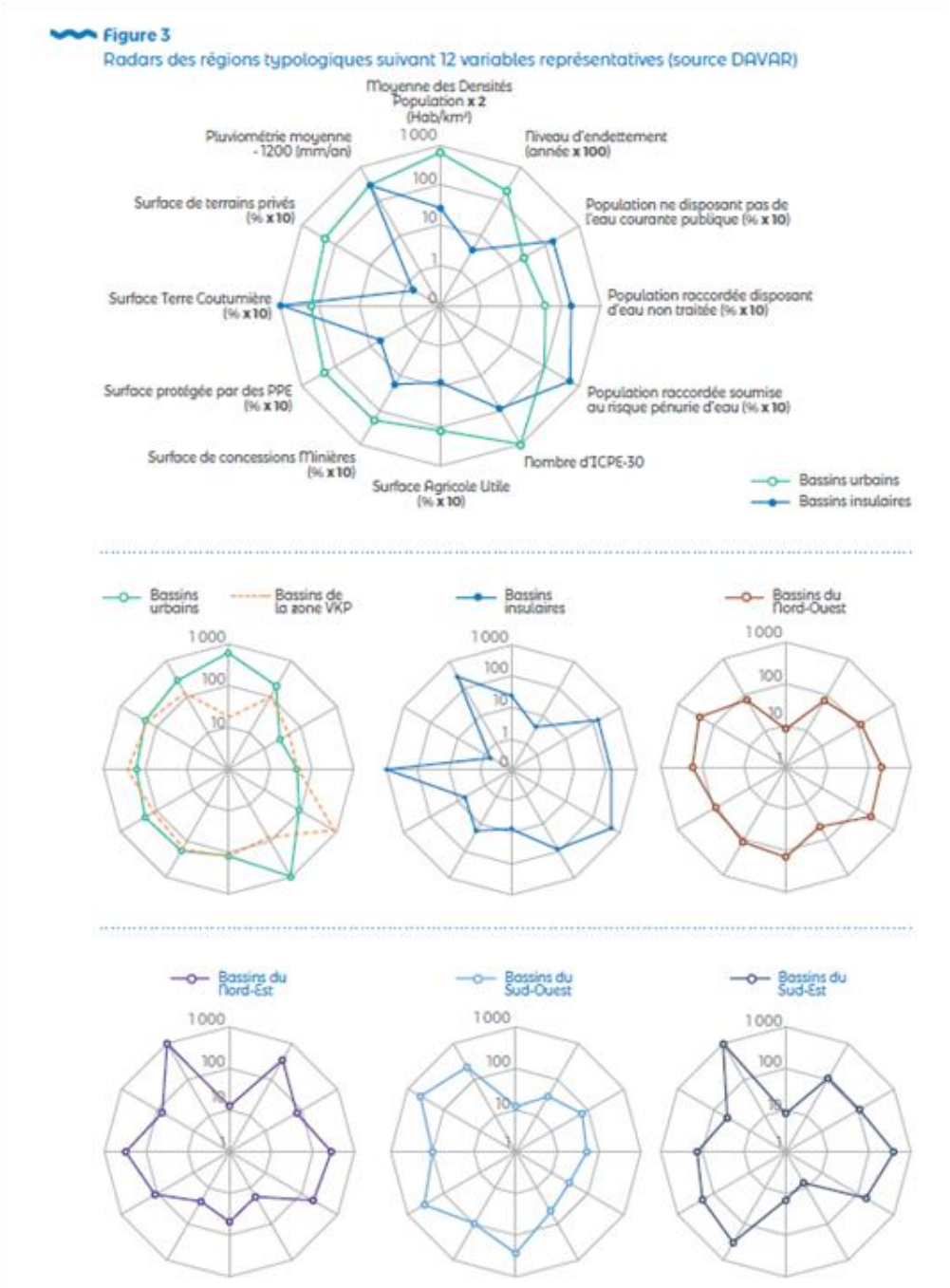


Figure 45: Representative Variables of the Policy Position of Shared Water (PEP, 2019)

- The VKP area is highly exposed to water scarcity risk. A significant share of the population lacks access to public running water and treated water. The area is characterized by mining activity, a strong presence of customary land, and relatively high levels of debt.
- The Islands face a major water scarcity risk, with a substantial portion of the population lacking access to running water and even more without treated water. They have few water protection perimeters (PPE), which can be explained by their reliance on freshwater lenses for supply. Land is largely customary, population density is low, and the islands have limited debt, relatively little mining activity, and low agricultural land area.
- The North-West basin is marked by very low population density and significant mining but especially agricultural activity. Water scarcity risk is high due to multiple water-intensive uses. A large share of the connected population still lacks access to treated water, and average rainfall is relatively low compared with the VKP and Island zones.
- The North-East basin, sparsely populated, is characterized by limited mining and agricultural activity. It has a very high rate of non-connection to the water network, with many residents lacking treated water. Land is predominantly customary.
- The South-West basin benefits from high rainfall and a relatively low risk of water scarcity. It is the most urbanized area of the territory, with notable rates of non-connection to the network but generally easier access to treated water. Agricultural activity is significant, and mining concessions are also present. Land is mainly privately owned, and this basin has the most developed network of water intake protection perimeters (PPE).
- The South-East basin is characterized by strong agricultural and mining activities, which contribute to a high-water scarcity risk. Population density is very low, land is largely customary, and both non-connection to the network and lack of access to treated water remain significant.

These parameters highlight their importance for water management: land tenure (customary or private), given the link between water and land use (e.g., boreholes); the presence of activities such as agriculture and mining; and population density, which influences water demand and can increase pressure on resources. The number of facilities classified for environmental protection also reflects industrial presence and raises questions about water consumption. However, these indicators represent only part of the challenges and are not exhaustive.

ii. Climatic hazards

The climate hazards affecting water security and considered in this study are presented in the table.

Table 26: Climatic hazards impacting food security

	Climatic hazards								Other pressures
CHALLENGE	**Flooding**	**Submersion**	**Heavy rain**	**Drought**	**Cyclone**	**Heatwave**	**Marine Heatwave**	**Wildfires**	**EEA**
Food safety	X	X	X	X	X	X		X	X

iii. Sensitivity and adaptive capacity

The sensitivity score given by the experts is 4 out of 4 (the same score was given in each province).

Table 27 : Expert Water Security Sensitivity Rating

	South Province	**North Province**	**Loyalty Islands**
Water Security	Very high	Very high	Very high

Among the sensitivity factors related to water security, the economy's strong dependence on the nickel sector is notable. Many waterways are heavily silted due to current or past mining activities that release metals and particles, which are then carried downstream by runoff. For example, the map below shows overlaps between mining cadastre areas and water protection perimeters. Except for the Southern Massif, these areas are often located along mountain ridges, meaning they can potentially affect multiple catchment basins and the entire length of their waterways.

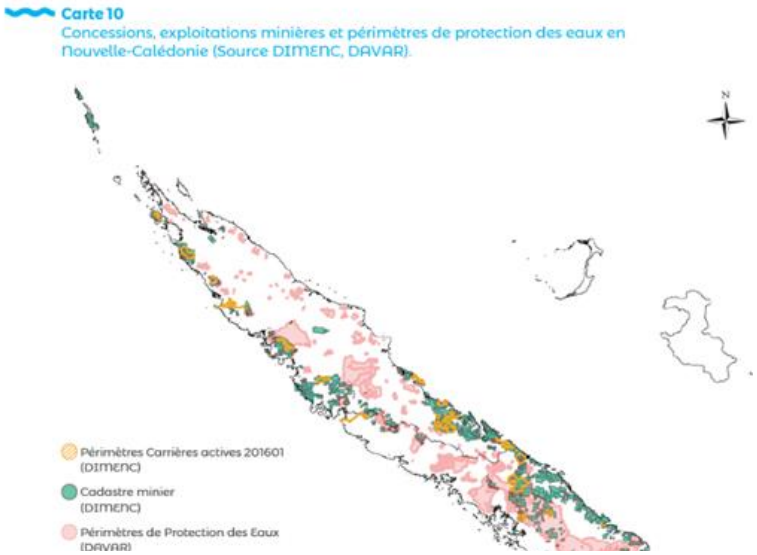


Figure 46: Example of a graphical synthesis

As a result, 90% of water protection perimeters are in a degraded condition due to mining activity. Given that one in ten New Caledonians drinks water directly drawn from rivers, this raises a major public health concern. Moreover, this water quality issue persists over the long term, as sedimentation can continue to intensify long after mining operations have ceased.

Water security is therefore a particularly important issue in both the Southern and Northern Provinces. The Southern Province appears to have a better adaptive capacity than rural areas and the islands, which is consistent with findings from the PEP.

The islands and the northern part of the Northern Province are the areas most affected by water quantity issues. Water quality is a major concern in the South-East and agricultural central zones, although quantity is also becoming problematic due to overconsumption by agricultural and mining activities in some areas. It is worth noting that, at the national level, there is significant overconsumption of drinking water, with annual use two to three times higher than in mainland France, where the average household consumption is about 150 m^3 per year. This can partly be explained by the relatively low cost of drinking water.

The socio-economic survey also highlighted that many respondents have already taken measures to avoid water shortages. For instance, rainwater harvesting and storage are common practices. Some respondents reported having their own boreholes or storing bottled water. All these measures reflect individual-level adaptation strategies.

Table 28 : Rating of water security adaptive capacity by experts, including reactive adaptive capacity (existing guardrails) and transformational adaptive capacity of the sector

	South Province	**North Province**	**Loyalty Islands**
Water Security	Very high	High	Not Rated

As with other issues, no feedback was available from the Loyalty Islands Province regarding the adaptive capacity of water security. Given the islands' particular situation and their strong dependence on freshwater lenses, it can be assumed that adaptive capacity does exist but is constrained by the insular context, which is more pronounced than on Grande Terre. This hypothesis could be further clarified when developing ecosystem-based adaptation options.

The Shared Water Policy (PEP), whose orientations were launched in 2019, represents a key framework for adaptation. Although it applies to the entire New Caledonian territory, it makes it possible to identify the most vulnerable areas and to address issues in a cross-cutting way at broader scales, such as catchment basins. For this issue, it is therefore difficult to reason at the municipal scale, since administrative boundaries often do not match hydrological ones—highlighting the importance of managing water at a wider territorial scale.

To strengthen drinking water security—both quantitatively (reducing shortage risks) and in terms of health (limiting bacteriological degradation)—it is first necessary to promote responsible consumption patterns, particularly by curbing the overconsumption frequently observed, an objective pursued by the PEP.

Additional efforts have also been undertaken through the Nickel Fund, via a multi-year program aimed at addressing erosion sources upstream and the downstream impacts of mining activities.

5. Individual and institutional adaptive capacity

a. Objective and methodology

We previously analysed the adaptive capacity of key issues, including economic sectors, infrastructure, and human well-being categories. To further refine the assessment of New Caledonia's adaptive capacity to climate change, we collected data on population practices and characteristics (at the individual level) as well as on institutional features (notably through their funding, policy development, and implementation). Adaptive capacity was therefore ultimately examined from three perspectives: economic sectors, populations (individual level), and institutions.

Population adaptive capacity was analysed across several subcategories, including socio-demographic characteristics, socio-economic status, geographic location and isolation, and community dependence on ecosystems for subsistence. The objective was to better understand individual adaptive capacity by examining social, economic, geographic, and cultural characteristics, as well as everyday practices, to assess individuals' ability to cope with climate change impacts.

To achieve this, data from ISEE were used, particularly the 2019 population census, along with complementary surveys on housing structure and comfort and community affiliation. Most of the collected data enabled a detailed analysis at the municipal scale using relatively recent information. Missing data were supplemented through analysis of results from the socio-economic survey conducted among the New Caledonian population. This survey helped clarify population access to basic infrastructure and services and, above all, assess dependence on ecosystem resources for various uses (see the previous section on ecosystem use).

It was also considered relevant to analyse institutional adaptive capacity using inspiration from the Resilience Compass, a tool developed by CEREMA. Although valuable, this would have required a largely qualitative assessment beyond the available timeframe. Nevertheless, two partial indicators were retained based on data availability: the density of firefighters per municipality and the share of the population informed about climate hazards, drawn respectively from a report by the Territorial Court of Auditors and the socio-economic survey. Additional observations were made to outline institutional characteristics in New Caledonia, particularly regarding resources and financing capacity.

Annex 1 presents the indicators used to assess individual and institutional adaptive capacity, along with the scoring rules applied. Each indicator was evaluated independently and then combined to derive an overall adaptive capacity score for each municipality.

The municipal-level assessment was further enriched by a detailed analysis of vulnerable groups based on the socio-economic survey. This analysis followed the principles of the PEBACC+ project and GEDSI (Gender Equity, Disability, and Social Inclusion) procedures, with particular attention to groups often marginalized due to gender, age, disability, ethnicity, income, and other factors. The ESRAM process in New Caledonia aims to make these more vulnerable groups visible, as climate change adds to existing difficulties and discrimination. This approach introduces a stronger social dimension within a holistic analysis.

To highlight vulnerable groups within the population, a dedicated section presents field survey findings for women, older adults, and youth; community affiliation—particularly Kanak identity; and individuals who are non-taxable or without employment. Disability could not be analysed as a vulnerability factor due to the limited available data and the survey's inability to establish a clear correlation. It was also more difficult to specifically survey people with disabilities given the methodology used (surveys conducted in public spaces rather than at home), where people with disabilities—especially those with mobility impairments, the most common in New Caledonia—are often less visible due to accessibility constraints (Territorial Court of Auditors, 2023).).

b. Survey results on vulnerable groups

i. Gender

The gender perspective is considered because women are generally assumed to be more vulnerable to the impacts of climate change than men. They often take on caregiving and support roles for the most vulnerable family members, which can increase their exposure to climate risks and limit their mobility. Women also face greater economic inequalities (lower wages for equivalent positions, unemployment, or homemaker status), which further heightens vulnerability.

The survey sample was close to gender parity (58.7% men and 41.3% women), while the 2019 ISEE census recorded perfect parity in New Caledonia overall, a balance also observed at the provincial level. However, this overall parity conceals some disparities between municipalities, although they remain relatively limited.

Survey results indicate that:

- Women are more dependent on natural resources harvested from ecosystems in the North-West mining zone, the North-East non-mining zone, and in the Loyalty Islands and the Isle of Pines.

- On average, women show greater dependence on ecosystem resources than men across all uses at the scale of New Caledonia.

In detail, women are less dependent on phytosanitary uses. This may be explained by traditional gender roles in New Caledonia, where men are often responsible for protecting the household and agricultural fields, including pest control using phytosanitary products (natural or otherwise). For other uses, women appear particularly vulnerable regarding food-related uses, followed almost equally by health-related uses and craft/construction uses.

It is also noteworthy that within the sample, 30 respondents lived in households headed by a single woman, representing just over 17%. Although this does not concern most households, single-headed households may face increased vulnerability. In some municipalities such as Nouméa, 22% of households are managed by a single person (ISEE, 2019).

ii. Community affiliation

Living on customary land could not be clearly identified as a vulnerability factor through the survey based on respondents' dependence on ecosystem resource extraction. However, community affiliation appeared more relevant.

This criterion was selected considering New Caledonia's history and cultural heritage. The Kanak community is strongly represented in the sample, accounting for nearly 78% of respondents (134 people), whereas Kanaks represent 41% of the New Caledonian population overall. Moreover, the Kanak population is unevenly distributed across the territory: it is mainly concentrated in the Northern Province and along the East Coast and constitutes a majority in the Loyalty Islands. According to ISEE census data, Kanaks represent 95% of the population in the Loyalty Islands Province, 72% in the Northern Province, and only 29% in the Southern Province.

Conversely, the Southern Province contains the largest share of the European population (30%) and other communities. The Wallisian and Futunan community, although a minority (11%), is also present in the Northern Province, where it accounts for 12% of the population. Other communities (e.g., Indonesian) are also present, with higher proportions in the Southern Province, where they represent 18% of residents.

This indicator was also selected because the Kanak population often experiences multiple vulnerabilities—geographic, social, economic, and cultural—that have persisted since the colonial period. It is therefore assumed that Kanak individuals may be more vulnerable to climate change, even though their traditional environmental knowledge could help mitigate this vulnerability.

Survey findings suggest that:

- Kanak respondents are more dependent on ecosystem resource extraction, particularly in the East Coast zone, the North-West mining area, the North-East non-mining area, and in the Loyalty Islands and Isle of Pines.

- On average, Kanak individuals show greater dependence on ecosystem resource extraction than other communities (European, Wallisian, Futunan) and those identifying with multiple affiliations, across all uses at the scale of New Caledonia.
- Food use appears to be the area where Kanaks are least vulnerable, compared with their dependence on health-related, phytosanitary, and craft/construction uses.

iii. Age

Age is a relevant indicator when studying vulnerability to climate change, as children and older adults are generally considered more exposed and affected. In New Caledonia, about 15% of the population is under 10 years old and nearly 30% under 20, highlighting a strong issue concerning younger populations. Older adults (over 70) are less represented, accounting for about 6% of the population.

The survey included 24 older adults and 15 young people, slightly overrepresenting the older group. Conducting surveys with minors—especially children—proved challenging. The survey age categories differ from those used by ISEE, as they were divided into three groups based on entry into the workforce and retirement age rather than standard decennial age groups. Nevertheless, several findings emerged by zone:

- Young people appear more dependent than other age groups (older adults and the working-age population) on ecosystem resource extraction for food and craft/construction uses in the VKP area.
- In East Coast mining municipalities, young people seem more dependent on ecosystem resources for health-related uses, while older adults appear more dependent on ecosystem resources for craft/construction uses.
- In the Loyalty Islands and the Isle of Pines, older adults appear more dependent on ecosystem resource extraction for food and craft/construction uses.

iv. Tax status / professional activity

The socio-economic survey collected data on respondents' economic and social situations through indicators such as tax liability and professional activity. These were considered relevant to illustrate how economic conditions influence vulnerability to climate change. Results suggest that lack of professional activity has a stronger effect on dependence on ecosystem resources than tax status alone.

Key findings include:

- Individuals without professional activity are the most vulnerable in the Centre-West agricultural basin, Greater Nouméa, and the Loyalty Islands and Isle of Pines.

- On average, unemployed individuals are more vulnerable than those in employment. Food use (food security) appears to be the area of greatest vulnerability for this group. When examined by use, they seem less dependent on health and craft/construction uses; for these uses, individuals with professional activity appear to rely more on ecosystem resource extraction.

v. Sexual minorities

Sexual minorities—those identifying with the LGBTQIA+ community—represent a vulnerable group for which there is no specific evidence of increased vulnerability to climate change. However, as with other vulnerable groups examined here, climate-related vulnerability can compound the challenges already associated with sexual orientation or gender identity.

Individuals identifying as part of a sexual minority represent a very small proportion of the survey sample (6.4%, or 11 respondents) and are mainly located in the Greater Nouméa urban area. There are no official statistics, as the topic remains somewhat taboo in both public and private spheres in New Caledonia, as well as across other French overseas territories. This made it difficult to analyse this group in greater detail. The invisibility of sexual minorities and the persistence of discriminatory or violent behaviours have nevertheless been highlighted, notably in a June 2018 report by the French National Assembly titled "Combating anti-LGBT discrimination in the Overseas Territories."

c. Individual adaptive capacity

The map below shows the individual adaptive capacity score assigned to each municipality based on the various indicators analysed.

Individual adaptive capacity ranges from moderate to high depending on the municipality.

Municipalities with the highest levels of individual adaptive capacity include: Pouembout, Païta, Mont-Dore, Farino, Nouméa, Dumbéa, Bourail, Koné (Northern Province), Koumac (Northern Province), Moindou, and Boulouparis (including 2 out of 9 municipalities in the Southern Province).

Municipalities with the lowest individual adaptive capacity are Ouvéa (Loyalty Islands Province) and Bélep, followed by Poum and Ouégoa (Northern Province).

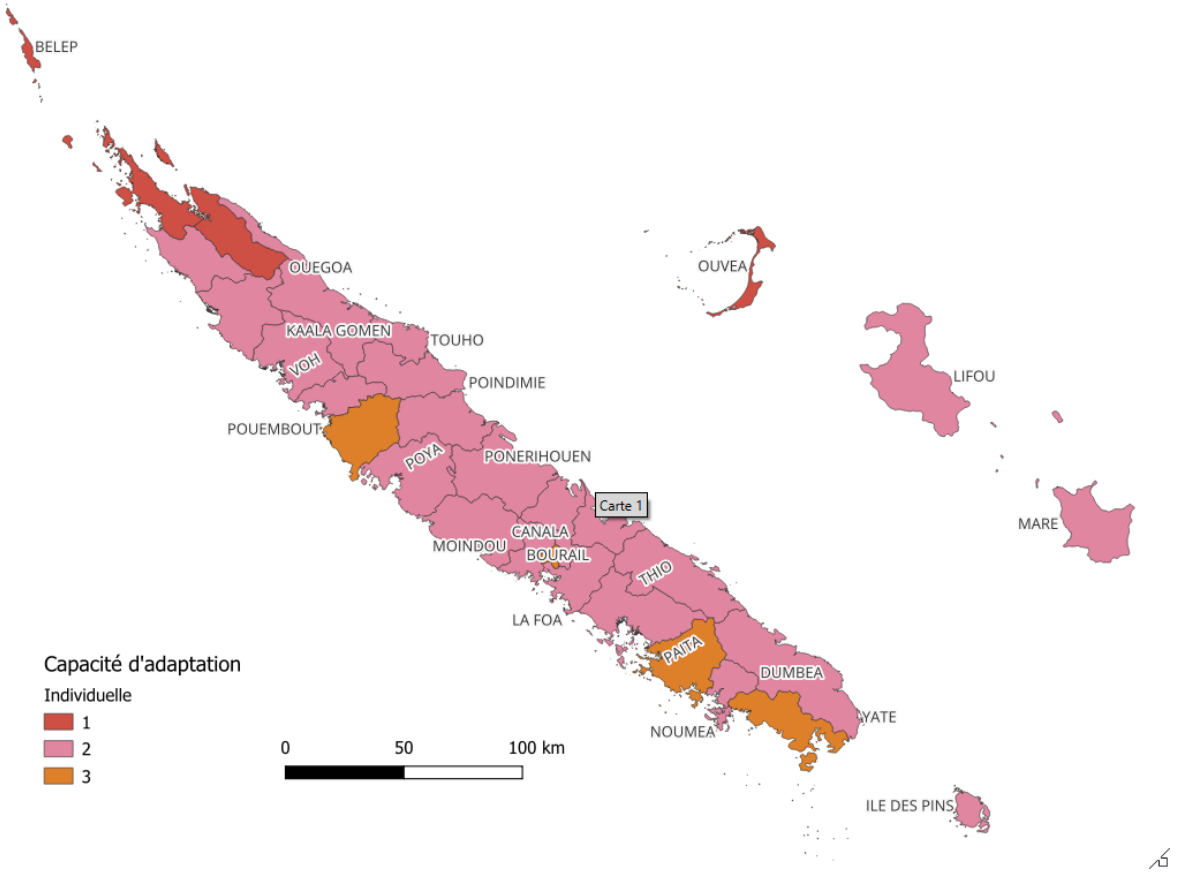


Figure 47: Classification of the municipalities of New Caledonia according to Growing *the adaptive capacity of their population*. Scores out of 4 aggregated from the different selected indicators (1 Low; 2- Medium; 3- Strong; 4- Moderate)

Municipalities with low adaptive capacity share several common characteristics:

- Lack of running water at home: 25.8% of the population in Ouvéa and 32.9% in Poum do not have access to piped water at home.
- Share of non-permanent housing: 13.6% in Bélep, 10.7% in Maré, and 30.1% in Ouvéa.
- Poverty rates: 43.4% in Ouégoa, 47.8% in Ouvéa, and 42.7% in Poum; similarly high levels are observed in Hienghène (48%), Maré (52.9%), Ponerihouen (48.4%), and Pouébo (47.9%).
- Education: low proportion of diploma holders in Ouégoa (9.8%) and Bélep (8.5%).
- High unemployment: 25.1% in Bélep and 23.8% in Ouégoa, with similarly elevated rates in Houaïlou (22%), Ponerihouen (23.1%), and Pouébo (23.6%).
- Share of youth and older adults: not a strongly differentiating factor across municipalities.
- High proportion of Kanak population: Bélep (98.5%), Canala (95.2%), Hienghène (94.2%), Houaïlou (90%), Isle of Pines (94%), Kouaoua (89.3%), Lifou (94%), Maré (97%), Ouvéa (91%), Ponerihouen (90%), Pouébo (94%), Poum (83%), and Yaté (96%). By contrast, municipalities

with higher adaptive capacity—such as Pouembout, Païta, Mont-Dore, Farino, Nouméa, and Dumbéa—have less than 30% Kanak population.

zone enquête	commune	Réseaux de solidarité	
Communes minières du Nord-Ouest	POUEMBOUT	60,6	4
Communes minières du Nord-Ouest	KONE	60,6	4
Communes minières du Nord-Ouest	KOUMAC	60,6	4
Communes minières du Nord-Ouest	VOH	60,6	4
Communes des Iles	LIFOU	69	4
Communes minières du Nord-Ouest	KAALA GOMEN	60,6	4
Communes des Iles	ILE DES PINS	69	4
Communes des Iles	MARE	69	4
Communes minières du Nord-Ouest	POUM	60,6	4
Communes des Iles	OUVEA	69	4

Figure 48: Municipalities with the highest percentage of solidarity networks (above 60%), data extracted from the survey.

Municipalities with the lowest adaptive capacity are generally those where socio-economic conditions are more challenging and where more vulnerable populations are present. However, residents of these municipalities appear to rely more strongly on solidarity networks, particularly mutual support among relatives and neighbors when extreme climate events occur.

In response to the question "Have you helped someone or received help (from relatives, neighbors, etc.) following an extreme event?", nearly 70% of respondents in the Loyalty Islands Province reported having either given or received help from close contacts. Similarly, 60% of respondents living in the North-West mining municipalities reported the same experience.

In other areas, fewer than 50% of respondents indicated such mutual assistance. The area where solidarity and mutual aid appeared least significant was the Centre-West agricultural basin.

6. Institutional adaptive capacity

The map below presents the adaptive capacity score associated with institutions. Only two indicators could be incorporated into the production of this map—the number of firefighters relative to the municipality's population and the level of information provided to residents during climate-related disasters—which should be considered when interpreting the results.

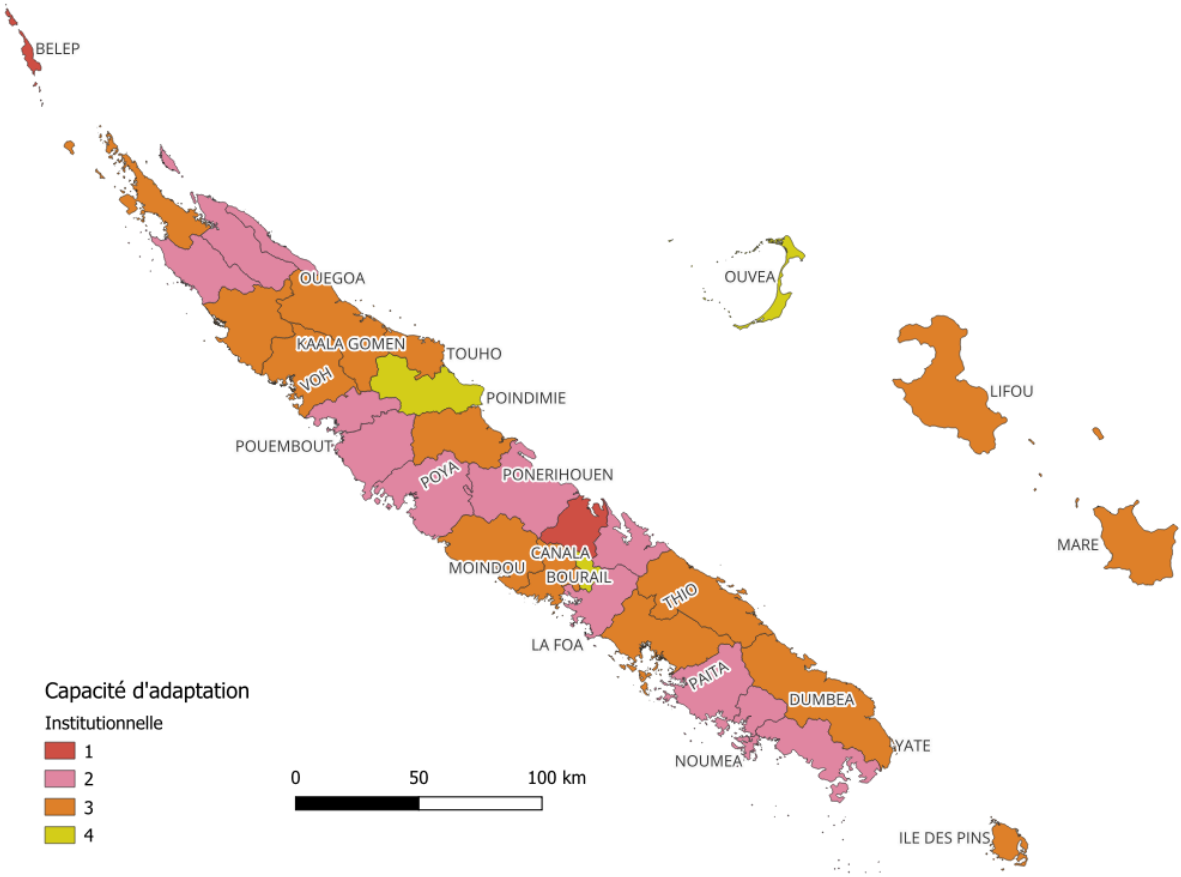


Figure 49 : Ranking of the municipalities of New Caledonia according to their increasing capacity for institutional adaptation. Aggregation of the two selected indicators.

Municipalities with the lowest institutional adaptive capacity do not necessarily coincide with those where population adaptive capacity is weakest, except for Bélep, which combines both and therefore stands out as highly vulnerable to climate change.

Municipalities in the Loyalty Islands Province and the Isle of Pines appear to benefit from stronger institutional adaptive capacity, with better-informed populations and a higher number of firefighters per inhabitant compared with densely populated areas such as Greater Nouméa. This tends to reduce the vulnerability previously identified in these areas.

Based on the two indicators analysed (firefighter presence and alert capacity), the municipalities offering the most protective resources for their populations are Poindimié in the Northern Province and Ouvéa in the Loyalty Islands Province. Given their high exposure to climate risks, it can be assumed that some institutions in these areas have taken proactive steps in response to threats that are already tangible, unlike municipalities that are less exposed.

Overall, there appears to be institutional commitment at the provincial level, although it remains difficult to quantify the scale and effectiveness of adaptation initiatives across provinces. Nevertheless, the issue has emerged in all three provinces, which contributes positively to territorial resilience.

Kouaoua stands out as a municipality where institutions appear particularly under-resourced, with a low density of firefighters and therefore limited civil protection capacity in climate emergencies, combined with a population that seems insufficiently informed about climate hazards. However, survey responses reveal that all respondents had received information about cyclone risks, and nearly all about droughts/heatwaves, as well as coastal erosion and sea-level rise. Adaptive capacity, therefore, appears strong for these hazards but weaker for others, such as heavy rainfall, for which more than 70% of respondents reported not receiving information. This suggests that public authorities are effective at informing populations about already recognized risks but face challenges in anticipating emerging hazards and preventing their impacts.

An additional perspective comes from respondents' perceptions of institutional support in addressing climate change, measured on a scale from 1 (not supported) to 10 (fully supported). Considering scores ≥5 as indicative of at least moderate support, the highest shares of respondents feeling adequately supported were found in non-mining municipalities of the North-East (88.9%) and mining municipalities of the North-West (75.8%). Greater Nouméa ranked last, with only 25.9% of respondents feeling well supported. Institutional support in the Northern Province thus appears to strengthen adaptive capacity and resilience in a region highly exposed to hazards and characterized by multiple sensitivity factors.

To deepen the analysis beyond the socio-economic survey's limitations, additional literature—particularly reports—was used to assess institutional financial capacity. Adaptation funding was examined through municipal debt levels. Although municipalities had relatively moderate debt levels in 2023 (around 65% on average, according to a 2024 AFD report), their financing capacity is constrained, especially following political unrest in May 2024. Local public finances were already fragile, and the situation worsened between May and July 2024, with medium-term implications for rebuilding damaged infrastructure.

These events also had broader socio-economic impacts, including rising unemployment and disruptions in sectors such as metallurgy and shrimp production. Immediate costs were largely borne by municipalities, as insurance companies adopted cautious positions. Damage was concentrated mainly in Greater Nouméa municipalities, which were already highly indebted before the unrest. Meanwhile, rural and island municipalities faced population inflows as residents left Greater Nouméa to return to their home areas. To manage the crisis, municipalities are likely to reduce both operating and especially investment expenditures, which could hinder climate adaptation unless external financial support from provinces or the national government offsets these constraints.

Further insight into institutional capacity can be drawn from the Territorial Chamber of Accounts' report on civil protection policy for major climate risks. According to this report, the policy remains embryonic, with shortcomings in planning and limited operational capacity. Persistent gaps in hazard knowledge contribute to insufficient communication and integration into planning, and the regulatory framework is considered too fragmented to be fully effective. Without improved planning, vulnerability to climate change could increase significantly, reducing territorial resilience.

A more comprehensive analysis of institutional adaptive capacity would also benefit from examining governance arrangements, levels of cooperation between actors and territorial scales, and the political commitment of provincial and municipal institutions to climate adaptation. These aspects—highlighted in CEREMA's Resilience Compass—could be explored in future studies.

III. Prioritization of Ecosystem-based Adaptation (EbA) options

A. Participatory workshops to prioritize geographic areas and EbA options

1. Methodology of the zone and EbA option prioritization workshops

These workshops were conducted with staff from the Southern and Northern Provinces, along with partners from relevant New Caledonian government departments, environmental associations/NGOs, and consular chambers. The provincial scale was chosen due to its responsibility for environmental management and protection, as well as territorial planning.

For each session, the methodology followed these steps:

Introduction:

- The PEBACC+ program and the ESRAM-NC mission were presented to participants.
- Participants were made aware of current and future climate change impacts in New Caledonia and introduced to the concept of EbA through local and Pacific regional examples.
- Results from the socio-economic survey on population resilience to climate change were then presented, with a specific focus on municipalities within each province.

Participants were subsequently divided into four working groups, each representing a major adaptation theme aligned with their interests or expertise:

- Economic activity, tourism, and recreational boating
- Securing water resources
- Food security
- Coastal risk management

Group work then unfolded in four stages:

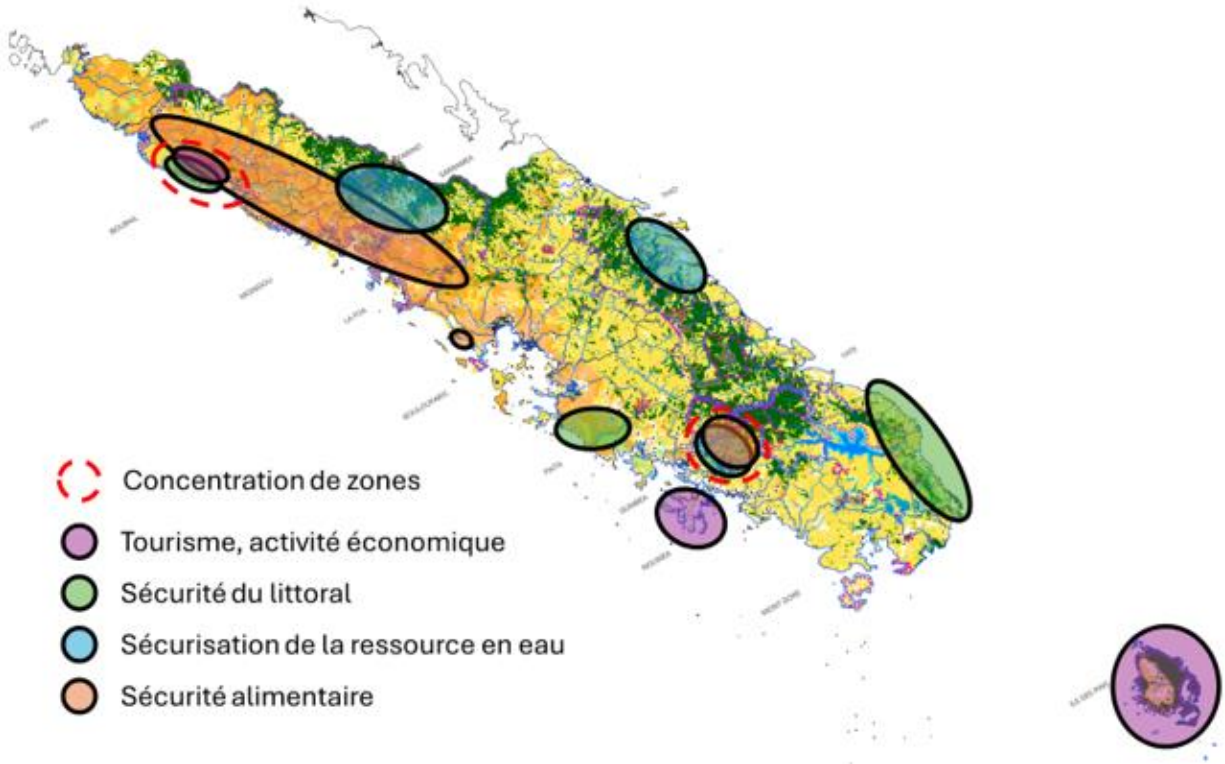
- Identify the main climate change impacts related to the theme, prioritizing a top 3 from a list of 21 elements.
- Identify three particularly vulnerable areas to these impacts.
- Select a top 3 EbA options (from 21 types) for each area.
- Detail an action plan for each area, including surface area, timeframe, project leaders, and financial or technical partners.

The exercise concluded with presentations from each group and documentation of results by the project team.

2. Summary of workshop results in the Southern Province

Following these workshops, several priority areas of interest were identified in both the Southern and Northern Provinces:

Schéma de synthèse de l'ensemble des zones priorisées par les quatre groupes thématiques



In the Southern Province, participants identified two major priority areas of interest.

1) **The Montagne des Sources**

This area was highlighted as the main water resource for the Greater Nouméa urban area, while also facing pressures from wildfire spread and invasive species.

The Ecosystem-based Adaptation (EbA) options targeted for this area include:

- Wildfire management, through the implementation of fire prevention plans and the establishment of vegetated firebreaks.
- Control of invasive species, with the deployment of early detection and rapid response plans for invasive species.
- Forest restoration and ecological connectivity, aimed at restoring forest ecosystems and maintaining terrestrial ecosystem continuity.

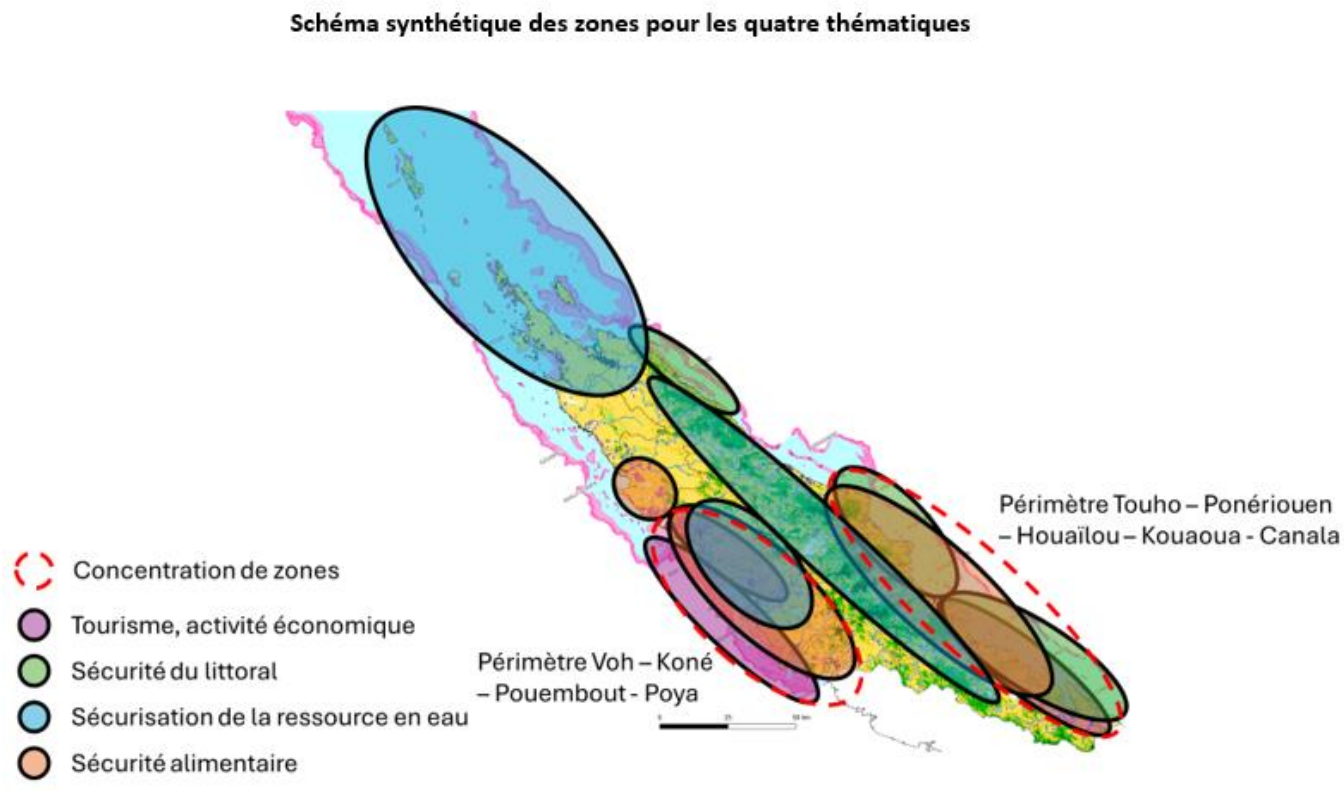
2) The **Poé coastline**

This area was identified for its economic importance and its exposure to marine flooding and coastal erosion.

The Ecosystem-based Adaptation (EbA) options proposed for this site include:

- Introducing regulatory constraints in the Urban Development Plan (PUD) and improved land-use management to strengthen coastal vegetation.
- Restricting vehicle access and involving local communities in restoration initiatives.
- Restoring aquatic environments and conserving flood expansion areas.
- Establishing marine parks and fisheries regulation zones.

3. Summary of workshop results in the Northern Province



In the Northern Province, priority zones were clearly grouped into two main areas:

1. **The Voh–Koné–Pouembout–Poya area**

This zone was identified due to its economic and agricultural importance and the threats linked to water resource degradation.

The targeted EbA options include:

- Development of agroforestry and silvopastoral practices, and more broadly, farming systems that conserve soils and water resources.
- Ecosystem management to support aquifer and freshwater lens recharge.
- Establishment of marine parks, regulated fishing zones, and fisheries management plans.
- Conservation of mangrove expansion areas and wetlands.
- Restoration of native coastal vegetation.

2. **The Touho–Ponérihouen–Houaïlou–Kouaoua–Canala area**

This zone was prioritized due to housing and agricultural challenges threatened by marine flooding, floods, and landslides.

The targeted Ecosystem-based Adaptation (EbA) options include:

- Control of invasive species that degrade forest ecosystems.
- Sediment trapping and runoff management through revegetation of bare soils.
- Conservation of mangrove expansion zones and wetlands.
- Sustainable mining management.

The two workshop reports are included in the annexes of this report.

B. Cost-Effectiveness Assessment of Priority EbA Options

1. Definition of Cost-Effectiveness Analysis and Rationale

"Cost-effectiveness analysis is a method that compares the 'return on investment' of a given option (the desired outcomes it produces relative to its cost) with other possible options. This method estimates the effectiveness of an option—its ability to maximize outcomes for each euro of public spending. It is useful for guiding public policy choices and allocating public expenditure within a given sector" (Rapp, 2023).

The objective is to provide decision-makers and project leaders with a tool to compare a range of options based on both financial criteria and socio-economic and environmental considerations.

2. Methodology

d. Selection of EbA Options

The selection of EbA options was carried out through workshops held in the Southern Province (19 February 2025) and the Northern Province (24 February 2025). During these workshops, participants were divided into four thematic groups: economic activities, tourism, and recreational boating; food security; coastal natural risk management; and securing water resources.

Participants first selected three priority sites (considered the most vulnerable to climate change) based on preliminary resilience analysis results. For each site, two to three EbA options were proposed to address local challenges. In total, 70 options were generated.

These 70 options were subsequently reclassified and prioritized according to their frequency of occurrence. Each option identified during the workshops was grouped under overarching categories defined by the Secretariat of the Pacific Regional Environment Programme (SPREP), namely:

1. Forest/watershed restoration (fire management, deer control, reforestation)
    - Water (drinking water supply, agriculture, rivers/flooding, coral reefs and associated ecosystems), public health, and tourism
2. Mangrove and estuary restoration/conservation (sediment and pollutant filtration)

- Food security (coral reefs and associated ecosystems, nurseries, fisheries, etc.) and tourism

3. Coastal vegetation restoration
    - Shoreline protection
4. Agroforestry / silvopastoralism and sustainable fisheries management / highly protected marine areas
    - Food security
5. Nature in urban areas / Oceanian habitat
    - Public health, safety, youth inclusion, disadvantaged neighbourhoods, and social cohesion.

Among the 10 preselected options, the option "sustainable management of natural resource extraction" was excluded because of its very broad scope, spanning mining, fisheries, and agriculture. In addition, at SPREP's request, the option "urban greening and soil de-sealing" was added to align with the major categories listed above.

The table below, therefore, presents the 10 final options selected for cost-effectiveness analysis, including the overarching categories, specific options, details of proposals made during the workshops, their frequency, and the sites proposed by participants.

Overarching Option Categories	EbA Options	Proposal of options by participants	Occurrence	Sites identified by workshop participants
Mangrove & Estuarine Restoration/Conservation (Sediment and Pollutant Filters)	**1. Sediment trapping**	Proposal 1: 1. Stop dike construction to allow natural processes to resume (coastal drift) 2. Plant vegetation to block and stabilise sediments 3. Install artificial reefs to reduce erosion and maximize sediment trapping. Proposal 2: 1. Work on watershed protection Proposal 3: 1. Install fascines upstream on pilot sites. 2. Maintain/manage outfalls. Proposal 4: 1. Optimize upstream sediment management, particularly in mining areas. 2. Conduct pilot operations to identify downstream solutions: riverbanks/estuaries. Proposal 5: 1. Develop watershed infrastructure (fascines, settling basins, etc.) to ensure proper water management. Proposition 6: Installation of vegetated fascines	7	• The Central Mountain Range • The Houaïlou–Kouaoua–Canala coastline (100 km of coastline) • The municipalities of Kouaoua–Touho • The Touho–Poindimié–Ponérihouen coastline (100 km of coastline) • Nouméa (45 km^2) • Southern mining area: Houaïlou–Kouaoua–Canala • Yaté – Unia and Goro tribes

Overarching Option Categories	EbA Options	Proposal of options by participants	Occurrence	Sites identified by workshop participants
Restoration/conservation of mangroves & estuaries (sediment and pollutant filters)	**2. Conservation of mangrove expansion areas and wetlands.**	Proposal 1: 1. Conserve and restore mangrove areas and wetlands. 2. Conduct a diagnostic assessment and identify priority areas. 3. Propose an action plan: - Involve the local population in implementation and monitoring. - Establish a mangrove nursery. Proposal 2: 1. Adapt land-use regulations (PUD) through revisions of the Master Urban Development Plan. 2. Communicate. Proposal 3: 1. Strengthen training in the restoration of mangroves and wetlands. Proposal 4: 1. Transfer expertise from associations (e.g., Ho Ut) for the establishment of nurseries and planting activities. 2. Identify potential restoration sites. 3. Plant. Proposal 5: 1. Expand Ho Ut's outreach across the three municipalities. Proposal 6: 1. Clean up mangroves. 2. Restore ecosystem functions (EVE management/water flow).	6	• The Houaïlou – Kouaoua – Canala coastline (100 km of coastline) • The Pouebo coastline (52 km of coastline) • The Touho – Poindimié – Ponérihouen coastline (100 km of coastline) • The inhabited coastal road of Païta • Yaté – the tribes of Unia and Goro • The Voh–Koné–Pouembout–Poya marine area

Overarching Option Categories	EbA Options	Proposal of options by participants	Occurrence	Sites identified by workshop participants
Forest restoration/watershed management (fire control, deer management, reforestation)	**3. Management of combustible vegetation and firebreaks.**	Proposal 1: 1. Use vegetated firebreaks made up of fire-retardant species. Proposal 2: 1. Develop a firebreak project using banyan trees and false mango trees. 2. Train local communities in wildfire risk management. 3. Work with customary authorities and families to establish sanctions. Proposal 3 & 4: 1. Identify risk-prone and high-stakes areas and implement intervention strategies. Proposal 4: 1. Identify risk-prone and high-priority areas and implement intervention strategies.	6	• The Dumbéa watershed and both slopes of the Montagne des Sources on the La Coulée side • The Far North: Pouébo – Belep – Ouégoa • The municipality of Kaala-Gomen • The municipality of Thio • The Montagne des Sources • The Sarraméa/Farino massifs – Dogny Plateau
Forest restoration / Watershed management (fire control, deer management, reforestation)	**4. Control of invasive species.**	Proposal 1: 1. Establish early detection and rapid response mechanisms. Proposal 2: 1. Drastically reduce population levels. 2. Implement the recommendations issued under the PROTEGE program. Proposal 3: 1. Regulate invasive ungulates (deer/pigs). Proposal 4: 1. Establish early detection and rapid response mechanisms. Proposal 5: 1. Organize regulation operations (deer/pigs). 2. Add value to and commercialize deer meat, including through processing. Proposal 6: Set up two pilot sites in Poindimié and Ponérihouen based on the Touho experience: ungulate regulation combined with biodiversity protection.	6	• The Dumbéa watershed and both slopes of the Montagne des Sources on the La Coulée side • The Central Mountain Range • The Montagne des Sources • The Sarraméa/Farino massifs – Dogny Plateau • The Touho – Poindimié – Ponérihouen coastline (100 km of coastline) • The Southern Mining Area: Houaïlou – Kouaoua – Canala

Overarching Option Categories	EbA Options	Proposal of options by participants	Occurrence	Sites identified by workshop participants
Forest restoration / Watershed management (fire control, deer management, reforestation)	**5. Restoration of ecological connectivity between ecosystems**	Proposal 1: 1. Identify, meet, and bring together all relevant stakeholders (government, protected areas, mayors, customary authorities, etc.). 2. Identify a preliminary study area to reduce initial investment. 3. Foster consultation among stakeholders to select appropriate measures: - Cut pine trees and replant sandalwood and araucaria. - Use felled pines to create anti-erosion stakes. - Plant and reforest with fire-resistant tree species. Proposal 2: 1. Cut mimosas and invasive species to plant useful species. 2. Prevent illegal occupation (squatting). 3. Establish a greening policy for flat rooftops. Proposal 3: 1. Require project developers to carry out restoration measures. 2. Encourage residents to take action along the coastline. Proposal 4: 1. Restore landscapes and ecosystems upstream of aquaculture ponds. 2. Diversify aquaculture production, including halophytic plants: value creation and restoration of pond bottoms. Proposal 5: 1. Train local communities in best practices (agroforestry, etc.) and provide technical and financial support.	6	• Île des Pins • The Central Mountain Range • Poé coastline • Nouméa (45 km^2) • The inhabited coastal road of Païta • The agricultural area of Boulouparis

Overarching Option Categories	EbA Options	Proposal of options by participants	Occurrence	Sites identified by workshop participants
Agroforestry / Silvopastoralism & sustainable fisheries management / highly protected marine areas	**6. Adoption of soil and water conservation agricultural practices**	Proposal 1: Promote and support agroecological agriculture, particularly for soil conservation, regenerative hydrology, and agroecological infrastructure. Proposal 2: 1. Provide experimental plots and support agricultural stakeholders through training and funding. 2. Transfer the results of experimental trials, particularly where improvements in crop yields are demonstrated. Proposal 3: 1. Establish agroecological infrastructure—hedgerows, crop diversification, soil cover, windbreaks—through calls for expressions of interest (EOIs) or calls for projects (CFPs). Proposal 4 & 5: 1. Train local communities in best practices (agroforestry, etc.) and provide technical and financial support.	5	• The Voh–Koné–Pouembout agricultural production basin • The Far North: Pouébo – Belep – Ouégoa • The Voh–Koné–Pouembout area • The agricultural plains of Bourail / Moindou / La Foa • The terrestrial area of Voh–Koné–Pouembout
Agroforestry / Silvopastoralism & sustainable fisheries management / highly protected marine areas	**7. Development of agroforestry and silvopastoralism.**	Proposal 1: 1. Promote the use of trees on Utilized Agricultural Areas (UAA) in sensitive zones. 2. Develop shading and windbreak systems through hedgerows (e.g., bois noir). Proposal 2: 1. Expand knowledge of agroforestry and silvopastoralism adapted to our ecosystems. 2. Provide experimental plots. 3. Support agricultural stakeholders through training and funding. Proposal 3: 1. Establish demonstration plots (pilot projects). 2. Relaunch awareness-raising actions regarding plantations, water catchments, and priority areas. Proposal 4: 1. Plant trees in pastures and ensure their protection.	5	• The municipality of Kaala-Gomen • The Pouébo coastline • The agricultural plains of Bourail / Moindou / La Foa • The Southern Mining Area: Houaïlou – Kouaoua – Canala • The terrestrial area of Voh–Koné–Pouembout

Overarching Option Categories	EbA Options	Proposal of options by participants	Occurrence	Sites identified by workshop participants
Restoration of coastal vegetation	**8. Restoration of native coastal vegetation and seagrass beds.**	Proposal 1: 1. Install stakes to retain sand and promote dune formation. 2. Replant native coastal species to maintain the dune ridge. 3. Plan mangrove planting, reef farming, and seagrass restoration. 4. Establish a protection policy for "lagoon gardeners." Proposal 2: 1. Introduce specific regulations within the Master Urban Development Plan (PUD) to require coastal revegetation/restoration. 2. Limit vehicle access to the coastline. 3. Work with nurseries to source planting stock. 4. Develop an overall communication strategy to involve local residents in the initiative. 5. Manage land tenure issues. Proposal 3: 1. Develop nurseries to enable local revegetation. Proposal 4: 1. Facilitate proper water circulation in mangroves and maintain their good ecological condition around aquaculture ponds. 2. Improve water treatment in aquaculture ponds by planting mangroves for their natural filtration role. Proposal 5: 1. Eradicate invasive plant species. 2. Restore coastal vegetation. 3. Develop eco-tourism and cultural tourism activities (Pidaï, Gatope, Foué).	5	• Bourail – ZCO (20,000 ha) • Poé coastline • The inhabited coastal road of Païta • The agricultural area of Boulouparis • The Voh–Koné–Pouembout–Poya marine area
Forest and watershed restoration	**9. Ecosystem management for aquifer recharge and freshwater lens replenishment.**	Proposal 1: 1. Re-vegetate deforested and burned areas. 2. Raise awareness about water use and implement the actions set out in the PEP. 3. Desalinate water. 4. Establish marine parks and fisheries regulation zones. Proposal 2: 1. Reforest water resource catchment areas. 2. Control invasive species. 3. Provide training on sustainable water use and resource monitoring. Proposal 3 & 4: Implement restoration measures.	4	• The Far North: Pouébo – Belep – Ouégoa • Île des Pins • The Voh–Koné–Pouembout area • The terrestrial area of Voh–Koné–Pouembout

Overarching Option Categories	EbA Options	Proposal of options by participants	Occurrence	Sites identified by workshop participants
Nature in the city / Oceanian habitat	**10. Urban greening and soil de-sealing**	Proposal 1: 1. Establish a tree preservation policy: one tree cut down / 1,000 trees replanted. 2. Green vacant and available spaces by setting planting quotas for each new construction project. 3. Manage stormwater runoff and promote its reuse for environmental purposes.	1	• Nouméa (45 km^2)

e. Creation of a data collection tool

An Excel template was developed based on the consulting firm's expertise to assess both the costs of the options described below and their effectiveness.

The first section of the template focuses on characterizing the option, including its surface area and the duration of implementation.

The second section addresses the cost analysis across the different phases of the option: design, implementation, and maintenance.

Costs related to works, equipment/supplies, and estimates of labour time and costs (including expert services or studies) are associated with each development phase.

This component also enables estimation of the number of full-time equivalents (FTEs) required for each option by linking them to socio-professional categories (farmers; artisans, traders, and business owners; executives and higher intellectual professions; intermediate professions; employees; workers) and sectors of activity (agriculture; industry; construction; trade, transport, and services; public administration, education, health, and social action) based on INSEE classifications.

The third section focuses on evaluating the effectiveness of each option against various objectives derived from the IUCN typology for nature-based solutions (IUCN, 2020):

- Climate change adaptation
- Climate change mitigation
- Natural risk management
- Food security
- Water security
- Public health
- Human activities
- Biodiversity

The template also includes additional elements such as:

- Levers and barriers to implementation, as well as areas for improvement.
- Monitoring and evaluation framework, including a brief review of indicators and systems used, identified gaps, and potential improvement pathways.
- Knowledge and research needs.

f. Data collection

Given the lack of precise data on options corresponding to our needs, the cost-effectiveness analysis of the options was conducted through expert judgment, supported by project documentation.

A data sheet was developed for each option and shared with several experts identified by the project team. Experts could either complete the sheet and return it by email or request an interview to receive support from Actierra in filling it out. Due to significant scheduling constraints—particularly because Actierra is based in mainland France—interview slots were limited, and autonomous completion followed by email submission was therefore preferred.

The table below lists the organizations contacted for each option.

Table 29: List of organisations contacted by ecosystem-based adaptation option

Options	Organisations contacted
1. Sediment trapping	North and South Provinces CNRT Conservation International
2. Conservation of mangrove expansion areas and wetlands	Bwara Tortue Caledoclean SOS Mangrove Ho Ut
3. Management of flammable vegetation and firebreaks	Conservation International WWF Civil Protection SDIS 66
4. Control of Invasive Species	FFCNC ANCB
5. Restoration of ecological connectivity between terrestrial ecosystems	CI ANCB
6. Adoption of soil and water conservation farming practices **7. Development of agroforestry and silvopastoralism**	CAP NC Biocalédonia Agir-nc Julien Lebreton IAC Repair
8. Restoration of native coastal vegetation and seagrass beds	Bwara Tortues Marines Caledoclean
9. Ecosystem management for aquifer recharge and freshwater lenses	IAC
10. Greening and depaving of cities	City of Doumbéa City of Nouméa ACTIERRA

g. Results

The results of expert interviews are presented below and organized according to the five overarching option categories. For each category, detailed information is provided on the

option(s) for which expert feedback was obtained or for which project documentation was available.

First, a summary table outlines the key characteristics of each option, including its surface area, duration, and total cost, as well as a breakdown by cost type (design, implementation, and maintenance). Costs were divided by 6 million FCFP to estimate the number of full-time equivalents (FTEs), distinguishing between managerial/employee roles and manual worker roles. This approach helps anticipate employment needs associated with implementing these options.

The effectiveness of each option was then evaluated in a table against various adaptation objectives derived from the International Union for Conservation of Nature (IUCN, 2020). Experts assigned scores from 1 to 5, with scores of 4 and 5 indicating high effectiveness for climate change adaptation.

Finally, experts identified barriers and enabling factors for implementation, as well as potential improvement pathways. They also described existing monitoring and evaluation mechanisms and their shortcomings, and highlighted current knowledge gaps that could enhance understanding and effectiveness—thereby helping to identify future research priorities.

i. Forest and watershed restoration (fire management, deer control, reforestation)

Cost analysis of ecosystem-based adaptation options.

EbA Options	Hypotheses	Surface type	Typical implementation duration	Typical monitoring duration	Total deployment cost (CFP francs)	Design costs (CFP francs)	Installation Costs (F.CFP/duration of implementation)	Maintenance costs (CFP francs / monitoring duration)	Need for volunteers	Number and type of FTEs (managers / trainers / employees)	Number and type of FTEs (workers / firefighters)	Source of information	Explanation of calculations
Fight against invasive animal species: regulatory operations	- Tribal information meeting and planning - Training, delivery of hunting permits - Participatory regulation actions over one or more days were renewed several times - Semi-professional regulation actions in autonomy	500 ha (a priority site, up to 10,000 ha)	2 years	10-15 years	3 548 000	600 000	2 948 000	1 691 000/ AN IF Participatory Regulation 469 500 / AN if semi-pro regulation	100 chasseurs/ jour	0.10	0.85	Literature review: REPRISE-WWF, 2021 (Restoration of forest ecosystems in Waa Wi Luu)	
Fight against invasive animal species: putting on the defensive	- Brush clearing - Installing a fence and special fittings	Applies to sites of less than 1000 ha: Here 1000 linear meters	Between August and November	10-15 years	3 900 000	300 000	3 600 000	NC, every 2/3 years	No identified need	0.05	0.42	Literature review: REPRISE-WWF, 2021 (Restoration of forest ecosystems in Waa Wi Luu)	Labor Cost = 2,500,000 (+1,100,000 supplies to get the installation cost)

Fight against invasive plant species (miconia)	-Prospecting -Fight via service provider only or intervention RIMAP (Pacific Marine Infantry Regiment-Polynesia) and volunteers -Awareness	200 days/ha/year	1 years	10-15 years	4 680 000- 6 900 000	80,000 (drone) - 1,000,000 (private helicopter) Development cost: Not known	4 to 5,000,0000/year (if provider) If other: costs not known according to distribution (provider / RIMAP / volunteers)	Not known	No identified need	-	0.78-1.15	Literature review - CEN (Simplified and prospective action plan on miconia)	Recommended effort: 500 days/year Min and max FTE values of the number of workers by dividing the overall cost by 6,000,000
Sediment Trapping (Marine)	- Feasibility study and design of marine sediment trapping devices (bamboo structures) - Installation of devices - Maintenance of devices	300 ha	3 years	10- 15 years	4 450 000	3 900 000	500 000	50 000	No identified need	0.65	0.09	Consultation with Conservation International	
Sediment trapping (woody weirs)	- Visit to the watershed to identify areas to be reinforced - Installation of woody weirs - Consolidation of existing structures and greening	600 linear metres	3 years	10- 15 years	1 200 000	150 000	400 000	650 000	No identified need	-	0.2	Consultation with the Northern Province	

Combustible vegetation and firebreak management	- Historical fire analysis and estimation of starting points - Discussion of maps (uses of fire) - Study trips to Australia (2 or 3) - Installation of green firebreaks (bouraos) - Prescribed burning	5,000 to 10,000 ha (average catchment)	2 to 3 years	10-15 years	3,007,000 + cost of study trip	21000 + cost of the study tour	3 005 000	2 000	1 citizen planting day, 1 association day, every 5-10 years of prescribed burning, 1 day of maintenance/year	0.0035	0.70	Consultation SPREP	Firefighters: 15 days*80,000 FCP then divided by 6,000,000
Participatory management of combustible vegetation and firebreaks	- 2 meetings or a participatory workshop to define the location and the species planted - 4 days of planting (2000 cuttings over 500m) if cuttings are already ready - Replacement of dead cuttings and reinforcement with other species; mowing and clearing of brush, fertiliser if necessary	2000 cuttings over 500 m	3 days min	10-15 years	595 000-822 500	25 000- 50 000	435 000	135 000 - 337 500	No identified need	0,004-0,008	0.095-0.13	Consultation Conservation International	Min-max range: (installation costs + maintenance costs) / 6000000 for workers Min-max range: design costs / 6000000 for frames

Restoration of ecological connectivity between ecosystems (ecological engineering)	- Study and identification of risk areas - Preparation of the ground, supply of equipment (coconut fibre socks; stone cords; wire benches) - Carrying out the fittings - Plant stabilization monitoring, maintenance	Hypothesis: 1 hectare	N/A	N/A	10 500 000	1 000 000	7 700 000 per ha	1,800,000 + 400 per plant replaced	No identified need	0.17	1.58	DDDT Consultation – Province South	
Restoration of ecological connectivity between ecosystems (large-scale plantations, mining maquis)	-Repair of access roads - Construction of a runway structure (remodelling, blackcurrant, decanter, riprap, etc.) -Production of mining maquis seedlings in nurseries -Planting (transport, hole, inputs, mulching, watering) -Realization and installation of wooden fascines, stone thresholds and stringcourses	N/A	N/A	N/A	N/A	1 000 / plant	15 550 - 22 500/ linear meter, unit	N/A	No identified need	N/A	1 to 2 machine drivers 1 to 2 shunting workers (according to project sheet)	Consultation DDDT-Province South	

Ecosystem management for freshwater aquifer and duckweed recharge	N/A

Analysis of the effectiveness of ecosystem-based adaptation options

EbA Options	*Adapting to the effects of climate change*	*Climate Change Mitigation*	*Natural hazard management*	*Food safety*	*Water safety*	*Public Health*	*Human activities*	*Biodiversity*
Combustible vegetation and firebreak management	3	5	4	1	3	3	3	5
Fight against invasive species	3	3	3	4	4	3	2	5
Restoring ecological connectivity between ecosystems	4	5	4	2	4	3	3	5
Ecosystem management for aquifer and duckweed recharge	Not available							

Very important
Important
Good
Low
Very Low

Enablers, barriers, and improvement pathways

Note: The enablers and barriers identified relate to options for managing combustible vegetation, vegetated firebreaks, and restoring ecological connectivity between ecosystems.

Enablers identified fall into several categories:

- Socio-economic: approaches accepted by local communities, with active participation in project implementation.
- Technical: mastery of fire management strategies and restoration techniques.
- Operational: training of local stakeholders.
- Ecological: use of locally adapted species and integrated management of invasive alien species.
- Institutional: support from public policies and financial incentives.

Barriers identified include:

- Temporal: delays between planting and observable effectiveness.
- Technical: limited availability of adapted native seedlings, insufficient knowledge of optimal planting techniques, logistical constraints, and challenges related to monitoring, indicators, and data harmonization.
- Environmental: difficult climatic conditions, advanced soil degradation, invasive species presence, and in some cases inadequate water management.

- Socio-economic: lack of stable and sufficient funding and land-use conflicts.
- Regulatory and institutional: sometimes inadequate or poorly enforced frameworks, lack of coordination among stakeholders, and complex administrative procedures.

Improvement pathways concern technical aspects (e.g., production of fire-resistant species), operational and financial dimensions, governance, communication of good practices, and the development of knowledge and research.

Evaluation of the monitoring and evaluation framework

Indicators used:

- for fire management: proportion of territory burned before/after interventions, share of local community involvement in citizen action days, and seedling survival rate.
- for ecological connectivity restoration: seedling growth and mortality rates.

Identified gaps: Experts highlighted insufficient long-term monitoring of projects. For replanting initiatives aimed at restoring ecological connectivity, monitoring of seedling growth and mortality was only conducted for the most recent planting site, with no centralized follow-up of earlier projects. However, a review study was carried out for the provincial rehabilitation and restoration program covering work undertaken since 2010.

Proposed improvement measures:

1. Establish sustainable and long-term financing mechanisms for project monitoring.
2. Promote knowledge sharing, including successful experiences and best practices among stakeholders.

More specifically for restoring ecological connectivity:

- Define clear ecological restoration objectives.
- Characterize reference sites.
- Develop systematic planting plans for each site.
- Implement standardized monitoring procedures applied routinely.

Knowledge needs

Experts emphasized the need for further research on the functioning and limitations of vegetated firebreaks. Continued research on species selection and restoration techniques for degraded habitats was also identified as a key area for future investigation.

ii. Mangrove and estuary restoration/conservation (sediment and pollutant filtering)

Cost analysis of ecosystem-based adaptation options

EbA Option	Hypotheses	Surface type	Typical implementation duration	Typical monitoring duration	Total deployment cost (CFP francs)	Design costs (CFP francs)	Installation costs (CFP francs/ implementation duration)	Maintenance costs (CFP francs/ monitoring duration)	Need for volunteers	Number and type of FTEs (managers/ trainers / employees)	Number and type of FTEs (workers/ firefighters)	Source of information	Explanation of calculations
Conservation of mangrove expansion areas and wetlands	- Site analysis through topographic surveys to identify constraints to water circulation and stakeholder engagement - Collection of propagules and nursery growth / direct planting - Awareness-raising - Photographic monitoring and ground maintenance	2.5 ha	5 years	10-15 years	954 080	N/A	N/A	N/A	Yes	0.16	N/A	Literature review – ADAPTOM Guide – Mangrove planting in Touho	The total cost is divided by 6,000,000, noting that the Ho UT association led the project with strong involvement of volunteers and the vocational training center.

Effectiveness analysis of ecosystem-based adaptation options

EbA Options	*Adaptation to climate change impacts*	*Climate change mitigation*	*Natural hazard risk management*	*Food security*	*Water security*	*Public health*	*Human activities*	*Biodiversity*
Conservation of mangrove expansion areas and wetlands	4	3	4	5	1	2	3	5

Enabling factors, barriers, and areas for improvement

The enabling factors identified by the experts are as follows:

- Spontaneous funding proposals (in this case from IUCN).
- A supportive local "cognitive" context based on elders' knowledge and the sharing of their experience, as well as the association members' expertise in mangrove planting.
- A favourable cultural context, with communities closely connected to their environment and familiar with ecosystem functions.
- Technical effectiveness stemming from the association's strong capacities (sound project management, rigour, and organisational skills).

The barriers identified are as follows:

- The regulatory and land-tenure context: regulations require prior authorisation before any on-site intervention (Environmental Code, activities carried out within the public maritime domain)
- Site-specific constraints, particularly potential damage caused by floods (drifting woody debris damaging young mangroves).

The improvement pathways identified are as follows:

- Deploy regulatory and legal tools to facilitate implementation of the action
- Implement the project at a larger scale to increase its transformational potential
- Strengthen the monitoring and evaluation framework.

Evaluation of the monitoring and evaluation framework

The monitoring system is considered incomplete. It mainly relies on visual observations (particularly of vegetation recovery and development, as well as fauna). The absence of coastal erosion monitoring was noted and, more broadly, the lack of long-term data has limited the establishment of a more robust monitoring framework.

Knowledge needs

A supporting study to guide the implementation of this adaptation solution could be explored.

iii. Coastal vegetation restoration

Cost analysis of ecosystem-based adaptation options

EbA Option	Hypotheses	Surface type	Typical implementation duration	Typical monitoring duration	Total deployment cost (CFP francs)	Design costs (CFP francs)	Installation costs (CFP francs/ implementation duration)	Maintenance costs (CFP francs/ monitoring duration)	Need for volunteers	Number and type of FTEs (managers/ trainers / employees)	Number and type of FTEs (workers/ firefighters)	Source of information	Explanation of calculations
Restoration of native coastal vegetation and seagrass beds	- Purchase of seedlings and nursery establishment - Site preparation, digging holes, and tree planting - Plot maintenance through weeding, organic inputs, and watering	5 ha	3 years	-	7 512 550	N/A	N/A	N/A	About 188 volunteer days (1,410 hours for planting and coordination activities)	1.25	-	Consultation with Bwara Tortues Marines	

Effectiveness analysis of ecosystem-based adaptation options

EbA Options	*Adaptation to climate change impacts*	*Climate change mitigation*	*Natural hazard risk management*	*Food security*	*Water security*	*Public health*	*Human activities*	*Biodiversity*
Restoration of native coastal vegetation and seagrass beds.	4	NA	5	1	2	4	4	5

Enabling factors, barriers, and areas for improvement

The enabling factors identified are as follows:

- The use of volunteer work
- Strong involvement of association members as well as collaboration with various stakeholders (mainly institutions)
- The diversity within the association allowing inclusion of people with very different profiles
- A participatory project design approach involving local communities, enabling better ownership

The barriers identified are as follows:

- The presence of vehicles that degrade the coastline
- The need to fence off restoration areas (installation of barriers) due to invasive species (deer and wild pigs)
- Lack of municipal planning (clearing of shrubs)
- Limited public awareness, which may lead to inappropriate behaviour

The improvement pathways identified are as follows:

- Implement complementary activities such as reef restoration to reduce wave energy
- Work on municipal land-use planning to designate protected areas
- Integrate facilities (tables, pathways, camping areas, parking) to guide public movement and limit ecosystem degradation
- Provide better accommodation for on-site volunteers (12 permanent volunteers) by improving the base camp. (Volunteer work represents a gain of €200,000, corresponding to the estimated seasonal salary value of volunteers.)

Monitoring and evaluation framework

The indicator currently used to monitor and evaluate the project is the survival rate of trees/seedlings (currently estimated at an 80% survival rate). However, no baseline assessment of the natural environment has been conducted—particularly for birds—which prevents precise measurement of the project's impact on biodiversity. One improvement pathway is therefore to carry out a scientific baseline biodiversity and bird survey.

Knowledge needs

The following topics could be further explored:

- The study of tree growth and ecosystem development over time.
- The restoration of soil life in agroforestry plots.

iv. Agroforestry / silvopastoralism and sustainable fisheries management / highly protected marine areas

Cost analysis of ecosystem-based adaptation options

EbA Option	Hypotheses	Surface type	Typical implementation duration	Typical monitoring duration	Total deployment cost (CFP francs)	Design costs (CFP francs)	Installation costs (CFP francs/ implementation duration)	Maintenance costs (CFP francs/ monitoring duration)	Need for volunteers	Number and type of FTEs (managers/ trainers / employees)	Number and type of FTEs (workers/ firefighters)	Source of information	Explanation of calculations
Adoption of soil and water conservation farming practices	- Identify and classify riparian forests in the Nera watershed, propose a diagnostic method, and identify riverbank restoration techniques - Restore or strengthen riparian zones through a call for expressions of interest (CEI), provide pilot sites, and support farmers by financing restoration work - Transfer experimental results to the agricultural sector and technical partners	15 ha	2 years	10-15 years	52 885 000	945 000	47 920 000	4 020 000	Two participatory work camps lasting a few days with 70 participants	0.16	8.66	Consultation with CAP NC and WWF	

EbA Option	Hypotheses	Surface type	Typical implementation duration	Typical monitoring duration	Total deployment cost (CFP francs)	Design costs (CFP francs)	Installation costs (CFP francs/ implementation duration)	Maintenance costs (CFP francs/ monitoring duration)	Need for volunteers	Number and type of FTEs (managers/ trainers / employees)	Number and type of FTEs (workers/ firefighters)	Source of information	Explanation of calculations
Development of agroforestry and silvopastoralism	- Diagnosis, soil analysis & design - Production of selected seedlings in nurseries - Weeding & soil preparation - Soil amendments - Preparation and planting of banana plants - Mulching - Planting of support trees - Irrigation	0.25	2-3 years	N/A	607 000	162 000	445 000	N/A	No identified need	-	0.10	Consultation with CAP NC	

Effectiveness analysis of ecosystem-based adaptation options

EbA Options	*Adaptation to climate change impacts*	*Climate change mitigation*	*Natural hazard risk management*	*Food security*	*Water security*	*Public health*	*Human activities*	*Biodiversity*
Adoption of soil and water conservation farming practices.	4	3	3	5	5	4	4	4
Development of agroforestry and silvopastoralism.	4	4	4	5	4	3	3	5

Enabling factors, barriers, and areas for improvement (provided for the first option)

The enabling factors identified are:

- Awareness-raising among voluntary project leaders during their identification
- Mobilisation and coordination of partners, particularly institutional and technical stakeholders, to ensure their commitment from the start of the project
- Strengthening this network to guarantee effective on-the-ground actions
- Working with local service providers located close to restoration sites
- Establishing regular and smooth monitoring.

The barriers identified are as follows:

- A limited intervention window (outside the flood season but before the end of the rainy season)
- Availability and quality of seedlings (requiring anticipation)
- Management of invasive species
- High logistical costs (transport of mulch and organic matter in particular), and the complexity of stabilisation works (going beyond simple restoration), with interventions across the entire watershed being difficult to implement.

The improvement pathways identified are as follows:

- Ensure sustainable management and optimisation of replanting operations
- Ensure that maintenance activities are largely mechanisable using appropriate equipment (e.g., flail mower)
- Secure a dedicated budget for plot maintenance
- Establish partnerships with other organisations to support farmers until plantations become viable
- Integrate economically valuable species within planting lines and promote agroforestry systems
- Provide upstream support from a consulting firm or provincial authorities to tailor riverbank restoration to site-specific conditions
- Capitalise on past erosion management experiences, particularly those implemented at sites such as Bakouya (e.g., ADRAF project).

Monitoring and evaluation framework

For the adoption of soil and water conservation farming practices:

- Baseline assessments of farms (diagnosis of agricultural practices and riparian vegetation carried out for each participating farm)
- Implementation of works (monitoring of restoration activities and their progress).

For agroforestry/silviculture, evaluation is carried out at plot level based on:

- Plot size
- Number of trees planted
- Production (by production type and in kg)
- Total labour time per plot (in hours).

Knowledge needs

No information provided.

v. Nature in cities / Oceanian habitat

Cost analysis of ecosystem-based adaptation options

EbA Option	Hypotheses	Surface type	Typical implementation duration	Typical monitoring duration	Total deployment cost (CFP francs)	Design costs (CFP francs)	Installation costs (CFP francs/ implementation duration)	Maintenance costs (CFP francs/ monitoring duration)	Need for volunteers	Number and type of FTEs (managers/ trainers / employees)	Number and type of FTEs (workers/ firefighters)	Source of information	Explanation of calculations
Urban greening and depaving	- Study phase with multidisciplinary project management - Works contract (finishing, reinforcement, planting) - Maintenance and upkeep (standard monitoring)	100 - 1000 m²	4-12 months	2-4 years	4 820 800- 24 128 000	4 000 000-12 000 000	700 000-12 000 000	60,000 CFP (first two years, then decreasing) Alternatively: 400–4,000 CFP for very low-maintenance landscaped spaces.	No identified need	0.67-2	0.13-2.00	Consultation with the City of Nouméa	Minimum–maximum range calculated as design costs divided by 6,000,000 (managerial FTEs).

Effectiveness analysis of ecosystem-based adaptation options

EbA Options	*Adaptation to climate change impacts*	*Climate change mitigation*	*Natural hazard risk management*	*Food security*	*Water security*	*Public health*	*Human activities*	*Biodiversity*
Urban greening and soil de-sealing (de-impermeabilisation) of cities	5	5	5	3	4	5	2	5

Enabling factors, barriers, and areas for improvement

- One enabling factor is the possibility for local authorities to request financial support for this type of development.
- The main barrier is cognitive: this type of option is not seen as necessary, as nature is often associated with tropical luxuriance ("here, in tropical areas everything grows, nothing needs to be done"), leading to the perception that urban greening is unnecessary or even undesirable. There is also a lack of cross-sector collaboration, project culture, and professional facilitation within the sector.
- To improve implementation, training initiatives could be developed, along with strengthening the profession of landscape designers. Systematizing and promoting project processes to build routine practices among professionals and commissioners is another key area. Finally, fostering professional coordination and making multidisciplinary project management mandatory appears necessary.

Monitoring and evaluation system

- Evaluation is empirical and based on field observation. Project success is mainly measured through public acceptance of the developments.
- It should be noted that the upstream complexity of the project is not considered.

Knowledge needs

Further research on urban soils (including work produced by ADEME with Wagon Landscaping) is identified as a topic worth exploring.

3. Analysis of barriers and enabling factors for implementing EbA options

a. Workshop methodology

On 28 January, two workshop sessions were held with private sector stakeholders (chambers of commerce, business federations/unions), and public sector stakeholders (New Caledonia government departments, the Customary Senate, funders, and public innovation actors).

The main objective of these sessions was to identify barriers and enabling factors for integrating EbA into public and sectoral policies, as well as for their operational implementation.

Summary of workshop structure:

- Introduction and awareness-raising
  - Presentation of EbA challenges
  - Contextualization of climate and environmental issues
- Small-group work
  - Participants grouped by expertise and field of action
  - Identification of barriers to EbA implementation
  - Discussion of enabling factors and possible solutions
- Synthesis and feedback
  - Compilation of results in tables and qualitative analyses
  - Identification of priorities and concrete recommendations to promote EbA adoption

Specific focus areas:

- **Public sector**: regulatory incentives and constraints, and success/failure factors of EbA projects
- **Private sector**: integration of EbA into compensation measures and corporate climate adaptation strategies

b. Barriers to integrating EbA into public policies

Public sector

Several obstacles hinder the integration of EbA into public policies:

- Regulatory: absence of specific obligations for nature-based solutions (NbS), institutional silos, lack of coordination, and lobbying against NbS.
- Financial: lack of dedicated funding and long-term financial support; NbS often perceived as less profitable or robust than conventional solutions.
- Economic: absence of proven business models complicates integration into planning and infrastructure strategies.
- Capacity and awareness: limited awareness among decision-makers and the public, insufficient training of engineers and urban planners, lack of shared culture and experience-sharing among public actors.

Private sector

Companies also face economic and regulatory constraints:

- Environmental regulations considered unsuitable for encouraging NbS
- High upfront costs, especially for SMEs
- Lack of financial incentives and subsidies
- Limited integration of NbS in public procurement
- Weak experience-sharing and absence of structured exchange networks
- Economic pressure favors conventional solutions perceived as safer
- Lack of training and support limiting companies' ability to integrate NbS into adaptation strategies.

c. Enabling factors for integrating EbA into public policies

Public sector

Key enabling factors include:

- Regulatory: integrating NbS into planning projects and developing fiscal incentives (e.g., municipal taxes)
- Financial: establishing long-term funding mechanisms
- Capacity-building: training elected officials and planners, awareness-raising from school age, and citizen training
- Knowledge and innovation: supporting research projects and integrating local knowledge
- Operational: developing adapted economic and technical models, structuring local expertise, and promoting participatory approaches.

Private sector

From a business perspective, potential levers include:

- Adapting the regulatory framework to better account for NbS
- Integrating NbS into public procurement and linking public aid to environmental criteria
- Introducing incentive taxes (e.g., on soil sealing or photovoltaics)
- Encouraging innovation and experimentation through targeted support
- Structuring exchange networks and collaborative workshops
- Establishing a one-stop shop to guide companies toward suitable solutions
- Promoting local best practices and flagship projects to demonstrate the viability and profitability of NbS and encourage private-sector adoption.

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V. List of appendices

Appendix 1: Data collection sheet for cost-effectiveness analyses
Appendix 2: Table of indicators used to assess individual adaptive capacity
Appendix 3: Detailed CEA of options in the category "Forest / watershed restoration (fire control, deer, reforestation)"
Appendix 4: Detailed CEA of options in the category "Mangrove and estuary restoration / conservation (sediment and pollutant filtering)"
Appendix 5: Detailed CEA of options in the category "Coastal vegetation restoration"
Appendix 6: Detailed CEA of options in the category "Agroforestry / silvopastoralism & sustainable fisheries management / highly protected marine areas"
Appendix 7: Detailed CEA of options in the category "Nature in cities / Oceanian habitat"

The Kiwa Initiative - Nature-based Solutions (NbS) for Climate Resilience aims to build the resilience of Pacific Island ecosystems, communities, and economies to climate change through NbS by protecting, sustainably managing and restoring biodiversity. It is based on simplified access to funding for climate change adaptation and biodiversity conservation actions for local and national governments, civil society, and regional organizations in Pacific Island Countries and Territories. The Initiative is funded by the European Union, Agence française de développement (AFD), Global Affairs Canada (GAC), Australia's Department of Foreign Affairs and Trade (DFAT) and New Zealand's Ministry of Foreign Affairs and Trade (MFAT). It has established partnerships with the Pacific Community (SPC), the Secretariat of the Pacific Regional Environment Programme (SPREP), and the Oceania Regional Office of the International Union for Conservation of Nature (IUCN - ORO).

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ISBN 978-982-04-1513-3
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