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NaTour4CChange

MAP CAP FERRAT
Identification and assessment of the main coastal tourism-related issues concerning climate change mitigation and adaptation

The Consortium:

institut za turizam / institute for tourism; CPMR CRPM; Natura Jadera – Public institution for management of protected areas in Zadar County; UN environment programme; Mediterranean Action Plan Barcelona Convention; Plan Bleu; Regione Autònoma de Sardigna / Regione Autonoma della Sardegna; IUCN; Junta de Andalucía – Consejería de Turismo, Cultura y Deporte; Περιφέρεια Κρήτης / Region of Crete; Hellenic Society for the Protection of Nature; Ministarstvo poljoprivrede, šumarstva i vodoprivrede HNŽ

Project Information	
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Version	Date	Contributors
V1	30/06/25	Alexis Tardif, Laure Herbert, Théodore Michel, Sandrine Dhénain
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Project Overview

The Mediterranean region is one of the most vulnerable hotspots for climate change and biodiversity loss. It is warming 20% faster than the global average and is the second biodiversity hotspot in the world. The increase in severe climate events is also likely to influence the destination and duration of holidays for its over 510 million inhabitants. The effects of climate change will put additional pressure on already strained ecosystems and vulnerable economies and societies, with tourism being one of the most affected economic sectors.

The recent Transition Pathway for Tourism and the Glasgow Declaration are building a global momentum for climate action in tourism, but policymakers and destinations need support to better develop efficient climate mitigation and adaptation policies using ecosystem-based approaches and improved multi-level governance structures, including robust planning, and to ensure the long-term engagement of the private sector and citizens. Indeed, ecosystem-based management is considered a best practice to effectively deal with these threats as it takes into account the different stakeholders and factors affecting ecosystems and the mechanisms involved, in order to find solutions.

NaTour4CChange builds on successful experiences at the Mediterranean and global level to test solutions for increasing the resilience of coastal destinations in the Mediterranean. The project will aim to define common methods to support participating regions in assessing their tourism-related climate adaptation and mitigation priorities, and to take climate action via plans and strategies, supported by cooperative governance.

In coastal destinations, cross-sector teams will deliver specific tourism-related climate action plans, focusing on climate adaptation, where Nature-based Solutions (NbS) will be tested to ensure their feasibility. At the same time, innovative destination marketing and communication approaches will engage private stakeholders, visitors, and residents in climate action.

The project will also ensure cross-fertilisation among the participating regions and destinations, to achieve common methods and to compare the different plans and solutions tested, leading to lessons, best practices, and policy.

Glossary

MPA: Marine Protected Area

IPCC : Intergovernmental Panel on Climate Change

GREC SUD: Regional Group of Experts on Climate in the South Provence-Alpes-Côte d'Azur Region.

NCA: Nice Cote d'Azur

TRACC: Reference warming trajectory for adaptation to climate change

FWI: Forest Fire Weather Index

TCI: Thermal Comfort Index

1. INTRODUCTION

The Cap Ferrat Marine Protected Area (MPA) was created in 2008-2009 in response to various pressures on the environment (pollution, mooring, etc.) and to preserve habitats of “community interest”. An environmental assessment carried out between 2010 and 2012 identified 13 habitats of community interest, some of which were identified as priority and emblematic habitats, such as Posidonia and coralligenous formations.

More broadly, the site falls within the perimeter of 5 coastal municipalities: Saint-Jean-Cap-Ferrat, Beaulieu-sur-Mer, Villefranche-sur-Mer, Eze and Cap d’Ail (Figure 1). Tourism is primarily at the seaside and mainly upmarket. The area boasts a prestigious range of tourist facilities, including luxury accommodation (4 and 5-star hotels, private villas), renowned gourmet cuisine, private beaches, yachting and an exceptional natural setting. This tourism is concentrated in the summer months, and is a major source of employment and economic spin-offs.

Various activities take place here, such as beach-related seaside tourism, yachting ([1]e.g. over 350 boats counted on 15 August 2019, with peaks identified every year during events such as the Monaco Grand Prix or the Cannes Film Festival), scuba diving, motorised and non-motorised water sports (paddleboarding, etc.), along with professional and recreational fishing. There is also heritage tourism (Villa Kerylos, etc.) and nature tourism (hiking paths).

The current challenges facing the area are the preservation of natural sites and beaches in a context of high visitor numbers and the erosion of certain areas. The Metropolis and tourist offices are considering how to grow visitor numbers during the low and mid seasons.

In this context, climate change is exerting additional pressure, now constituting a major challenge for coastal areas, particularly in a sensitive region such as the Mediterranean basin, which is recognised by the IPCC as a “climate change hotspot”, i.e. a region characterised by high vulnerability and exposure to current and future climate effects.

Faced with these findings, this study aims to assess the vulnerability of tourism in the Cap Ferrat MPA, an emblematic site in the Côte d’Azur (French Riviera). The aim is to start thinking about the compatibility of tourism activities with the future climate, looking ahead to 2050 and 2100, by identifying the risks they may face in the future and possible levers for adaptation.

[1] IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (H.-O. Pörtner et al., Eds.). Cambridge University Press. https://doi.org/10.1017/9781009325844.

To analyse this vulnerability, a methodology was used that combined exposure[2], sensitivity[3] and adaptative capacity[4]. Specific indicators have been defined to characterise exposure (e.g. rise in water temperature, frequency of heat waves) and sensitivity (e.g. economic dependence on summer tourism, etc.), in order to best estimate the risks encountered. For the adaptative capacity, in the absence of quantitative indicators, a qualitative analysis has been carried out based on discussions with local stakeholders. These aspects were also discussed at a feedback workshop, enriching analysis through stakeholder experience.

[2] According to the 5th IPCC report, exposure represents the "presence of people; livelihoods; species or ecosystems; environmental functions, services and resources; infrastructure; or economic, social or cultural assets in places and settings that could be adversely affected." (IPCC, AR5, 2022)
[3] "Degree to which a system or species is influenced, positively or negatively, by climate variability or climate change. The effects may be direct or indirect." (IPCC, AR5, 2022)
[4] "The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences." (IPCC, AR5, 2022).

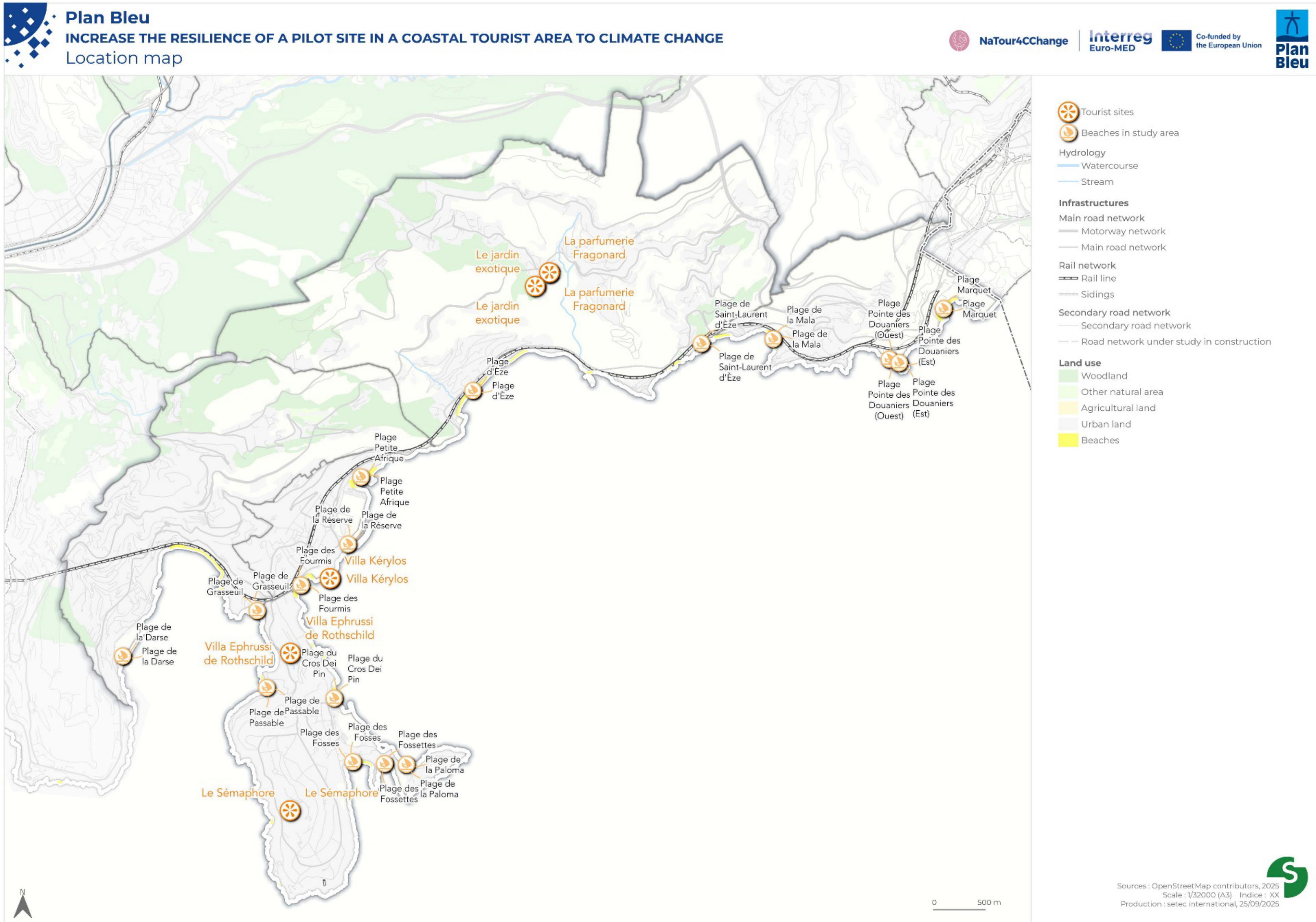

FIGURE 1: MAP SHOWING THE LOCATION OF THE STUDY AREA, BEACHES AND TOURIST SITES. SOURCE: SETEC INTERNATIONAL

2. COLLECTION AND ANALYSIS OF CLIMATE AND SOCIO-ECONOMIC DATA

Various sources were used to collect data.

GREC Sud (regional group of experts on climate) has produced a number of useful reports for the study (Tourism report[5], Sea and Coastlines report[6], along with a report on the Nice Côte d'Azur (NCA) Metropolis[7]).

The climate data used in this report was taken from the latest IPCC report and from Météo France via their platform ClimaDiag Commune, bringing together many relevant climate indicators across several time periods (current, 2050 and 2100). These indicators are available in TRACC format (French reference warming trajectory for adaptation to climate change)[8], which defines three levels of warming relative to the pre-industrial era: +2.0°C by 2030, +2.7°C by 2050, and +4.0°C by the end of the century, which are values for mainland France.

With regard to erosion, the national shoreline indicator developed by CEREMA[9] was used. Erosion data and sand nourishment data were provided by the Metropolis departments.

Map data on marine habitats and changes to the status of Posidonia were consulted via the Medtrix[10] platform, an online tool for monitoring marine ecosystems in the Mediterranean, which centralises spatial information on habitats, species and environmental pressures.

Data from the CATNAT database relating to marine hazards, along with various scientific publications on sea level rise, ocean temperature and acidification, was used.

Finally, information on water resources was collected through an interview with the Eau d'Azur water management company.

For socio-economic data, in addition to information provided by the tourist offices and by Côte d'Azur France Tourisme, institutional sources, such as INSEE and URSSAF were also consulted. These sources have provided precise data on tourist accommodation capacity and the employed workforce in each municipality.

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[5] GREC-SUD. (2024). Le tourisme face au changement climatique en région Provence-Alpes-Côte d'Azur (64 p.). https://www.grec-sud.fr/publications/le-tourisme-face-au-changement-climatique-en-region-provence-alpes-cote-dazur/

[6] GREC-PACA. (2022). La mer et le littoral de Provence-Alpes-Côte d'Azur face au changement climatique (92 p.). https://www.grec-sud.fr/publications/le-cahier-mer-et-littoral/

[7] GREC-SUD. (2021). La Métropole Nice Côte d'Azur face aux risques climatiques (64 p.). https://www.grec-sud.fr/publications/cahier-metropole-nice-cote-dazur/

[8] Since 2023, France has had a Global Warming Trajectory to provide a coherent direction for the development of adaptation strategies and plans. This trajectory is included in the National Climate Change Adaptation Plan adopted in 2024.

[9] CEREMA. (2015). Érosion côtière : connaissances, impacts et adaptation. Technical report, October 2015.

[10] https://medtrix.fr/

In order to triangulate the information and data, interviews were conducted with the various tourist offices in the municipalities studied: Beaulieu-sur-Mer, Cap d'Ail, Èze, Saint-Jean-Cap-Ferrat et Villefranche-sur-Mer, the NCA ports service and MPA representatives.

A site visit was organised, including tourist offices, local elected officials and MPA managers, with the aim of gaining a practical understanding of the issues and dynamics of the region.

A number of data gaps were identified during the course of the study:

First, some hazard indicator data for coastal risk analysis is missing, difficult to access or not up to date, such as MPA beach profiles, more detailed erosion analyses and in situ sea temperatures. For coastal hazards, erosion, coastal flooding and sea level rise are a particularly complex part of the analysis. It also represents a major challenge for local stakeholders and government departments. A report by the Metropolis departments is undergoing validation, based on detailed monitoring and modelling. It will undoubtedly provide further details on this key aspect for the area. The analyses of the coastal hazards presented in this report are based on a combination of available data, our field visit with our maritime expert and interviews. They provide a first level of understanding of the phenomena, which could be added to at a later date.

Second, there is also a lack of disaggregated data at the municipal level, particularly on tourist numbers (hotels, beaches) and economic data by tourist sector. Correlations relating to the local impacts were based on a triangulation between the hazard and socio-economic data available, the qualitative interviews and field visit.

2.1 Inventory of climate action planning and assessment

Several climate diagnosis reports exist for the MPA area, including several publications by GREC-SUD, in particular the 2021 territorial report on the NCA Metropolis, and the thematic reports on tourism (2024) and the sea and coastline (2017), which provide additional information on climate-related territorial dynamics.

This study is also based on documents that constitute the Territorial Climate Air and Energy Plan (PCAET, 2019[11] and 2024[12]), particularly the part concerning vulnerability of the area to the effects of climate change at the scale of the Nice Côte d'Azur Metropolis. In its mid-term review, PCAET proposes several strategic focuses for adaptation of the tourism sector, such as greening urban centres, promoting soft mobility and developing the adaptation component in the next 2032 Climate Plan.

The 2015 targets document (DOCOB[13]) of the MPA is currently under revision. It also establishes an inventory of the various demographic, socio-economic and climate issues, with developments around natural heritage and human activities, mainly linked to tourism.

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[11] Nice Côte d'Azur Metropolis. (2019). *Territorial Climate, Air and Energy Plan 2019–2025*. https://www.nicecotedazur.org/services/environnement/protection-du-climat/plan-climat-air-energie-territorial/.

[12] Nice Côte d'Azur Metropolis. (2024). Mid-term review of the 2025 Climate Plan. https://www.nicecotedazur.org/wp-content/uploads/2025/02/Bilan-mi-parcours-Plan-Climat-acte.pdf.

[13] a) Nice Côte d'Azur Metropolis, & Meinesz, C. (2014). Targets document (DOCOB) for the Natura 2000 site FR 9301996 "Cap Ferrat". Volume 1 – Diagnostics, enjeux et objectifs de conservation (126 p.), b) Nice Côte d'Azur

2.2 Analysis of past weather events and projections of future events

In the Mediterranean, the IPCC estimates that warming is around 20% faster than the global average, and droughts, heat waves, coastal flooding and extreme events are set to intensify. This situation is exacerbated by a unique combination of factors: high urban population density, growing dependence on water for agriculture, an economy largely driven by tourism, and already fragile ecosystems. These factors make the Mediterranean a region particularly exposed to climate risks, both for Mediterranean societies and for the associated natural environments.

Furthermore, recent climate projections indicate that, on a global scale, the threshold of +1.5°C of average atmospheric warming could be exceeded permanently by 2100, even in ambitious emission-reduction scenarios. This marks a critical turning point, as it is associated with irreversible impacts on ecosystems and human societies. (Tollefson[14], 2025)

Analysis of the past and present climate status was based on the latest GREC SUD reports for the study area, along with the Territorial Climate Air and Energy Plan (PCAET) of the Nice Côte d'Azur Metropolis. Additional analysis has also been carried out using IPCC data (AR6), in particular to place local trends in a global context, along with the CATNAT database, which lists past climate events and natural disasters in the region.

The analysis of future projections will be based primarily on indicators provided by Météo France via their tool "Climadiag Commune" for the municipalities of Beaulieu-sur-Mer, Cap d'Ail, Èze, Saint-Jean-Cap-Ferrat and Villefranche-sur-Mer. This tool provides a list of climate indicators for each municipality across several time periods and TRACC scenarios (reference warming trajectory for adaptation to climate change). Compared to the pre-industrial era, it is +2.7 °C by 2050 and +4.0 °C by the end of the century. Please note that on the Climadiag Commune tool, future climate projections are roughly identical for the five municipalities studied, but small variations on certain indicators are visible (e.g. 1°C difference in average temperature during the summer season in 2100 between Èze and Saint-Jean-Cap-Ferrat). The time periods studied are **2050** and **2100**, compared with the reference period of **1976-2005**.

2.2.1 Rising temperatures

2.2.1.1 Current status

Since 1960, the rise in average annual temperatures has been +0.3°C per decade in the Provence-Alpes-Côte-d'Azur region. Over the same period, in Nice, the average temperature anomaly has changed by +1.5°C (GREC SUD, 2021). The following graph shows average annual temperature deviations from the observed average over the period of 1961-1990 (Figure 2). Since 1986, these temperature deviations have always been positive, and have been increasing in recent years (PCAET, 2019). It is important to emphasise that these

Metropolis, & Meinesz, C. (2015). Targets document (DOCOB) for the Natura 2000 site FR 9301996 "Cap Ferrat". Volume 2 – Objectifs de gestion et préconisation de mesures (88 p.), c) Nice Côte d'Azur Metropolis. (2015). Targets document (DOCOB) for the Natura 2000 site FR 9301996 "Cap Ferrat" – Summary Report (30 p.).

[14] Tollefson, J. (2025). Earth Breaches 1.5 °C Climate Limit for the First Time: What Does It Mean? Nature, 637(8047), 769–770. https://doi.org/10.1038/d41586-025-00010-9.

climate analyses are based on inter-annual averages, which helps identify general long-term trends. However, this must not conceal the persistence of seasonal extremes, such as occasional severe cold spells in winter.

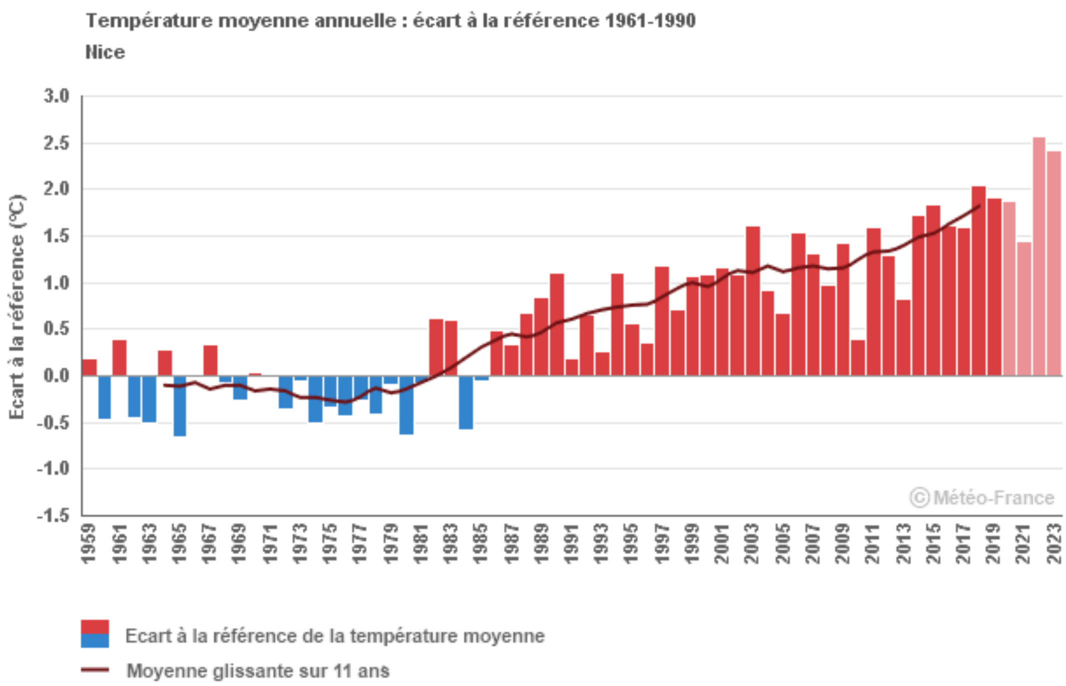


FIGURE 2: DEVIATION FROM REFERENCE AVERAGE ANNUAL TEMPERATURE FOR THE PERIOD OF 1961-1990 - NICE STATION. SOURCE: MÉTÉO FRANCE.
(AVERAGE ANNUAL TEMPERATURE: DEVIATION FROM 1961-1990 REFERENCE PERIOD // NICE // DEVIATION FROM THE REFERENCE (°C) // LEGEND: DEVIATION FROM AVERAGE TEMPERATURE REFERENCE // 11-YEAR ROLLING AVERAGE)

2.2.1.2 FUTURE PROJECTIONS

Looking at the Climadiag indicator of average temperature by season, one can observe an **overall rise in average temperatures across all seasons in the future**. These trends follow the warming estimated using the TRACC for the various time periods studied. For example, for the municipality of Beaulieu-sur-Mer, the average summer temperature would increase by +2.3°C by 2050 (Figure 3) and +3.8°C by 2100 (Figure 4) compared with the reference values over the period of 1976-2005, with a very high degree of certainty around these values (the high and low values are very close to the median value).

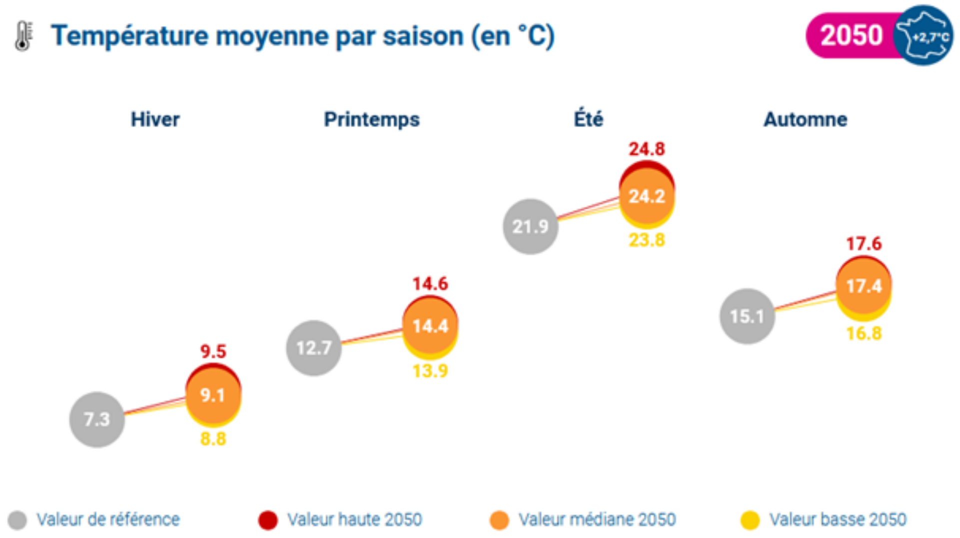


FIGURE 3: CHANGE IN AVERAGE TEMPERATURE BY SEASON BETWEEN THE REFERENCE PERIOD AND 2050. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(AVERAGE TEMPERATURE BY SEASON (IN °C) // WINTER // SPRING // SUMMER // AUTUMN // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2050 // MEDIAN VALUE FOR 2050 // LOW VALUE FOR 2050)

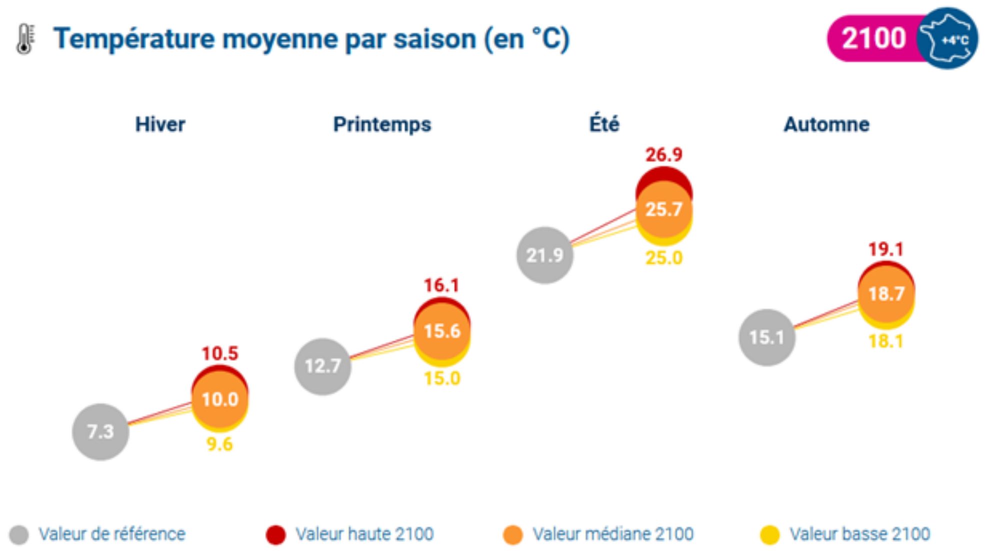


FIGURE 4: CHANGE IN THE AVERAGE TEMPERATURE BY SEASON BETWEEN THE REFERENCE PERIOD AND 2100. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(AVERAGE TEMPERATURE BY SEASON (IN °C) // WINTER // SPRING // SUMMER // AUTUMN // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2100 // MEDIAN VALUE FOR 2100 // LOW VALUE FOR 2100)

In a pessimistic scenario (RCP8.5), **monthly temperature anomalies would likely reach +5°C to +8°C on the coast**. Summer temperatures along the Nice coast are likely to be similar to those inland in North Africa, or even the northern fringes of the Sahara. (GREC SUD, 2021).

This rise in temperature can also be observed by analysing the change in the annual number of very hot days, i.e. with a temperature exceeding 35°C. In Beaulieu-sur-Mer, taking the years 1976 -2005 as a reference value, this number rises from 0 to 3, and then 6, in 2050 (Figure 5) and 2100 (Figure 6). There is significant disparity between climate models, and according to the high values of climate projections, the number of very hot days could reach 18 by 2100.

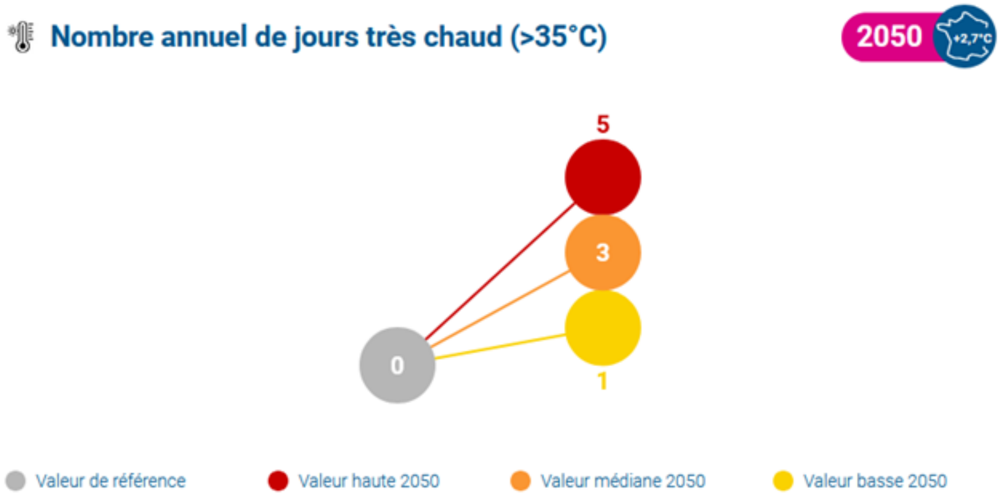


FIGURE 5: CHANGE IN THE NUMBER OF VERY HOT DAYS BETWEEN THE REFERENCE PERIOD AND 2050. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(ANNUAL NUMBER OF VERY HOT DAYS (>35°C) // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2050 // MEDIAN VALUE FOR 2050 // LOW VALUE FOR 2050)

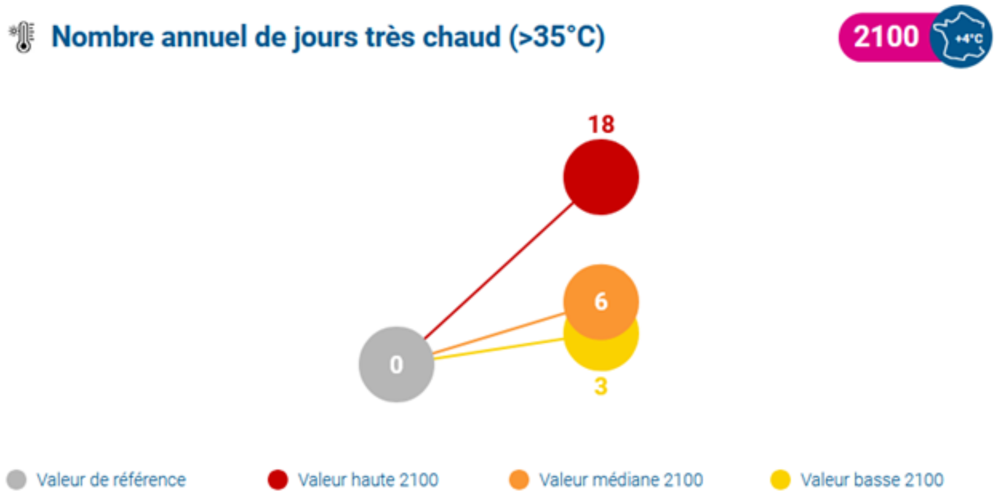


FIGURE 6: CHANGE IN THE NUMBER OF VERY HOT DAYS BETWEEN THE REFERENCE PERIOD AND 2100. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(ANNUAL NUMBER OF VERY HOT DAYS (>35°C) // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2100 // MEDIAN VALUE FOR 2100 // LOW VALUE FOR 2100)

2.2.2 TROPICAL NIGHTS

2.2.2.1 CURRENT STATUS

The number of "tropical" nights (minimum temperature ≥ 20°C) increased **fivefold between the years 1960-70 and 2019 in Nice** (Figure 7), which marks a profound change in the thermal comfort of residents, particularly in the heart of cities (over 90 tropical nights in 2018, i.e. 3 months). (GREC SUD, 2021)

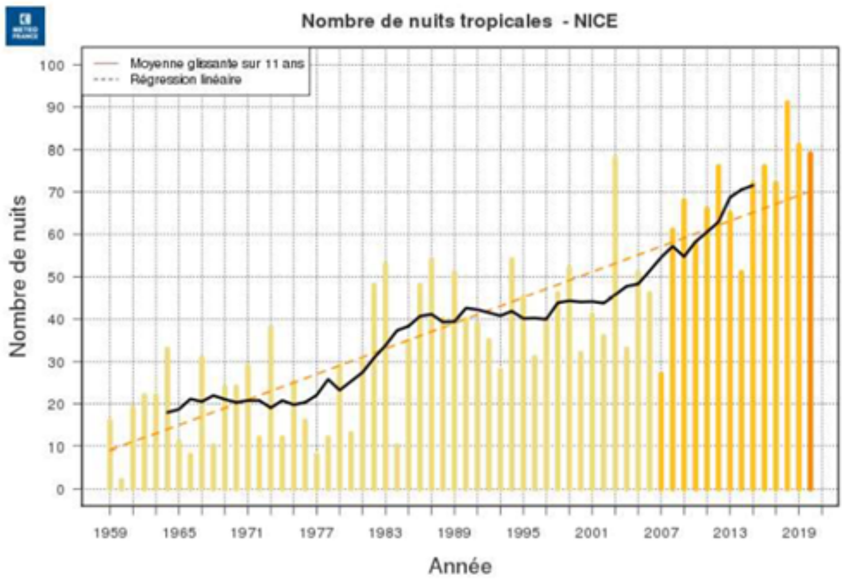


Figure 7: Number of tropical nights in Nice (source: Météo France, GREC SUD, 2021)
(Number of tropical nights – NICE // Legend: 11-year rolling average // Linear regression // Number of nights // Year)

2.2.2.2 Future projections

This number of tropical nights is also increasing in the different municipalities, particularly in Èze, rising from around 33 tropical nights over the reference period to 74 (Figure 8) and 96 (Figure 9) for the time periods studied.

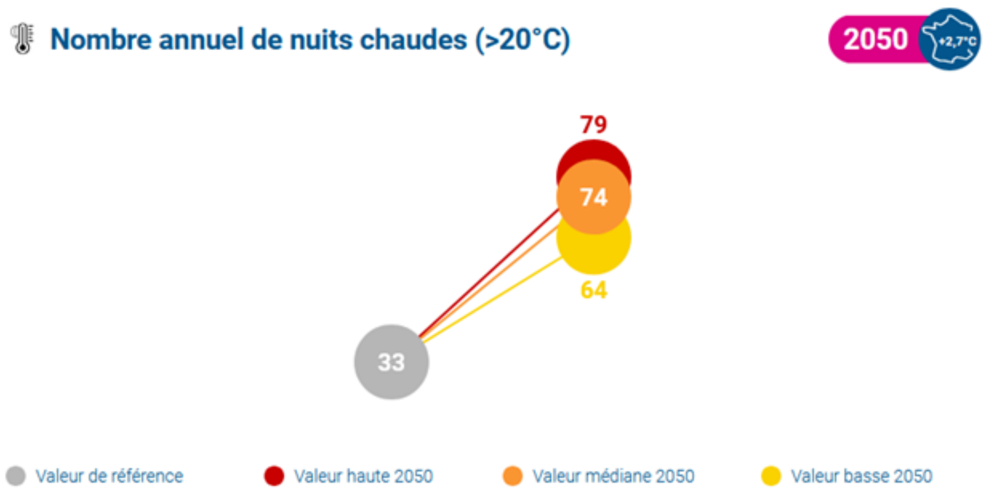


Figure 8: Change in the number of warm nights between the reference period and 2050. Source: Climadiag by Météo France.
(Annual number of warm nights (>20°C) // Legend: Reference value // High value for 2050 // Median value for 2050 // Low value for 2050)

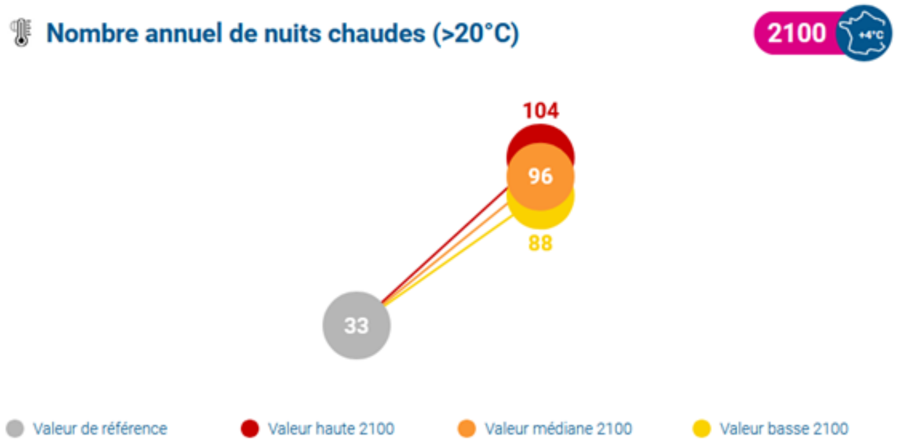


FIGURE 9: CHANGE IN THE NUMBER OF WARM NIGHTS BETWEEN THE REFERENCE PERIOD AND 2100. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(ANNUAL NUMBER OF WARM NIGHTS (>20°C) // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2100 // MEDIAN VALUE FOR 2100 // LOW VALUE FOR 2100)

2.2.3 SUMMER DAYS

2.2.3.1 CURRENT STATUS

A day is considered to be a summer day if the maximum daily temperature reaches 25°C. In the South Provence-Alpes-Côte-d'Azur region, the annual number of summer days varies greatly from one year to the next. Overall, there has been an **increase in the number of summer days since 1959** on the graph below (Figure 10) for the Cannes weather station (PCAET, 2019). The years 2022 and 2023 seem to mark a turning point, with a particularly high number of summer days.

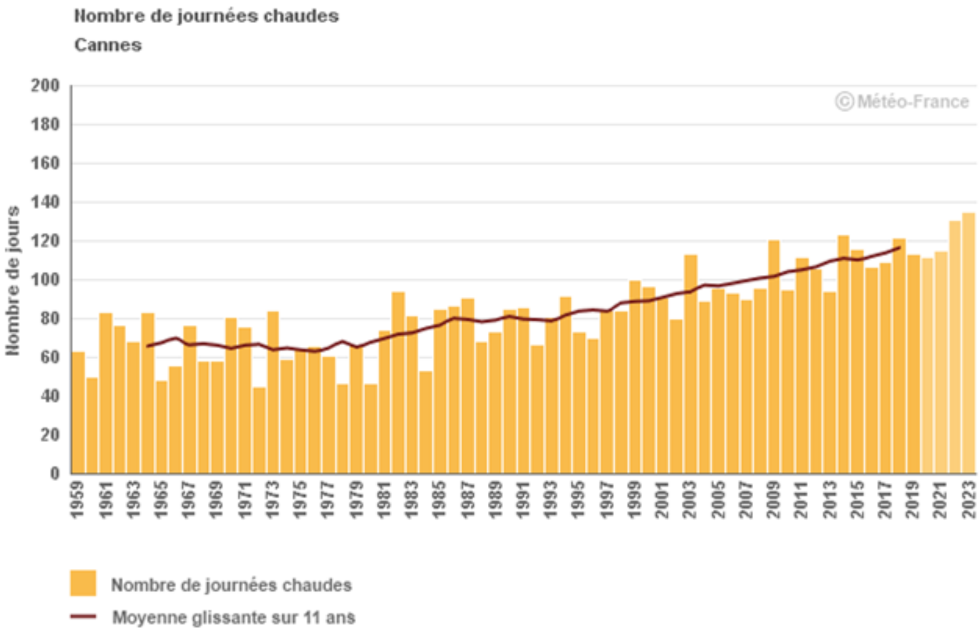


FIGURE 10: NUMBER OF SUMMER DAYS (>25°C) - CANNES STATION. SOURCE: MÉTÉO FRANCE.
(NUMBER OF HOT DAYS // CANNES // LEGEND: NUMBER OF DAYS, NUMBER OF HOT DAYS, 11-YEAR ROLLING AVERAGE)

2.2.3.2 FUTURE PROJECTIONS

This number is also set to increase sharply in the future. For example, in the municipality of Saint-Jean-Cap-Ferrat, it is set to rise from 82 for the reference period to 115 in 2050 (Figure 11) and 134 in 2100 (Figure 12).

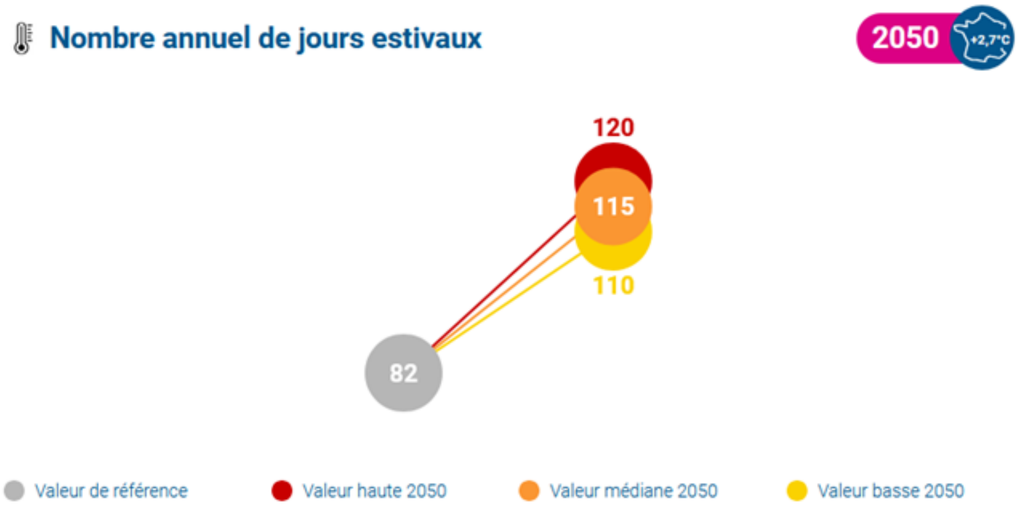


FIGURE 11: CHANGE IN THE NUMBER OF SUMMER DAYS BETWEEN THE REFERENCE PERIOD AND 2050. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(ANNUAL NUMBER OF SUMMER DAYS // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2050 // MEDIAN VALUE FOR 2050 // LOW VALUE FOR 2050)

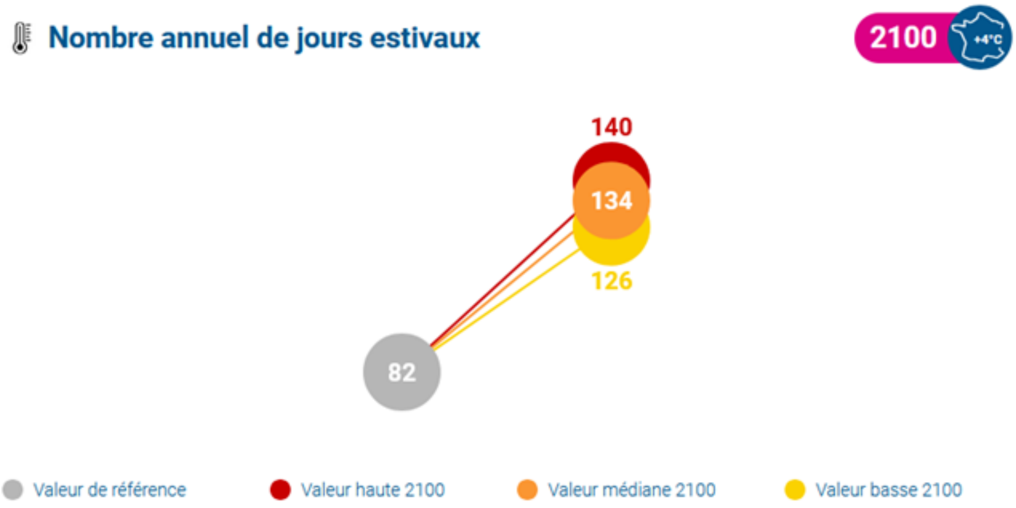


FIGURE 12: CHANGE IN THE NUMBER OF SUMMER DAYS BETWEEN THE REFERENCE PERIOD AND 2100. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(ANNUAL NUMBER OF SUMMER DAYS // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2100 // MEDIAN VALUE FOR 2100 // LOW VALUE FOR 2100)

2.2.4 HEAT WAVES

2.2.4.1 CURRENT STATUS

A day is considered to be a heatwave if it falls within a summer period of several consecutive days on which the maximum daily temperature exceeds a certain threshold. This threshold is often defined on the basis of the 95th percentile of maximum temperatures recorded over a reference period in the area. This means that the temperature must be higher than that observed 95% of the time during past summers.

The heat wave indicator can be compared with the previous indicator on summer days.

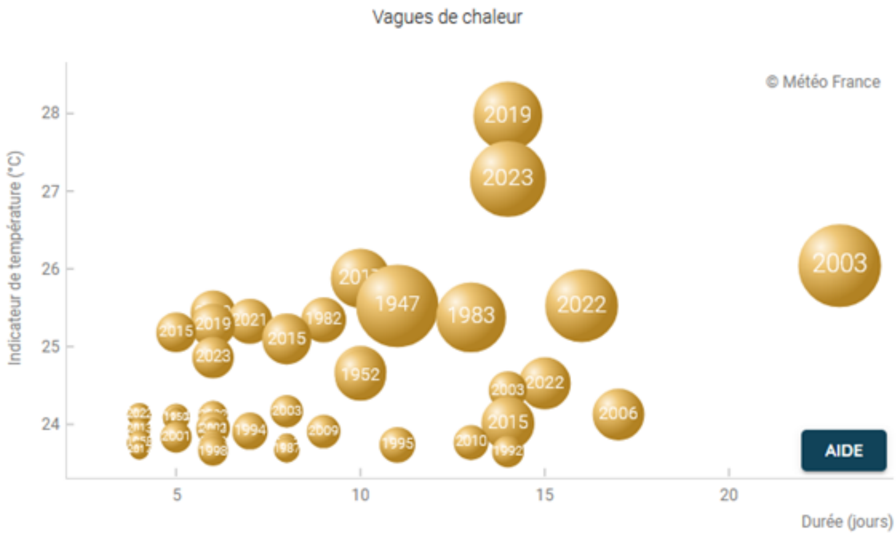


FIGURE 13: HEAT WAVES IDENTIFIED FROM 1947 TO 2023 IN PROVENCE-ALPES-CÔTE-D'AZUR. SOURCE: MÉTÉO FRANCE
(HEATWAVES // LEGEND: TEMPERATURE INDICATOR (°C) //DURATION (DAYS))

In this graph (Figure 14**Erreur ! Source du renvoi introuvable.**), one can observe that for the 2003 heatwave, in the South PACA region, the regional heat indicator reached a maximum of 26°C (considering the hinterland area), with a temperature above the 23°C threshold for 16 days.

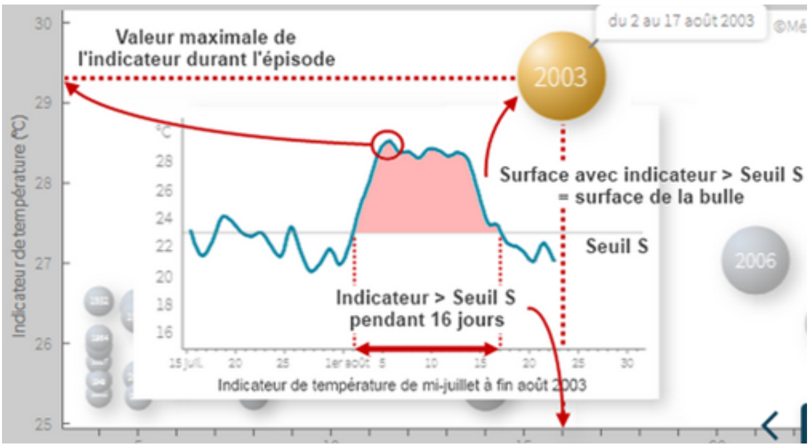


FIGURE 14: SUPPORT IN READING THE PREVIOUS GRAPH. SOURCE: MÉTÉO FRANCE.
(TEMPERATURE INDICATOR (°C) // MAXIMUM VALUE OF THE INDICATOR DURING THE EPISODE // SURFACE AREA WITH INDICATOR > THRESHOLD S = SURFACE AREA OF THE BUBBLE // THRESHOLD S // INDICATOR > THRESHOLD S FOR 16 DAYS // TEMPERATURE INDICATOR FROM MID-JULY TO END AUGUST 2003)

It is interesting to note **that from the 2000s onwards, heat waves have not only multiplied, but are also distinguished by their longer duration, marking a worrying change in the climate** (Figure 13).

2.2.4.2 FUTURE PROJECTIONS

In Saint-Jean-Cap-Ferrat, the number of days of heat waves increases from 0 for the reference period to 4 and then 9 for 2050 (Figure 15) and 2100 (Figure 16), with rather strong disparity between climate projections, whereby the number of days of heat waves is 25 according to the highest estimates. The projections for this indicator are similar for the 5 municipalities studied.

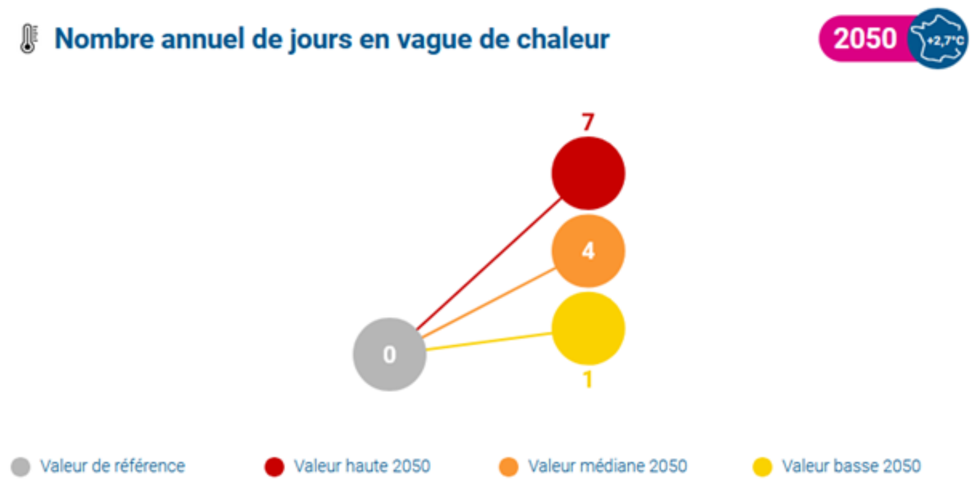


FIGURE 15: CHANGE IN THE NUMBER OF DAYS OF HEAT WAVES BETWEEN THE REFERENCE PERIOD AND 2050. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(ANNUAL NUMBER OF HEATWAVE DAYS // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2050 // MEDIAN VALUE FOR 2050 // LOW VALUE FOR 2050)

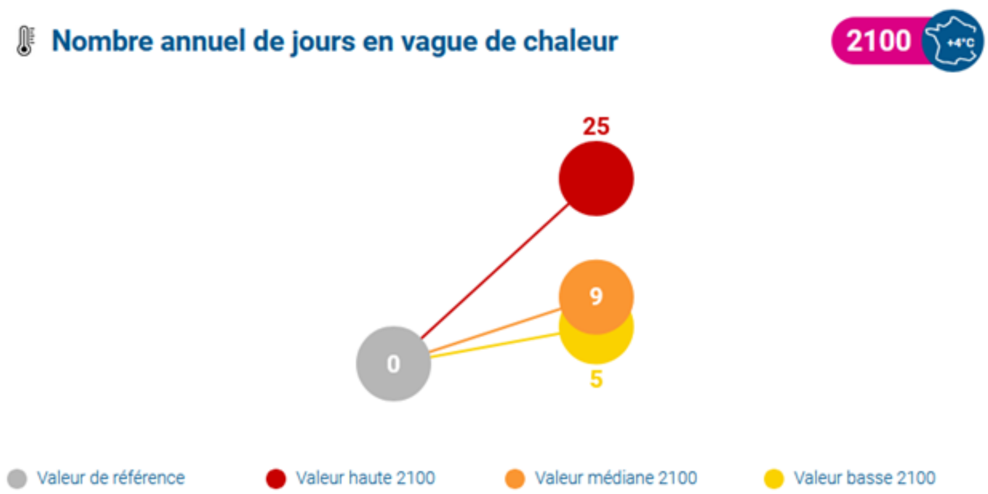


FIGURE 16: CHANGE IN THE NUMBER OF DAYS OF HEAT WAVES BETWEEN THE REFERENCE PERIOD AND 2100. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(ANNUAL NUMBER OF HEATWAVE DAYS // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2100 // MEDIAN VALUE FOR 2100 // LOW VALUE FOR 2100)

⚠ **All temperature-related indicators are rising.** The IPCC estimates an **almost certain rise in future temperatures**.

The thermal comfort index (TCI) is a composite indicator used to describe climate conditions favourable to tourist activities. It takes into account several weighted factors, such as thermal comfort, rainfall and sunshine. The Mieczkowski TCI has been calculated here using a set of climate models.

The associated graphic visualisation shows a **general trend towards a decline in TCI in the Mediterranean** (Figure 17). However, the results are more nuanced for the Provence-Alpes-Côte d'Azur region: around **half of the models predict an improvement**, while the other half anticipate a **deterioration** (GREC-SUD[15]). No conclusions should be drawn about the development of tourism in the area.

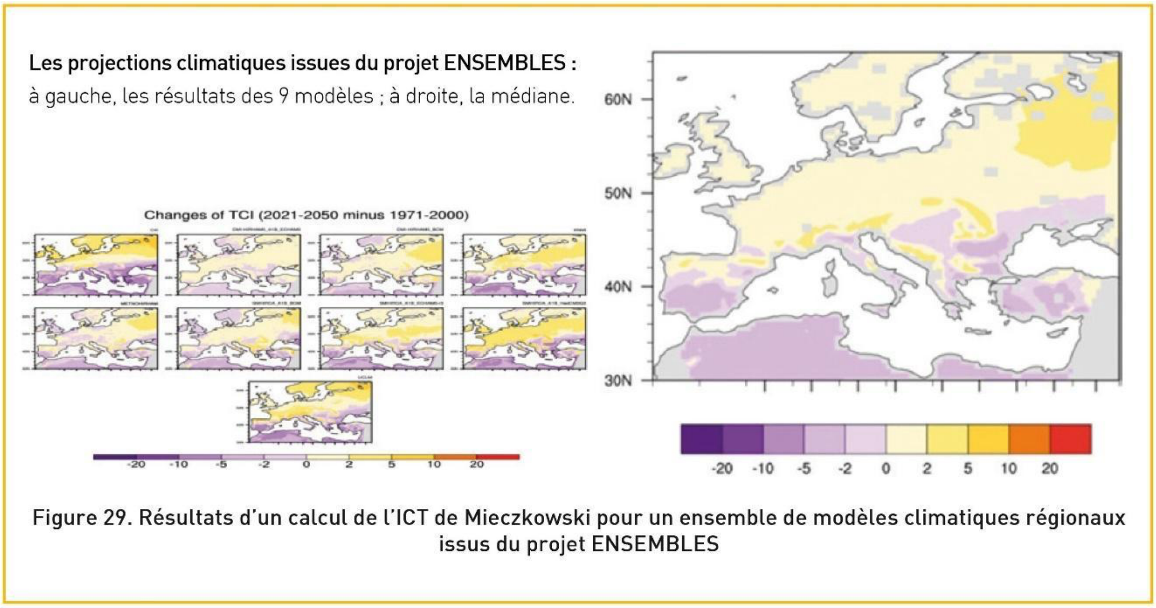


FIGURE 17: TCI CALCULATED FOR SEVERAL REGIONAL CLIMATE MODELS. SOURCE: GREC SUD (CLIMATE PROJECTIONS FROM THE EMSEMBLES PROJECT: LEFT, RESULTS OF THE 9 MODELS; RIGHT, THE MEDIAN. // FIGURE 29. RESULTS OF A CALCULATION OF THE MIECZKOWSKI TCI FOR A SET OF REGIONAL CLIMATE MODELS FROM THE EMSEMBLES PROJECT.)

2.2.5 FIRES

2.2.5.1 CURRENT STATUS

As part of the Natural Risk Prevention Plan, and more specifically the prevention of forest fires, it seems relevant to include a specific indicator linked to this type of risk (Figure 18). Assessment of the "forest fire" hazard in the Alpes-Maritimes Forest Fire Protection Plan (*Plan Départemental de Protection de la Forêt Contre les Incendies*) - PPFCI[16], 2020) for the 2019-2029 period, classifies the level of risk as between medium and high in all five of the municipalities studied. The study area is located within a coastal mountain range, which is an exposed sector, where 78 fires were recorded between 2009 and 2017, with a total of 62 hectares burnt, as illustrated in Figure 19.

[15] [15] GREC-SUD. Exemples d'études thématiques récentes. Accessed on 26 June 2025. https://www.grec-sud.fr/article-cahier/articles-du-cahier-climat/perspectives-futures/exemples-detudes-thematiques-recentes/.
[16] Alpes-Maritimes Prefecture. (2020). *Departmental Forest Fire Protection Plan (PDPFCI) - Alpes-Maritimes (126 p.).* https://www.alpes-maritimes.gouv.fr/content/download/34332/266140/file/PDPFCI.pdf

This risk is all the more worrying given that global warming is making the ranges drier, meaning that they are more vulnerable to outbreaks of fire. The risk of peri-urban fires is therefore very high, particularly due to population density and the proximity of urban areas.

Calculation of the hazard in the PPFCI (Figure 18) is based on the probability of the occurrence of a phenomenon of a given intensity, by combining historical events and physical data from the coastal range. However, the current risk map does not take climate projections into account, and is based solely on the current state of the coastal ranges and past fire probabilities, which could lead to an underestimation of future risk.

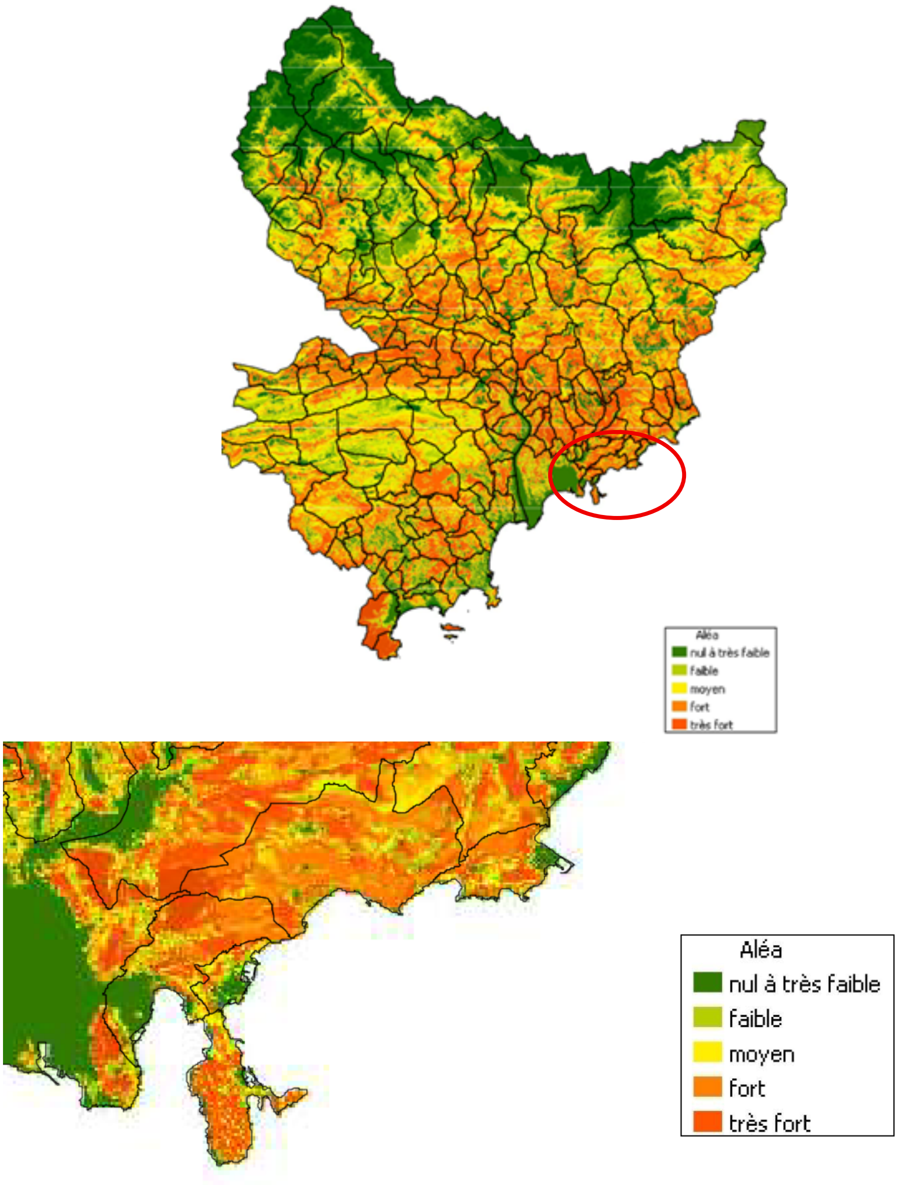
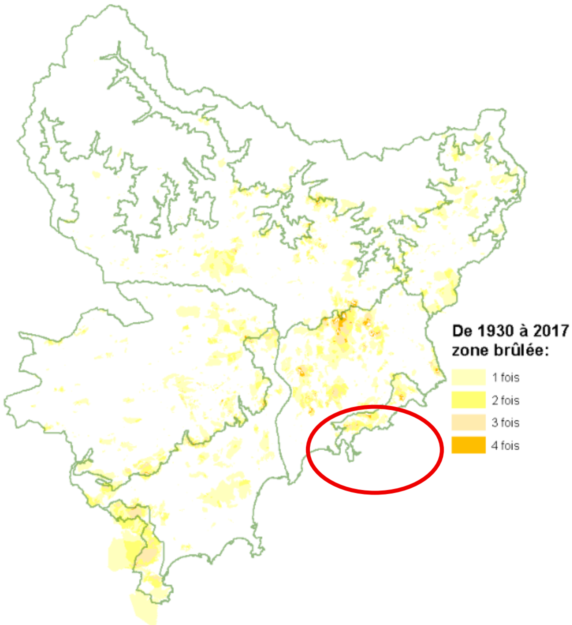


FIGURE 18: FOREST FIRE RISK MAP OF THE ALPES-MARITIMES, SOURCE: PDPFCI, 2019-2029
(RISK // ZERO TO VERY LOW // LOW // MODERATE // HIGH // VERY HIGH)



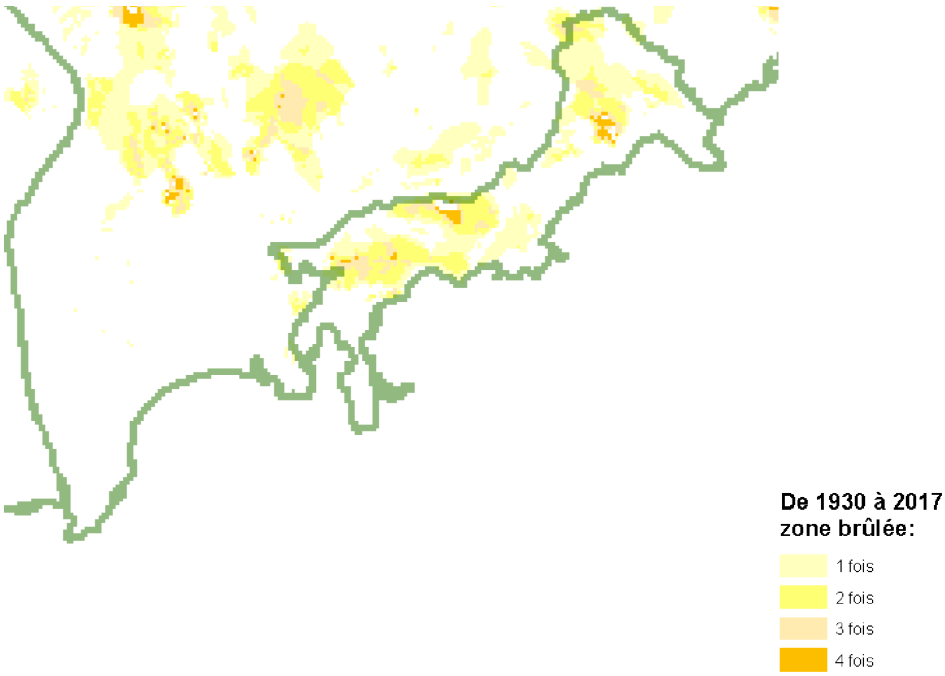


FIGURE 19: MAP SHOWING THE AREAS BURNT BETWEEN 1930 AND 2017 IN THE ALPES-MARITIMES, SOURCE: PDPFCI, 2019- 2029
(FROM 1930 TO 2017 AREA BURNED: ONCE // TWICE // 3 TIMES // 4 TIMES)

2.2.5.2 FUTURE PROJECTIONS

A day is considered to represent a significant risk of wildfire when the Forest Fire Weather Index (FWI) is above 40. This index is used to assess the extent to which weather conditions are conducive to fires starting and spreading. This index is calculated using meteorological data, such as temperature, air humidity, wind speed and rainfall. The reference value for

Villefranche-sur-Mer is 4 days, which is set to increase to 8 in 2050 (Figure 20) and then 13 in 2100 (Figure 21).

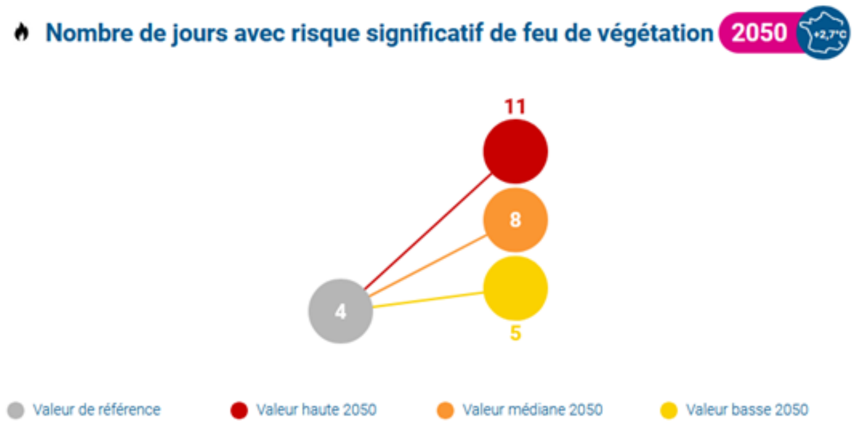


FIGURE 20: CHANGE IN THE NUMBER OF DAYS WITH A SIGNIFICANT RISK OF WILDFIRE BETWEEN THE REFERENCE PERIOD AND 2050. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(NUMBER OF DAYS WITH A SIGNIFICANT RISK OF WILDFIRE // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2050 // MEDIAN VALUE FOR 2050 // LOW VALUE FOR 2050)

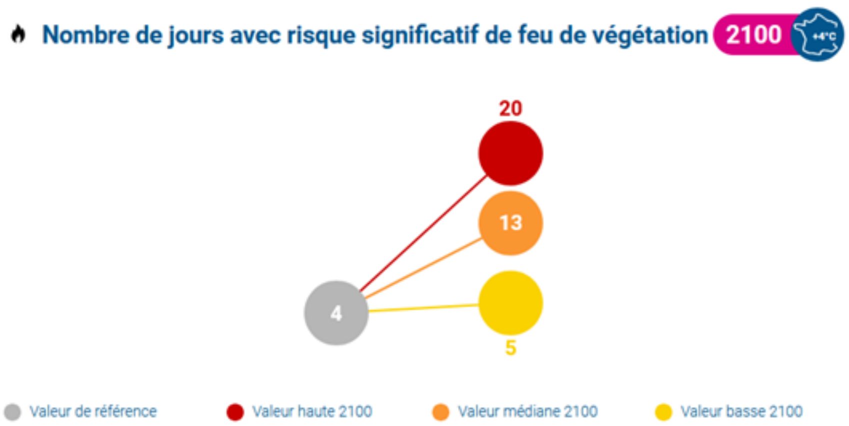


FIGURE 21: CHANGE IN THE NUMBER OF DAYS WITH A SIGNIFICANT RISK OF WILDFIRE BETWEEN THE REFERENCE PERIOD AND 2100. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(NUMBER OF DAYS WITH A SIGNIFICANT RISK OF WILDFIRE // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2100 // MEDIAN VALUE FOR 2100 // LOW VALUE FOR 2100)

The FWI indicator does not mean that there will necessarily be a fire, but that meteorological conditions are favourable for the outbreak and spread of a fire.

The number of days with a significant risk of wildfire doubles by 2050 and triples by 2100. **This increase indicates a rising occurrence of this hazard in the future across the area**.

2.2.6 RAINFALL

2.2.6.1 CURRENT STATUS

Cumulative annual rainfall in Nice is tending to fall. This decline is most significant in spring and summer with a drop of around 50% in spring and 60 % in summer (GREC SUD, 2021).

However, as Figure 22 shows, it is difficult to observe an inter-annual trend indicating a potential decrease in rainfall in the past.

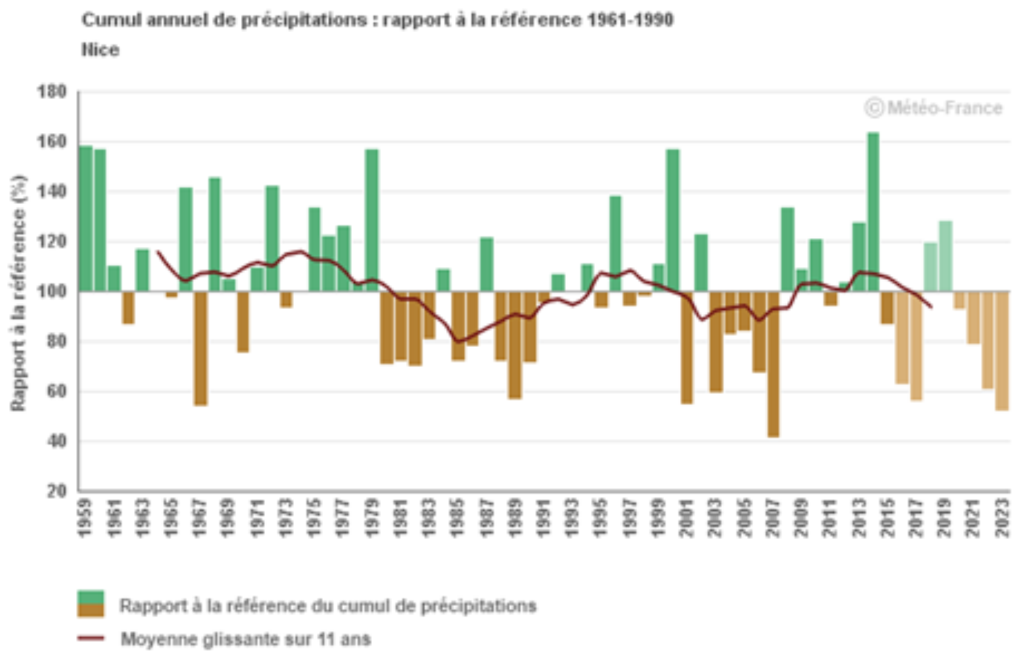


FIGURE 22: RATIO (%) TO NORMAL (1961-1990) CUMULATIVE SUMMER RAINFALL IN NICE. SOURCE: MÉTÉO FRANCE.

(CUMULATIVE ANNUAL RAINFALL: RATIO (%) TO NORMAL (1961-1990) // NICE // LEGEND: RATIO TO NORMAL (%) // RATIO TO NORMAL OF CUMULATIVE RAINFALL // 11-YEAR ROLLING AVERAGE)

2.2.6.2 FUTURE PROJECTIONS

It is more difficult to determine the future trajectory of the indicator showing the number of days of rainfall per season. In 2100, there appears to be a decline in the number of days, which is more or less pronounced depending on the projections, across all seasons. In Villefranche-sur-Mer, the number of days decreases from 11 to 8 in 2100 in summer (Figure 24).

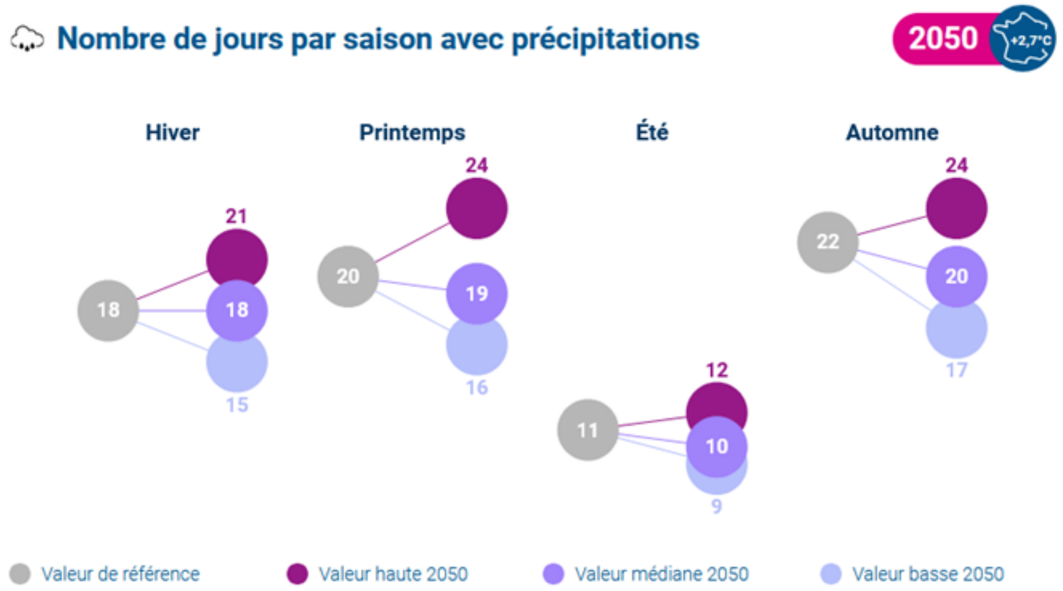


FIGURE 23: CHANGE IN THE NUMBER OF DAYS WITH RAINFALL BETWEEN THE REFERENCE PERIOD AND 2050. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(NUMBER OF DAYS PER SEASON WITH RAINFALL // WINTER // SPRING // SUMMER // AUTUMN // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2050 // MEDIAN VALUE FOR 2050 // LOW VALUE FOR 2050)

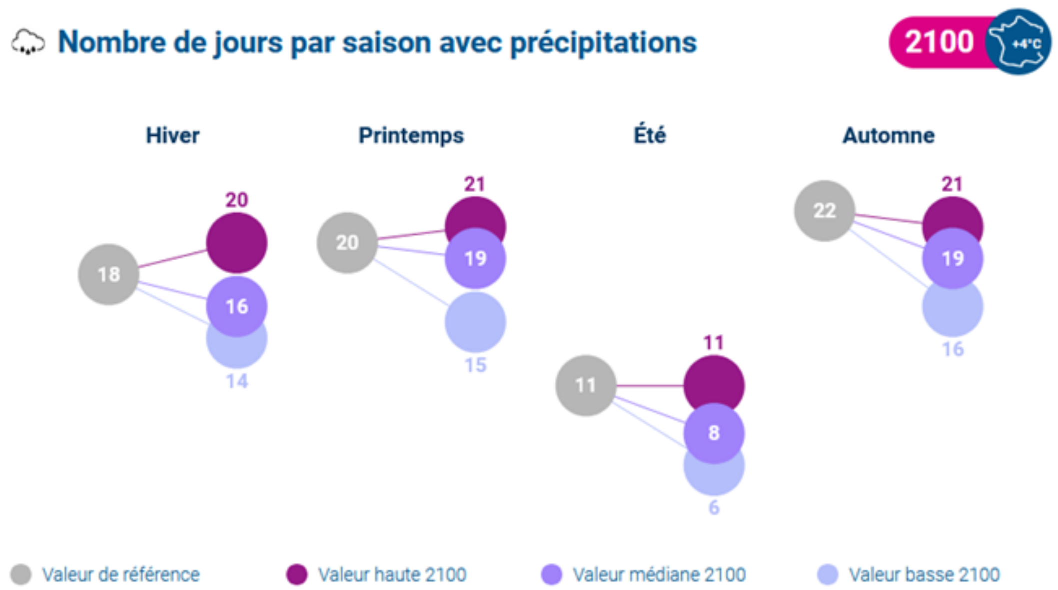


FIGURE 24: CHANGE IN THE NUMBER OF DAYS WITH RAINFALL BETWEEN THE REFERENCE PERIOD AND 2100. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(NUMBER OF DAYS PER SEASON WITH RAINFALL // WINTER // SPRING // SUMMER // AUTUMN // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2100 // MEDIAN VALUE FOR 2100 // LOW VALUE FOR 2100)

The change in this indicator remains limited, with a **slightly downward trend**.

On this subject, the IPCC states that according to projections in the Mediterranean region, **rainfall is projected to decrease by around 4% per degree of global warming** (high confidence for global warming levels above 2°C), across all seasons in the central and southern basin, and mainly in summer in the north. (IPCC, Cross-Chapter Paper 4, 2022)

2.2.7 Extreme rainfall or Mediterranean rainfall events

2.2.7.1 Current status

Mediterranean extreme rainfall events are common in the region: on 13 October 1973 in Nice, 191.4mm fell in just a few hours. Further inland in Saint-Martin-Vésubie, the record is 500mm on 2 October 2020 (Storm Alex). There appears to be an **increase in the intensity of these rainfall events (>200mm rainfall) since the 1960s** (+22% with a significant uncertainty range of 7% to 39%), with double the frequency of events exceeding the threshold of 200mm rainfall per day and an increase in the areas affected, although uncertainties remain. (GREC SUD, 2021)

2.2.7.2 Future projections

Considering the number of days per season with heavy rainfall (water quantity exceeding 20mm) or remarkable cumulative daily rainfall (a value that is exceeded on average only one day in 100, i.e. 3 to 4 days a year), it is difficult to identify any trends in these extreme rainfall events.

The number of days with heavy rainfall will change very little between 2050 and 2100. As the figures were virtually stable, only the year 2100 was represented (Figure 25 and Figure 26).

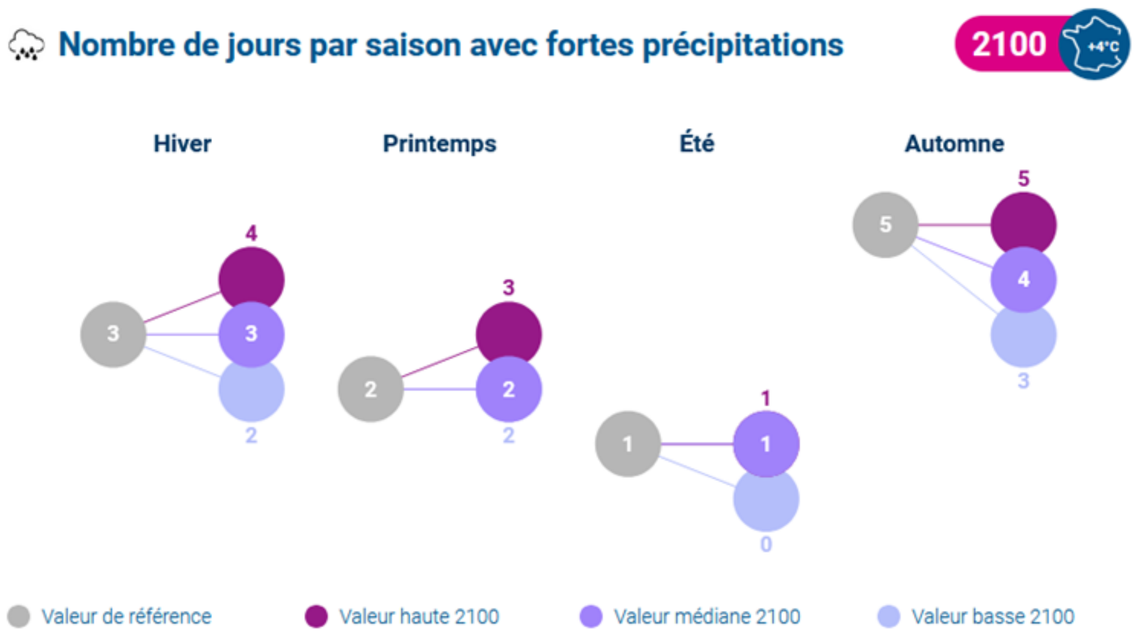


Figure 25: Change in the number of days with heavy rainfall between the reference period and 2100. Source: Climadiag by Météo France.
(Number of days per season with heavy rainfall // Winter // Spring // Summer // Autumn // Legend: Reference value // High value for 2100 // Median value for 2100 // Low value for 2100)

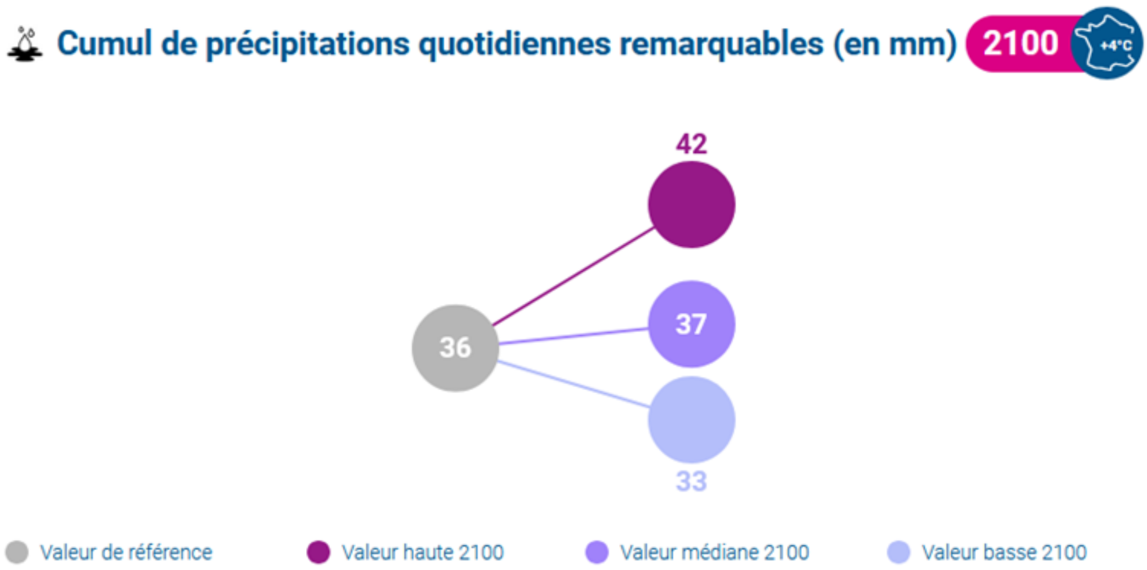


Figure 26: Change in remarkable cumulative daily rainfall between the reference period and 2100. Source: Climadiag by Météo France.
(Remarkable cumulative daily rainfall (in mm) // Legend: Reference value // High value for 2100 // Median value for 2100 // Low value for 2100)

The future trajectory of extreme rainfall events remains uncertain, due to the complexity of the climate mechanisms involved and the high natural variability of these phenomena. Their localised, brief and intense nature makes them particularly difficult to observe and model. However, recent studies carried out in the French Mediterranean region indicate a trend towards an increase in intensity since the 1960s, with an average rise of 22% (range of 7-39%), with double the frequency of very intense events and an extension of the areas affected. These changes are largely attributed to climate change, particularly rising temperatures. Therefore, although uncertainties remain, the projections converge on a **very likely increase in the frequency and intensity of extreme rainfall in the coming decades**. (GREC SUD, 2021)

2.2.8 Water resources in the area

2.2.8.1 Current status

The five municipalities studied benefit from a complex, interconnected water supply system, based mainly on the Vésubie river. The water is transported via a 30km canal to the Super Rimiez treatment plant and then to the Villefranche-sur-Mer treatment plant. Alongside this system is the Mont Alban pumping station in Nice, which pumps water from the Var's alluvial aquifers. In the event of failure of one of these sources, during floods, landslides or a drop in flow, the Roguez station takes over, transporting water from the Var's aquifers to the canal of the Super Rimiez treatment plant, thereby ensuring continuity of the water supply, mainly using gravity to limit the energy consumption of the water transport.

2022 illustrated the vulnerability of this system to climate hazards. An exceptional drought led to the introduction of a decree in March, which was the first of its kind. This was only lifted in December thanks to rainfall which stabilised levels. The aquifers were only recharged in November 2022 following a storm. The Eau d'Azur stakeholders pointed out that a third consecutive year of drought could have compromised the region's water supply. The flow of the Vésubie and the water level in the aquifers had reached an all-time low, meaning that the pumps had to be lowered to offset the drop in level.

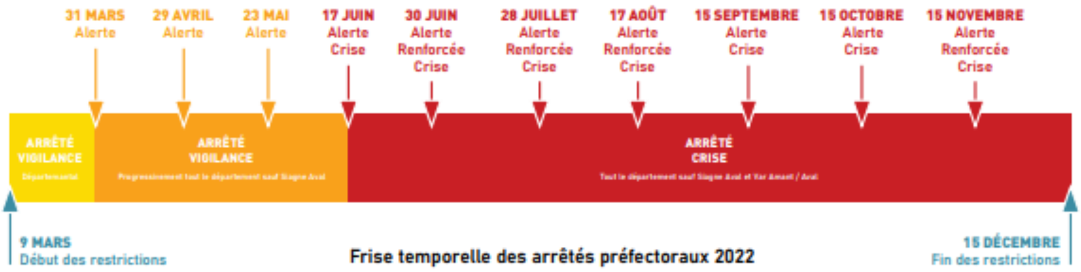


Figure 27: 2022 decrees from the Préfecture concerning the drought. Source: Eau d'Azur
(31 March: Alert // 29 April: Alert // 23 Mai: Alert // 17 June: Crisis Alert // 30 June: Higher Crisis Alert // 28 July: Higher Crisis Alert // 17 August: Higher Crisis Alert // 15 September: Crisis Alert // 15 October: Crisis Alert // 17 November: Higher Crisis Alert // Vigilance decree // Crisis decree // 9 March : Start of restrictions // 15 December: end of restrictions // Time chart of decrees from the Préfecture in 2022)

Concerning uses, tourist pressure is a major factor in resource management. However, the link between tourism and water resources is difficult to identify. By way of illustration, during the drought decrees of 2022, the restrictions that could affect tourists only related to fountains and a few restrictions on filling swimming pools. On the other hand, some coastal municipalities, such as Saint-Jean-Cap-Ferrat, have the highest per capita water consumption in the region. Across the entire metropolitan area, the extra consumption linked to tourism is estimated to represent an additional population of 100,000 residents, within a metropolis that has around 570,000 year-round residents.

2.2.8.1.1 Future situation

The effects of climate change will undoubtedly weaken the availability of this resource and are already being felt by water managers. They note that the snowpack is recharging less in winter, and that glaciers are on the verge of disappearing in the coming years. Extreme weather events, which are becoming more and more frequent, are also putting a strain on transport infrastructure. Prolonged droughts affect not only the quantity of water available but also its quality, with an increase in sulphate concentrations and the development of algae, leading to eutrophication. Lastly, climate forecasts of rising sea levels suggest a growing risk for coastal water tables, which could become a major issue in the years to come. An HMUC study of resources and uses in the Var catchment area and its alluvial aquifers is currently underway.

Faced with these challenges, a number of courses of action are envisaged, based on both short-term actions (active participation in sharing information about the situation in the Vésubie, searching for leaks through targeted campaigns, investment in back-up water tanks, etc.) and medium-term thinking on resource allocation, water savings (with consumption-based billing) and the search for new resources, via other back-up abstractions, etc.

Communication campaigns aimed at tourists have already been implemented:

Campagne de communication du CIEAU été 2022

FIGURE 28: EXAMPLE OF A WATER-SAVING COMMUNICATION CAMPAIGN AIMED AT TOURISTS - SOURCE: EAU D'AZUR
(CIEAU COMMUNICATION CAMPAIGN, SUMMER 2022)

2.2.9 CLAY SHRINK-SWELL

2.2.9.1 CURRENT STATUS

This phenomenon occurs when clay soil shrinks during periods of drought and swells when it rains again. With climate change, temperatures are rising and rainfall is becoming more irregular, making soils more sensitive to these variations. Clay shrink-swell is now the **natural hazard that causes the most damage to buildings in France**.

In view of the classification of the municipalities around the MPA at level 2/3 on the government's Géorisques portal and the presence of zones with high exposure on the BRGM map (Figure 29) to the clay shrink-swell phenomenon in these municipalities, it is worth considering an indicator for this hazard.

FIGURE 29: MAP OF THE CLAY SHRINK-SWELL HAZARD AROUND THE MPA. SOURCE: BRGM.

2.2.9.2 FUTURE PROJECTIONS

A day is considered to have dry soil when the soil water index (SWI) is less than 0.4. By 2100, for these municipalities, the rise in temperature across the whole area will mean an increase in the number of days with dry soil. One of the consequences will be an increase in the risk of damage to buildings as a result of clay shrink-swell (Climadiag, Météo France). Here in Villefranche-sur-Mer, the number of days with dry soil would increase across all seasons by 2050 and 2100 (Figure 30 and Figure 31).

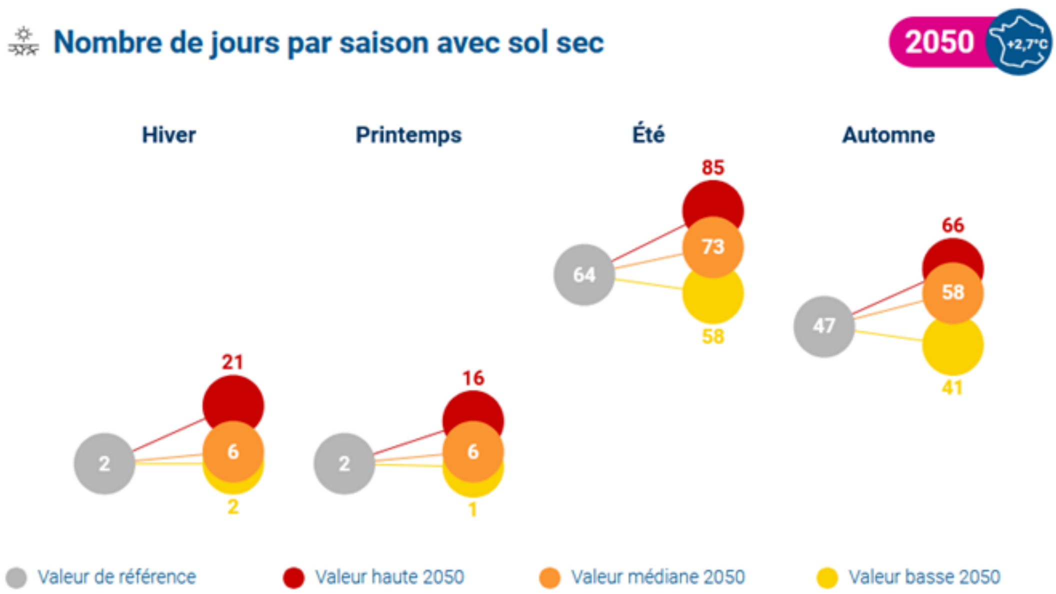


FIGURE 30: CHANGE IN THE NUMBER OF DAYS WITH DRY SOIL BETWEEN THE REFERENCE PERIOD AND 2050. SOURCE: CLIMADIAG BY MÉTÉO FRANCE.
(NUMBER OF DAYS PER SEASON WITH DRY SOIL // WINTER // SPRING // SUMMER // AUTUMN // LEGEND: REFERENCE VALUE // HIGH VALUE FOR 2050 // MEDIAN VALUE FOR 2050 // LOW VALUE FOR 2050)

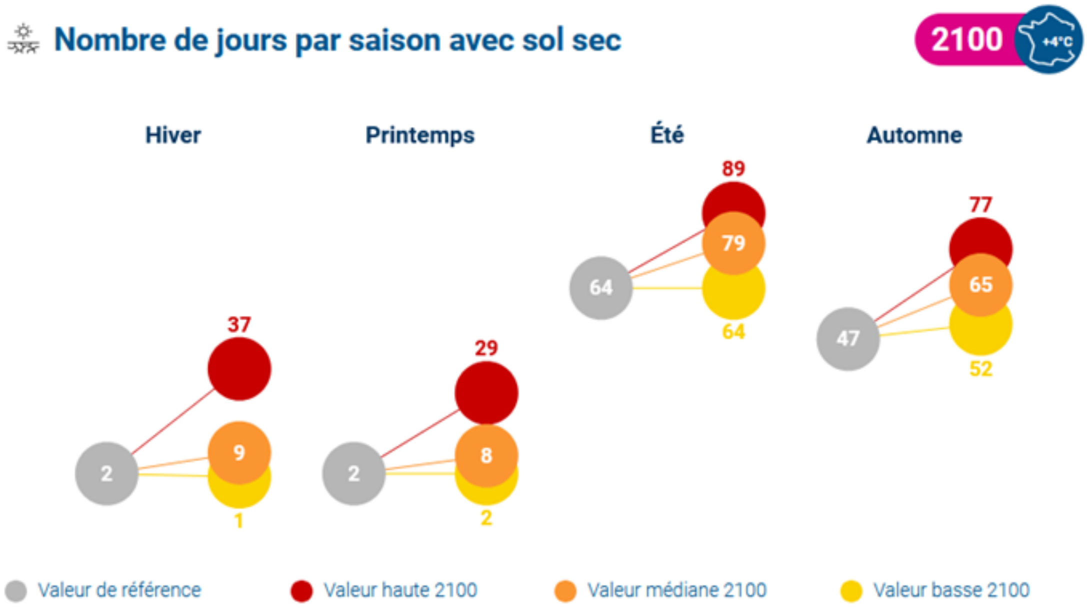


Figure 31: Change in the number of days with dry soil between the reference period and 2100. Source: Climadiag by Météo France.
(Number of days per season with dry soil // Winter // Spring // Summer // Autumn // Legend: Reference value // High value for 2100 // Median value for 2100 // Low value for 2100)

2.2.10 Storms and flooding

2.2.10.1 Current status

Flooding events are determined by local and temporary physical phenomena. Several variables come into play and, through the cumulative effect of their interactions, can lead to coastal flooding.

Examples of physical phenomena include:

- **Astronomical tide (elevation due to gravitational forces):**

Although limited in the Mediterranean, the average tidal range in the Bay of Nice is around 21cm. This limited tidal range makes astronomical tides less significant than the effects of variations in atmospheric pressure on sea level.

- **Barometric tide (storm surge):**

A barometric tide is a local variation in sea level caused by an atmospheric depression, resulting in a surge added to the water level. This phenomenon occurs during certain types of weather event.

- **Wind-induced tide:**

Winds, depending on their direction, intensity and coastal topography, can influence the coastline. By pushing masses of surface water towards specific points on the coast, winds also contribute to storm surge phenomena.

- **Urban run-off:**

This phenomenon can occur in a very uneven and built-up city and in a climate prone to intense rainfall over short periods, which can overwhelm drainage systems. In this case, rainwater flows directly into the outflows of coastal districts and, when combined with high sea levels, can trigger or exacerbate coastal flooding. This hazard is therefore considered an aggravating factor in marine flooding events.

- **State of the sea (waves / choppiness):**

The series of waves cause very localised variations in water level, which can lead to the overflow of coastal structures.

Analysis of past events is based on the CATNAT decrees. These are issued as official acknowledgements of natural disasters.

For the municipalities considered in this study, several events have been recorded under the hazard category, "Mechanical impacts due to wave action" (relating to the energy generated by the swell, capable of destroying human installations under the effect of the pressure generated[17]).

However, the CATNAT reports clearly refer to flooding caused by wave action. A total of 10 events were recorded during the 2000-2025 period:

- 2 October 2020
- 20 December 2019
- 23 November 2019
- 29 October 2018
- 8 November 2011
- 4 May 2010
- 14 December 2008
- 30 November 2008
- 31 October 2003
- 5 November 2000

It should be noted that the content of these decrees does not allow for the precise qualification of the intensity of the climate impacts. It provides information on the occurrence of climate events that have caused significant material damage.

As it stands, it is complicated to reflect the intensity of the hazard associated with marine flooding. Feedback from the *département* primarily concerns rainfall-related flooding (mainly inland). The lack of data also reflects the moderate intensity of these events at present.

To complete analysis on this subject, it would be useful to carry out a campaign of interviews with people affected by marine flooding and/or mechanical wave impact to obtain a more detailed understanding of the types of damage that can occur for a given climate event.

[17] Source: GEORISQUES

TABLEAU 1: EVENTS RECORDED IN THE CATNAT DECREES. SOURCE: LEGIFRANCE.

code CATNAT	Commune	Libélé du risque	date de début	Aléa constaté
INTE2026671A	Beaulieu-sur-Mer	Chocs Mécaniques liés à l'action des Vagues	02/10/2020 00:00	Inondations et coulées de boue / Inondations par choc mécanique des vague
	Cap-d'Ail	Chocs Mécaniques liés à l'action des Vagues		
	Saint-Jean-Cap-Ferrat	Chocs Mécaniques liés à l'action des Vagues		
	Villefranche-sur-Mer	Chocs Mécaniques liés à l'action des Vagues		
INTE2005870A	Cap-d'Ail	Chocs Mécaniques liés à l'action des Vagues	20/12/2019 00:00	Inondations par choc mécanique des vagues
INTE2000953A	Beaulieu-sur-Mer	Chocs Mécaniques liés à l'action des Vagues	23/11/2019 00:00	Inondations par choc mécanique des vagues
	Cap-d'Ail	Chocs Mécaniques liés à l'action des Vagues		
INTE2014521A	Villefranche-sur-Mer	Chocs Mécaniques liés à l'action des Vagues		
INTE1910693A	Cap-d'Ail	Chocs Mécaniques liés à l'action des Vagues	29/10/2018 00:00	Inondations par choc mécanique des vagues
IOCE1134317A	Beaulieu-sur-Mer	Chocs Mécaniques liés à l'action des Vagues	08/11/2011 00:00	Inondation et choc mécanique liés à l'action des vagues
	Cap-d'Ail	Chocs Mécaniques liés à l'action des Vagues		
	Saint-Jean-Cap-Ferrat	Chocs Mécaniques liés à l'action des Vagues		
	Villefranche-sur-Mer	Chocs Mécaniques liés à l'action des Vagues		
IOCE1015123A	Beaulieu-sur-Mer	Chocs Mécaniques liés à l'action des Vagues	04/05/2010 00:00	Inondation et choc mécanique liés à l'action des vagues
	Cap-d'Ail	Chocs Mécaniques liés à l'action des Vagues		
	Saint-Jean-Cap-Ferrat	Chocs Mécaniques liés à l'action des Vagues		
	Villefranche-sur-Mer	Chocs Mécaniques liés à l'action des Vagues		
IOCE0911363A	Villefranche-sur-Mer	Chocs Mécaniques liés à l'action des Vagues	14/12/2008 00:00	Inondation et choc mécanique liés à l'action des vagues
	Villefranche-sur-Mer	Chocs Mécaniques liés à l'action des Vagues		
	Villefranche-sur-Mer	Chocs Mécaniques liés à l'action des Vagues	30/11/2008 00:00	Inondation et choc mécanique liés à l'action des vagues
	Villefranche-sur-Mer	Chocs Mécaniques liés à l'action des Vagues		
INTE0400220A	Cap-d'Ail	Chocs Mécaniques liés à l'action des Vagues	31/10/2003 00:00	Inondation et choc mécanique liés à l'action des vagues
	Saint-Jean-Cap-Ferrat	Chocs Mécaniques liés à l'action des Vagues		
	Villefranche-sur-Mer	Chocs Mécaniques liés à l'action des Vagues		
INTE0100107A	Beaulieu-sur-Mer	Chocs Mécaniques liés à l'action des Vagues	05/11/2000 00:00	Inondation et choc mécanique liés à l'action des vagues
	Cap-d'Ail	Chocs Mécaniques liés à l'action des Vagues		
INTE0100107A	Saint-Jean-Cap-Ferrat	Chocs Mécaniques liés à l'action des Vagues	06/11/2000 00:00	Inondation et choc mécanique liés à l'action des vagues
	Villefranche-sur-Mer	Chocs Mécaniques liés à l'action des Vagues		

(CATNAT CODE // MUNICIPALITY // DESCRIPTION OF RISK // START DATE // OBSERVED HAZARD // MECHANICAL IMPACTS DUE TO WAVES // FLOODING AND MUDSLIDES / FLOODING VIA MECHANICAL IMPACT OF WAVES // FLOODING VIA MECHANICAL IMPACT OF WAVES // FLOODING AND MECHANICAL IMPACT OF WAVES)

TABLE 2: OBSERVED OCCURRENCES OF FLOODING RISK BY MUNICIPALITY IN THE CATNAT DATABASE.

	Occurrence (out of 10)
Beaulieu-sur-Mer	5
Cap-d'Ail	8
Saint-Jean-Cap-Ferrat	5
Villefranche-sur-Mer	10

A higher number of events is observed for the municipalities of Villefranche-sur-Mer and Cap d'Ail, which may indicate greater exposure to real coastal flooding risks. For example, of the 10 weather events recorded, Villefranche-sur-Mer was declared a natural disaster zone in all of them. This increased exposure is likely to persist under the influence of climate change.

2.2.10.2 FUTURE PROJECTIONS

2.2.10.2.1 FUTURE PROJECTIONS OF AVERAGE SEA-LEVEL RISE

On a global scale, observations indicate a rise in sea level of around 1.7 - 2 mm per year throughout the 20th century, around 3.5 mm per year in the early 21st century, and projections estimate values of between 4 and 8 mm per year in the second half of this century - or even more if the melting of the ice caps occurs more quickly than currently anticipated (GREC SUD, 2021).

According to the SSP5-8.5 scenario, a sea-level rise of around 0.68 metres is considered for 2100, compared with the 1995-2014 reference period, with a likely range of between 0.55 and 0.90 metres.

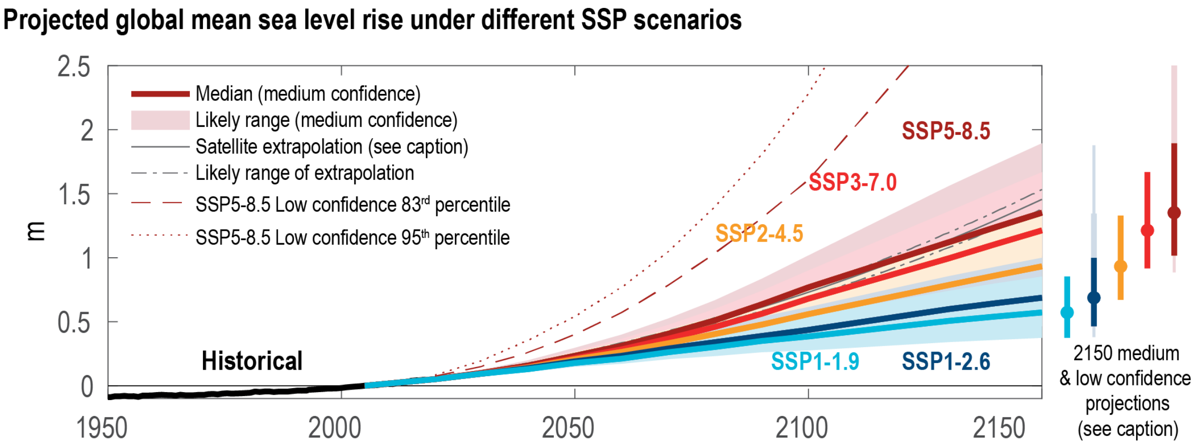


FIGURE 32: SEA LEVEL PROJECTION BASED ON SSP SCENARIOS. SOURCE: IPCC AR6

This level should, by analogy, be considered as a **definition of static sea level**. This level is not directly responsible for flooding events, but it does increase the exposure of coastal areas whose infrastructure was designed for a lower static water level.

For example, sea levels are expected to rise by **65 cm (0.63 - 1.02 m) by 2100** compared with 1950 (SSP5-8.5).

2.2.10.2.2 FUTURE FLOODING PROJECTIONS

The effects of climate change on these levels are difficult to model and confidence levels for long-term projections (for 2100) are relatively low. However, the studies conducted by Vousdoukas et al.[18] in 2018 are among the few that have attempted to model extreme coastal weather events on a global scale. These studies served as the basis for the IPCC reports (AR5 and AR6).

According to their findings, **in the Mediterranean region, events currently considered 100-year events (around 0.80 m ASL) are expected to occur annually by 2100** (Figure 33). This forecast was made as part of the SSP2-4.5 scenario. **In the SSP5-8.5 scenario, these events are expected to occur several times per year.**

[18] Vousdoukas, M. I., et al. (2018). Global Probabilistic Projections of Extreme Sea Levels Show Intensification of Coastal Flood Hazard. Nature Communications, 9(1), 2360. https://doi.org/10.1038/s41467-018-04692-w

A storm like the one on 24/11/2019 (Tableau 1) would be classified as a once-in-a-decade event.

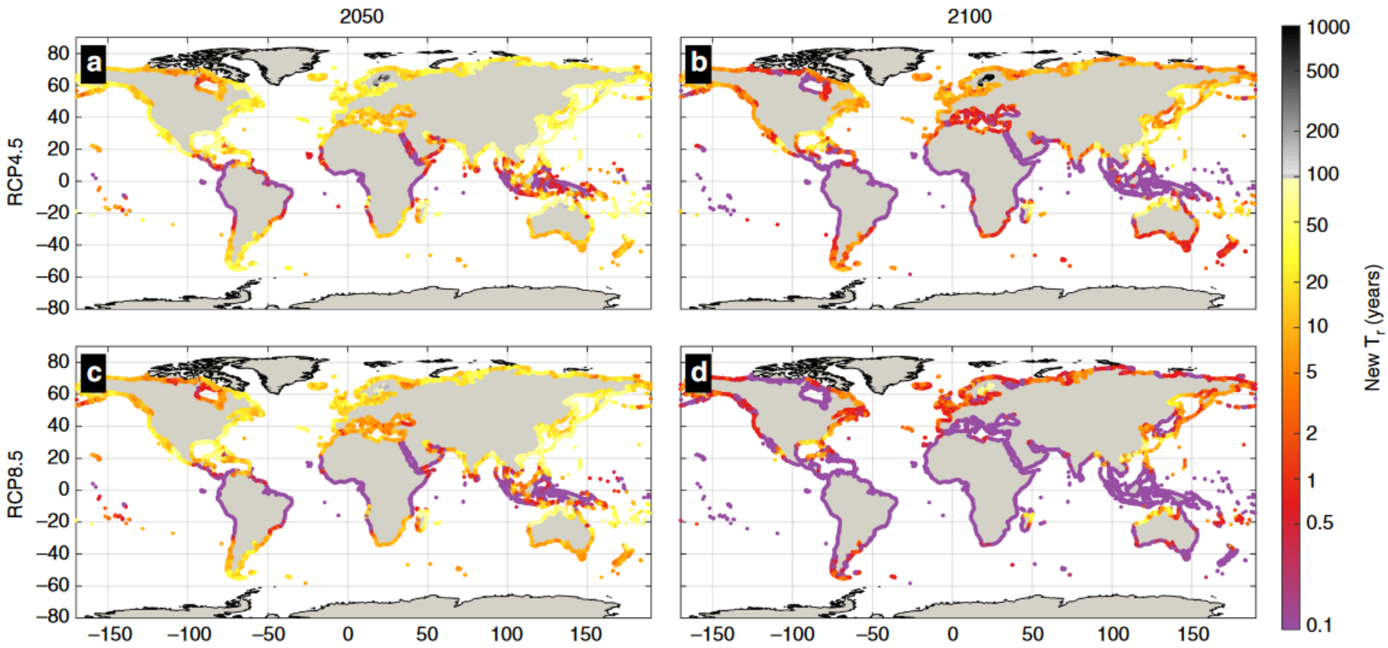


FIGURE 33: REPRESENTATION OF FUTURE RECURRENCE INTERVALS FOR A 100-YEAR EVENT (WATER LEVEL) IN 2050 AND 2100 ACCORDING TO TWO EMISSIONS SCENARIOS (RCP 4.5 AND 8.5). SOURCE: VOUSDOUKAS ET AL., 2018.

2.2.11 SEA TEMPERATURE

2.2.11.1 CURRENT STATUS

Over the period of 2007-2019, the surface water temperature[19] in the bay of Villefranche-sur-Mer rose by 0.65°C per decade, which is significantly faster than the global average and the average for coastal oceans (GREC SUD, 2021).

[19] Temperature measured in the top centimetres of the water column. It is a key indicator of ocean and climate dynamics.

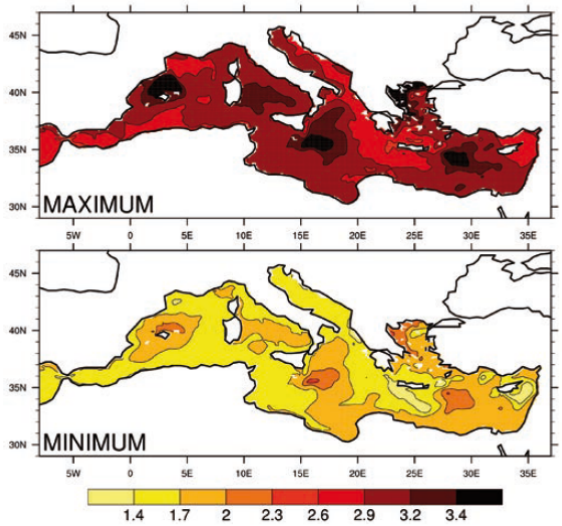


FIGURE 34: MAP OF MINIMUM AND MAXIMUM SURFACE TEMPERATURE ANOMALIES (IN °C) IN THE LATE 21ST CENTURY (COMPARED WITH THE LATE 20TH CENTURY) ESTIMATED BY A SET OF SIX SIMULATIONS. SOURCE: ADLOFF ET AL.[20], 2015, GREC-PACA, 2017)

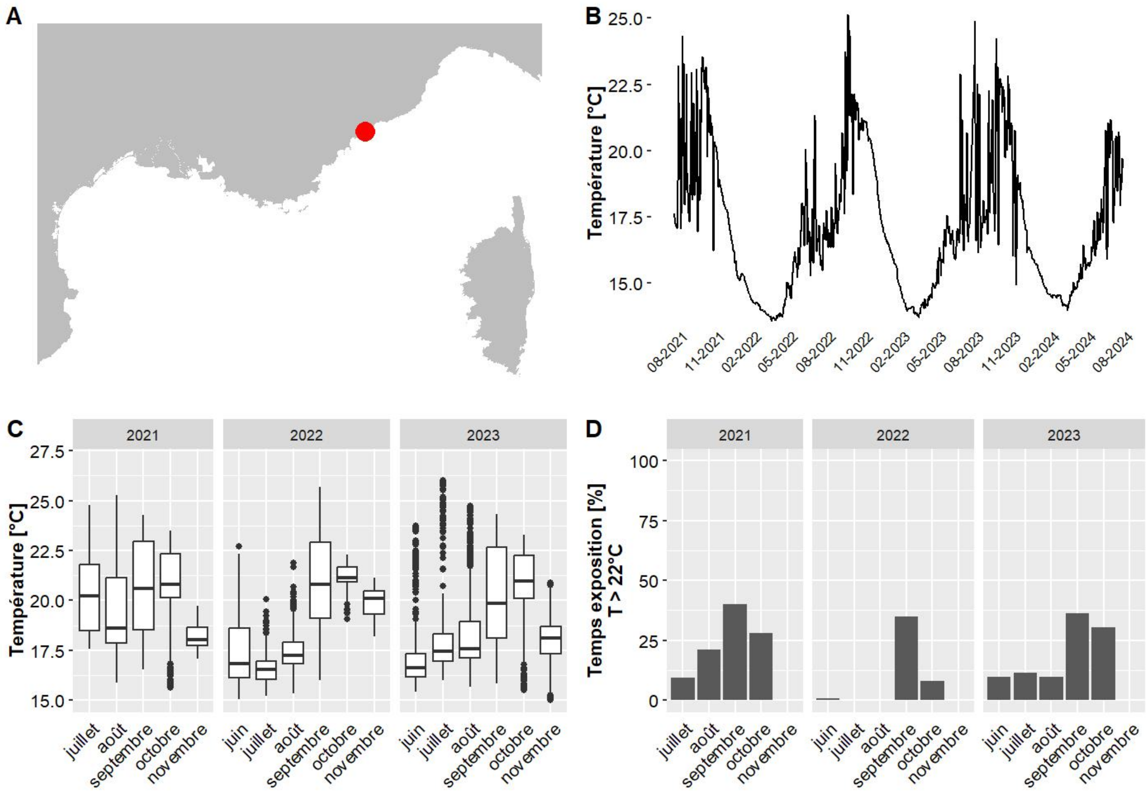


FIGURE 35: MONITORING OF THE TEMPERATURE IN THE BAY OF BEAULIEU-SUR-MER AT A DEPTH OF 29.1 METRES BETWEEN 2021 AND 2024. SOURCE: MEDTRIX.
(TEMPERATURE [°C] // EXPOSURE TIME [%] T > 22°C // JUNE // JULY // AUGUST // SEPTEMBER // OCTOBER // NOVEMBER)

[20] Adloff, F., et al. (2015). *Mediterranean Sea Response to Climate Change in an Ensemble of Twenty First Century Scenarios*. Climate Dynamics, 45(9), 2775–2802. https://doi.org/10.1007/s00382-015-2507-3

The warming of marine waters is gradually becoming apparent at depth, as shown by readings at 29.1 metres in the bay of Beaulieu-sur-Mer (Figure 35). Although this change is not very noticeable at the moment, it is part of a global trend linked to climate change. In the long term, the intensification of summer heat waves could accentuate this phenomenon, with significant impacts on aquatic ecosystems, particularly in terms of oxygenation, biodiversity and habitat stability.

Moreover, underwater heat waves can have a strong impact over shorter periods. For example, in 2023, marine heat waves were recorded in the Mediterranean, with temperature anomalies reaching 5.5°C above average.

2.2.11.2 Future projections

The IPCC predicts an increase of 2.7°C by 2100 compared with the 1970-2005 reference period (under SSP5-8.5). In addition, **marine heat waves are expected to become more frequent, more intense and longer.**

The Mediterranean basin is warming around 20% faster than the average for the rest of the world. The Mediterranean Sea is the world’s largest semi-enclosed sea. The waters of the Mediterranean Sea are replenished slowly and are highly sensitive to global warming. As the water warms, it evaporates, increasing the concentration of heat and humidity in the Mediterranean atmosphere.

Although temperature is not a primary variable in assessing vulnerability, it has consequences on ocean acidification, O2 availability and ocean stratification, leading to the loss of certain biotopes (and their associated ecosystem services).

For example, **with more frequent, intense and longer marine heat waves, many habitats will be affected (particularly Posidonia seagrass and gorgonian coral)**, resulting in a loss of habitat and associated ecosystem services, such as the provision of habitats for many species (supporting local fisheries), a decrease in carbon sequestration and mitigation of the impact of storm surges and associated erosion.

2.2.12 Acidification of the sea

2.2.12.1 Current status

Weekly measurements taken in the bay of Villefranche-sur-Mer since 2007 clearly show a decrease in pH. The decline is 0.028 units per decade, which is comparable to measurements taken in other regions of the world. It is estimated that ocean acidity has increased by around 30% since the start of the industrial revolution and could triple by 2100, depending on future trends in CO_2 emissions. (GREC-PACA, 2017).

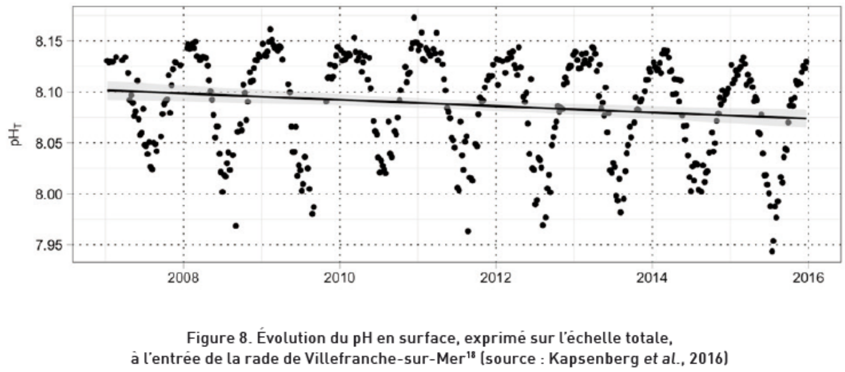


FIGURE 36: CHANGE IN SURFACE PH, EXPRESSED ON THE TOTAL SCALE AT THE ENTRANCE TO THE BAY OF VILLEFRANCHE-SUR-MER. SOURCE: KAPSENBERG ET AL.[21], 2016, GREC PACA, 2017)
(FIGURE 8. EVOLUTION OF SURFACE PH, EXPRESSED ON THE TOTAL SCALE, AT THE ENTRANCE OF THE VILLEFRANCHE-SUR-MER HARBOUR18 [SOURCE: KAPSENBERG ET AL., 2016])

2.2.12.2 FUTURE PROJECTIONS

As previously mentioned, pH values are linked to temperature data. They will therefore change in similar proportions.

The increase in ocean acidification, like the increase in temperature, is leading to **significant changes in the physical and chemical conditions of the marine environment**. The increasing uptake of atmospheric CO_2 by the ocean increases the concentration of dissolved CO_2, which **reduces the pH of the water** and decreases the availability of calcium carbonate ($CaCO_3$), an element essential for **biocalcification**. This process directly affects calcifying organisms such as shellfish, corals, coralligenous and fixed species like seagrass beds. These changes **will affect the most sensitive ecosystems** and impair how ecosystem services function (e.g., attenuation of wave energy on beaches provided by seagrass and coralligenous reefs).

2.2.13 RECEDING COASTLINE

2.2.13.1 CURRENT STATUS

EROSION DYNAMICS OVER SEVERAL YEARS (CHRONIC RECESSION)

To date, no significant potential changes to the coastal profile (chronic recession) have been reported in the metropolitan area. More specifically, there do not appear to be any trends associated with extreme swells between 1979 and 2005, and although the relationship between marine storm surges and pressure fields is evident in the region, trends indicating an increase have yet to be confirmed. **The signal remains uncertain and too weak to result in accelerated coastal erosion.**

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[21] Kapsenberg, L., & Hofmann, G. E. (2016). *Ocean pH Time-series and Drivers of Variability along the Northern Channel Islands, California, USA*. Limnology and Oceanography, 61(3), 953–968. https://doi.org/10.1002/lno.10264.

On the other hand, it is certain that over time, **human developments in urbanisation have encroached on the natural coastal mobility zone**[22]. The low erosion rate has led to a skewed human perception and has contributed to coastal development very close to the shoreline.

To date, recession measured from multi-year data shows negligible variation within the study area. Over the observation period from 1924 to 2011, the beaches are generally stable, although a slight recession (0.5 m per year) has been observed on the beaches of Èze.

This data reflects long-term recession trends and does not account for storm-induced erosion.

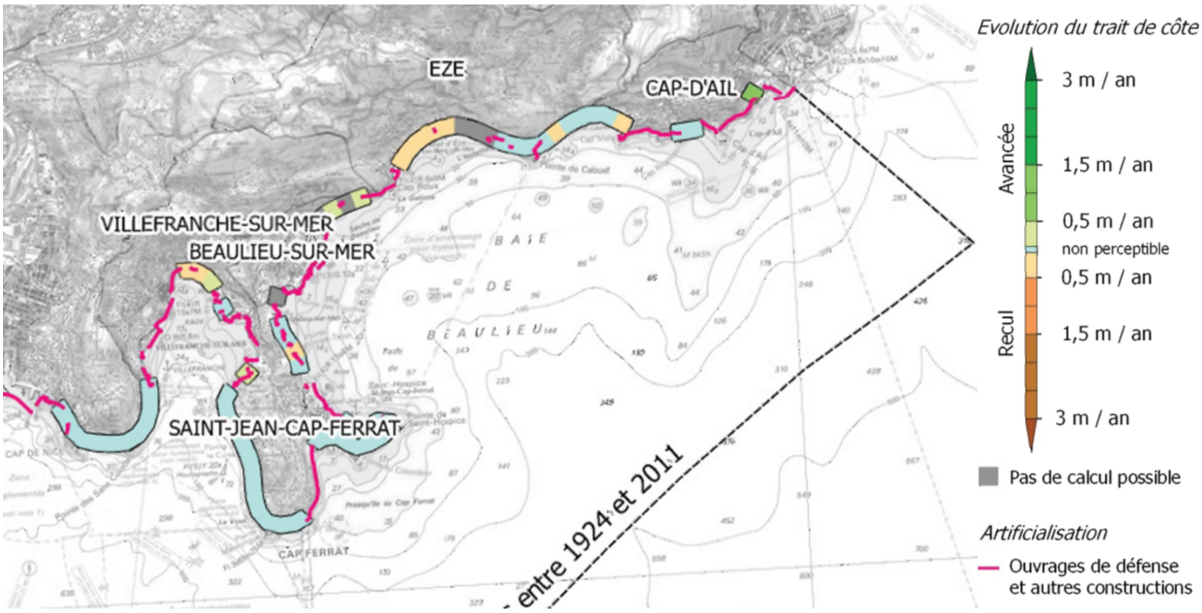

FIGURE 37: EROSION DYNAMICS IN THE STUDY AREA. SOURCE: NATIONAL COASTAL EROSION INDICATOR, CEREMA, OCTOBER 2015.
(EVOLUTION OF COASTLINE // ADVANCE // RECESSION /// YEAR // IMPERCEPTIBLE // NO CALCULATION POSSIBLE // ARTIFICIALISATION // DEFENSIVE WORKS AND OTHER CONSTRUCTION)

Chronic recession does not have a particularly strong short-term effect on the sustainability of human activities and facilities, however, extreme events (storms, etc.) have an acute and temporary impact. This considerably increases the vulnerability of these structures, particularly in the face of extreme events, which have sudden and severe impacts.

It is also worth noting that the municipality of Èze is listed in the government's official publication (2022) as one of the 126 priority municipalities for tackling coastal erosion. The

[22] The natural coastal mobility zone is the area in which the shoreline moves naturally under the effect of erosion, storms or rising water. In the South, tourist and residential developments have been built too close to the shore, exposing them directly to coastal hazards without being able to prevent them.

inclusion of Èze on this list is due more to the concentration of facilities and housing close to the shore than to the recession dynamics themselves.

STORM EROSION

This variable is more difficult to assess in the study area due to the absence of data and the regular monitoring of storms. In any case, **the beaches identified as experiencing slight erosion (or as balanced) in the previous figure undergo annual replenishment.**

It is therefore important to distinguish between “trend-based” shoreline recession and post-storm recession. Replenishment is a response to a loss of material caused by storm events (usually in winter).

It is also worth noting that storms do not cause uniform erosion on beaches. This means that certain stretches (those most exposed to swell) will be more affected and the facilities behind them more threatened by storms (mechanical impacts from waves and occasional flooding).

TABLE 3: QUANTITIES OF MATERIALS BROUGHT IN TO REPLENISH THE BEACHES MANAGED BY THE NICE CÔTE D'AZUR METROPOLIS BETWEEN 2020 AND 2024 - SOURCE: NICE CÔTE D'AZUR METROPOLIS

	Quantities of materials brought in (tonnes)					
	2020	**2021**	**2022**	**2023**	**2024**	**Total**
Beaulieu - Fourmis	300	300	300	0	0	900 tonnes
Beaulieu - Petite Afrique	300	350	400	0	0	1050 tonnes
Eze	-	-	950	800	800	2550 tonnes
Cap d'Ail	300	400	400	400	400	1900 tonnes

For example, Le Marquet beach in Cap d'Ail has demonstrated a stable profile over the last three years. This stability has been maintained thanks to replenishment operations, which amount to around 400 tonnes a year for all the municipality's beaches.

The intensity of winter erosion is correlated with storm events.

At present, the data available does not allow us to assess the recession values associated with a specific event. We are therefore unable to quantify the retreat of the coastline due to storm events.

2.2.13.2 FUTURE PROJECTIONS

The beaches of the bay of Villefranche-sur-Mer et Beaulieu-sur-Mer, are apparently stable but, in reality, are retreating very slowly, and will gradually be submerged. Around 50% of their current surface area is expected to disappear, but their inland migration is hindered by physical barriers (or solid protective walls) such as rock escarpments, parapets or seawalls.

Although the effects of climate change on shoreline recession cannot yet be quantified with a high level of confidence, a continued rise in sea level is nevertheless expected. This trend will intensify the mechanical erosion processes affecting beaches that are already vulnerable (and is also likely to have an impact on coastal areas that have been spared until now).

The beaches in the study area rest on a hard substrate. As a result, erosion will be considerably slowed down in contact with this substrate. However, sediment loss will continue (which could lead to the depletion of sediment stocks if no additional measures are implemented). **As the area is experiencing a sediment deficit, the beaches will continually lose sediment (small pebbles)**, which will have an impact on the beach gradient.

Increasing the slope of the beach will increase the impact of waves on shoreline installations as the steeper slope will reduce the beach's capacity to dissipate hydrodynamic forces. In the event of a storm, the damage to these structures is likely to be greater

2.2.14 SUMMARY OF MARITIME HAZARDS AND ANTICIPATED IMPACTS ON THE ECOSYSTEM

It is widely recognised that the risks described above (in particular, temperature rise, acidification, etc.) will have significant impacts on the sustainability of ecosystems and their functions. While it is relatively simple to assess the effect of a single hazard on a specific species, it is much more complex to anticipate the effects of multiple and simultaneous hazards on a species within a given ecosystem. This complexity results from the cumulative effects and cascading interactions that can link several species within the ecosystem.

For example, the optimum growth temperature for *Posidonia Oceanica* is between 13°C and 28°C (GREC SUD, 2022). Exceeding these thresholds is likely to have **a negative impact on its development**. The same is true of increased acidification, which tends to cause **deep retreat of the seagrass**. These stressors are likely to inhibit the plant's growth and are considered to be key factors in its decline. Added to this is **the rise in sea level**, which reduces the light available at depth and causes **a regression of the seagrass at the lower levels.** If this rise accelerates, as some scenarios predict (up to 40 mm per year by the end of the century), the Posidonia will no longer be able to keep pace. Meanwhile, shallower areas, where it could theoretically grow, are also becoming inhospitable because of the heat. *Posidonia Oceanica* is thus facing a **double threat** - it is losing ground at depth without being able to regain any on the surface, which is compromising its long-term survival.

At the same time, temperature increase seems to influence the feeding behaviour of herbivorous fish such as the Saupe (*Sarpa salpa*), which tends to graze more on Posidonia meadows in warmer waters, exacerbating the stress on the meadow (Bunuel et al.[23], 2020).

Beach nourishment operations can also affect the growth of seagrass beds. These impacts will vary depending on the depth, as shallow areas are more vulnerable. Uncontrolled beach replenishment in the vicinity of Posidonia meadows could temporarily increase turbidity and smother young shoots, thereby inhibiting the development of the meadow as a biocenosis.

[23] Buñuel, Xavier, et al. "The Dominant Seagrass Herbivore Sarpa Salpa Shifts Its Shoaling and Feeding Strategies as They Grow". *Scientific Reports*, vol. 10, no. 1, June 2020, p. 10622. *www.nature.com*, https://doi.org/10.1038/s41598-020-67498-1.

This, in turn, can reduce the ability of these seagrass beds to mitigate wave energy and stabilise beaches after storms [GONZALEZ-CORREA et al.[24], 2008; ARAGONES et al.[25], 2015].

Coastal marine ecosystems are on the front line of climate change. As well as affecting their growth, the more frequent and intense marine heat waves have also caused mass mortality in certain species, particularly gorgonian coral (Estaque et al.[26], 2024). These species play a major ecological role by providing essential ecosystem services such as shelter and nurseries for a wide variety of marine organisms. Summer 2022 was marked by historic thermal anomalies in the Mediterranean, with surface temperatures exceeding 28°C and anomalies reaching +4.6°C locally. These extreme conditions led to a wave of mass mortality among gorgonian coral, observed from the end of August in the Calanques National Park, before spreading to the whole of the French Mediterranean coastline.

The cumulative impact of these stressors, leading to habitat loss, aggravates the effects of climate change, as it results in the degradation of the protective functions provided by the ecosystem services of Posidonia meadows. Improperly managed beach nourishment could reduce the productivity of a habitat that plays a key role in limiting coastal erosion.

The above information is presented as an example to illustrate the complexity of interactions between ecosystems. Further studies will be needed to gain a better understanding of the dynamics involved.

2.2.15 Summary of the trajectory of hazards

TREND-BASED CHANGES IN THE CLIMATE AROUND THE CAP FERRAT MPA

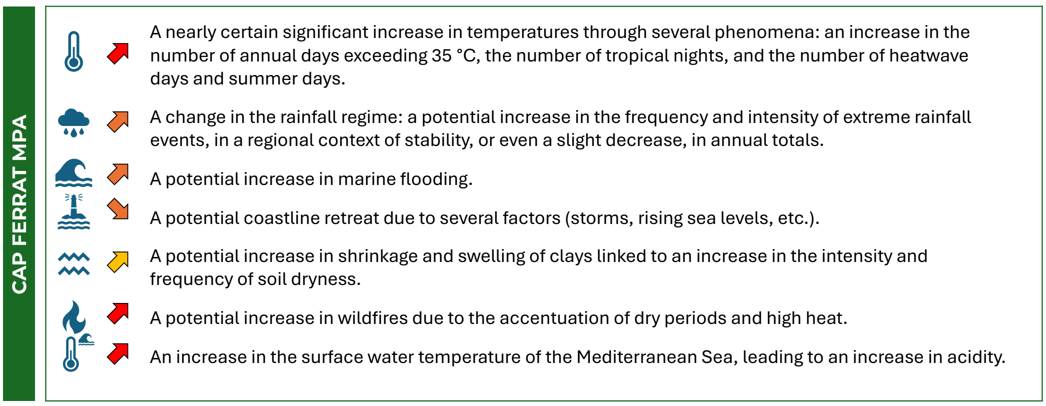

Figure 38: Summary of the business-as-usual trajectory for the climate around the Cap Ferrat MPA. Source: SETEC International.

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[24] González-Correa, José M., et al. "Long-term effect of beach replenishment on natural recovery of shallow *Posidonia oceanica* meadows". *Estuarine, Coastal and Shelf Science*, vol. 76, no. 4, March 2008, p. 834-44. *ScienceDirect*, https://doi.org/10.1016/j.ecss.2007.08.012.

[25] Aragonés, L., et al. "Beach nourishment impact on *Posidonia oceanica*: Case study of Poniente Beach (Benidorm, Spain)". *Ocean Engineering*, vol. 107, October 2015, p. 1-12. *ScienceDirect*, https://doi.org/10.1016/j.oceaneng.2015.07.005.

[26] Estaque, T., Bianchimani, O., Garrabou, J., Hartmann, V., & Cheminée, A. (2024). Intensification des vagues de chaleur marines : État actuel des populations de gorgones rouges (Paramuricea clavata) (30 p.).

3. IDENTIFICATION OF VULNERABILITIES

3.1 DESCRIPTION OF THE SITE AND ITS CHALLENGES

The Cap Ferrat Natura 2000 site (FR 9301996) is a fully marine area covering 8,958 hectares. It is located in the South of France (Provence-Alpes-Côte-d'Azur), in the Alpes-Maritimes *département*, stretching along the coastline of five municipalities: Saint-Jean-Cap-Ferrat, Beaulieu-sur-Mer, Villefranche-sur-Mer, Èze and Cap-d'Ail.

Its boundaries stretch from Pointe de la Gavinette in the west to the sea wall of Marquet beach in the east. Up to 6 nautical miles offshore, the site encompasses part of one of the underwater canyons near Nice, known as the Paillon Canyon.

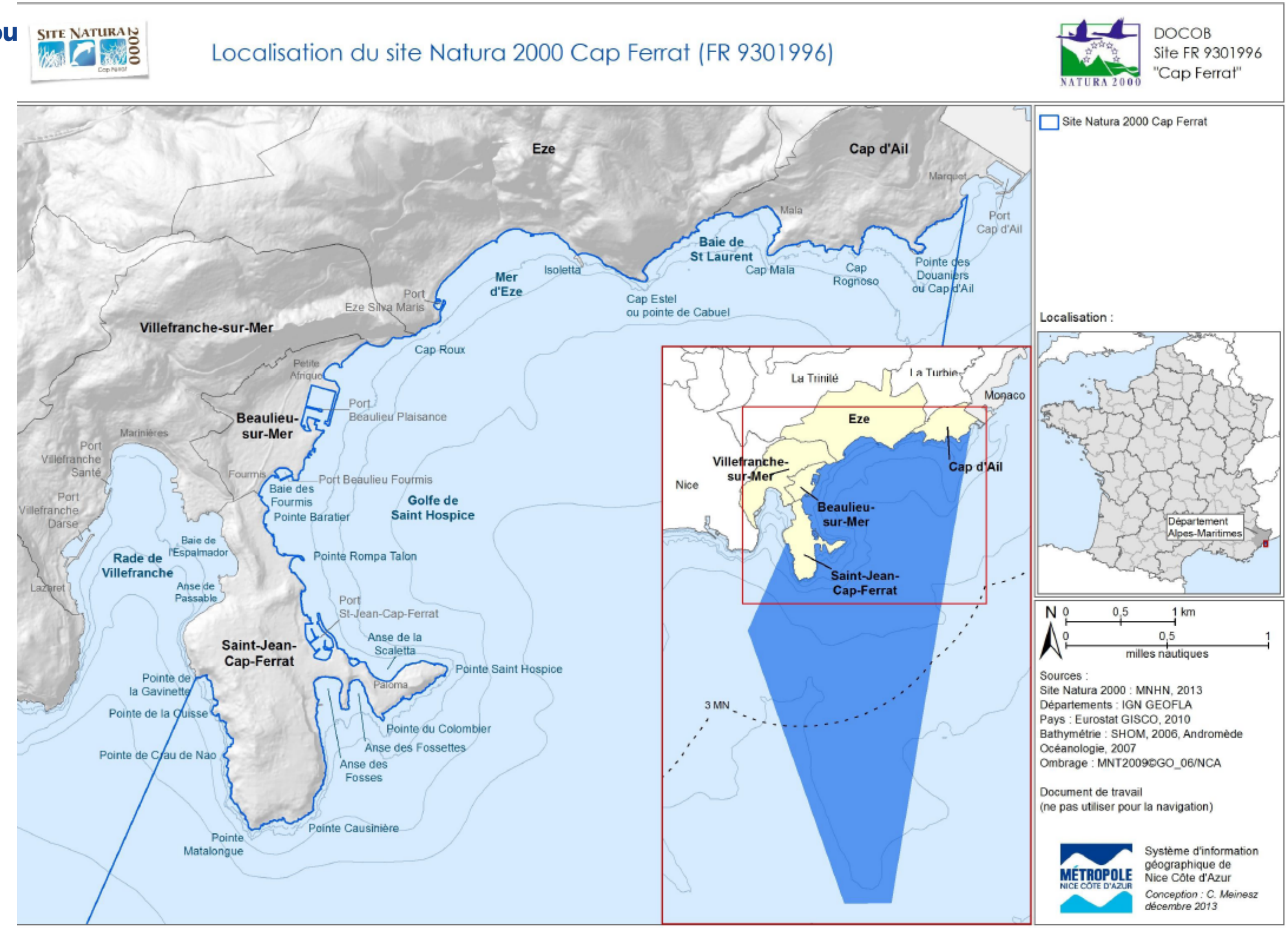


FIGURE 39: MAP SHOWING THE LOCATION OF THE CAP FERRAT MPA. SOURCE: DOCOB CAP FERRAT, 2014.

3.1.1 Demographic context

The MPA site is located in the Alpes-Maritimes *département*, which experienced significant demographic growth in the late 20th century, with its population doubling in fifty years, now exceeding one million inhabitants according to the 2019 census. This increase is mainly the result of positive net migration, which still increased slightly (by 0.17%) over the 2013-2019 period (INSEE).

The *département* has a high coastal concentration, with coastal municipalities accounting for around 65% of the population (INSEE RP 2010), despite representing just 6% of the *département*'s total surface area. This spatial distribution can be explained both by the strong appeal of the coastal strip (tourism, sea-related activities) and by the topographical constraints of the regions' hinterland.

The *département* also has a particularly high proportion of residents aged 60 and over, who account for 31% of the population, compared with less than 17% nationally (BCE2021, PR - 2019).

The municipalities in the MPA follow these same trends, as illustrated in the table below. **The municipalities are also impacted by strong population concentration and summer tourist activity,** with 185,000 annual stays on average.

Table 4: Summary of socio-economic indicators. Source: INSEE.

	France (INSEE)	Alpes-Maritimes (INSEE)	**Study area** (INSEE)
Population	65.8 M inhab.	1,082,440 inhab.	**17,964 inhab.**
Surface area	551,695 km^2	4,299 km^2	**19.91 km^2**
Population density	119 inhabitants per square kilometre	252 inhabitants per square kilometre	**902 inhabitants per square kilometre**
Percentage of vulnerable people (60+)	27.7%	31.9%	**33.4%**
Number of tourist stays	Around 100 M	Around 11 M	**Around 185,000**
Increase in population linked to tourism (approx.)	X 1.5	X 10	**X 10**

The table below shows the main demographic and socio-economic data available for each of the five municipalities studied, providing a better understanding of the local context.

Table 5: Summary of demographic and socio-economic data for the 5 municipalities studied

	Èze	Beaulieu-sur-Mer	Cap d'Ail	Villefranche-sur-Mer	Saint-Jean-Cap-Ferrat
Population (INSEE)	2155	3796	4508	5012	1492
Surface area	9.47 km^2	0.95 km^2	2.13 km^2	4.88 km^2	2.48 km^2
Population density	227 inhab./km^2	3995 inhab./km^2	2116 Inhab./km^2	1027 inhab./km^2	601 inhab./km^2
Percentage of vulnerable people (60+)	33.5%	33.1%	27.1%	56.0%	37%

3.1.2 Socio-economic context

In the Alpes-Maritimes *département*, 72% of jobs are concentrated in local activities, compared with 65% nationally. **Tourism accounts for 12% of total employment, twice the national average (6% in 2019).** Similarly, the retail and real estate sectors account for a higher proportion of jobs than at national level. While businesses are smaller on average as a result of this economic structure, the *département* is also home to a number of **internationally renowned** companies. These include companies specialised in software and technology in the Sophia Antipolis technology park, satellite construction in Cannes, perfumery and essential oils in Grasse, and the pharmaceutical industry on the Carros industrial estate. One example is the **Fragonard laboratory and plant in Èze**, which is open to visitors.

Between 1990 and 2020, employment growth in the *département* was higher than the national average. The biggest increase took place between 1998 and 2007, thanks to the expansion of information technology, scientific and technical services, administrative and support services, construction, public administration, social services, **hospitality and food service**. The financial crisis of 2008 interrupted this growth and impacted the Alpes-Maritimes economy, in line with national trends. From 2014 to 2019, employment increased again, before being affected by the COVID-19 crisis in 2020.

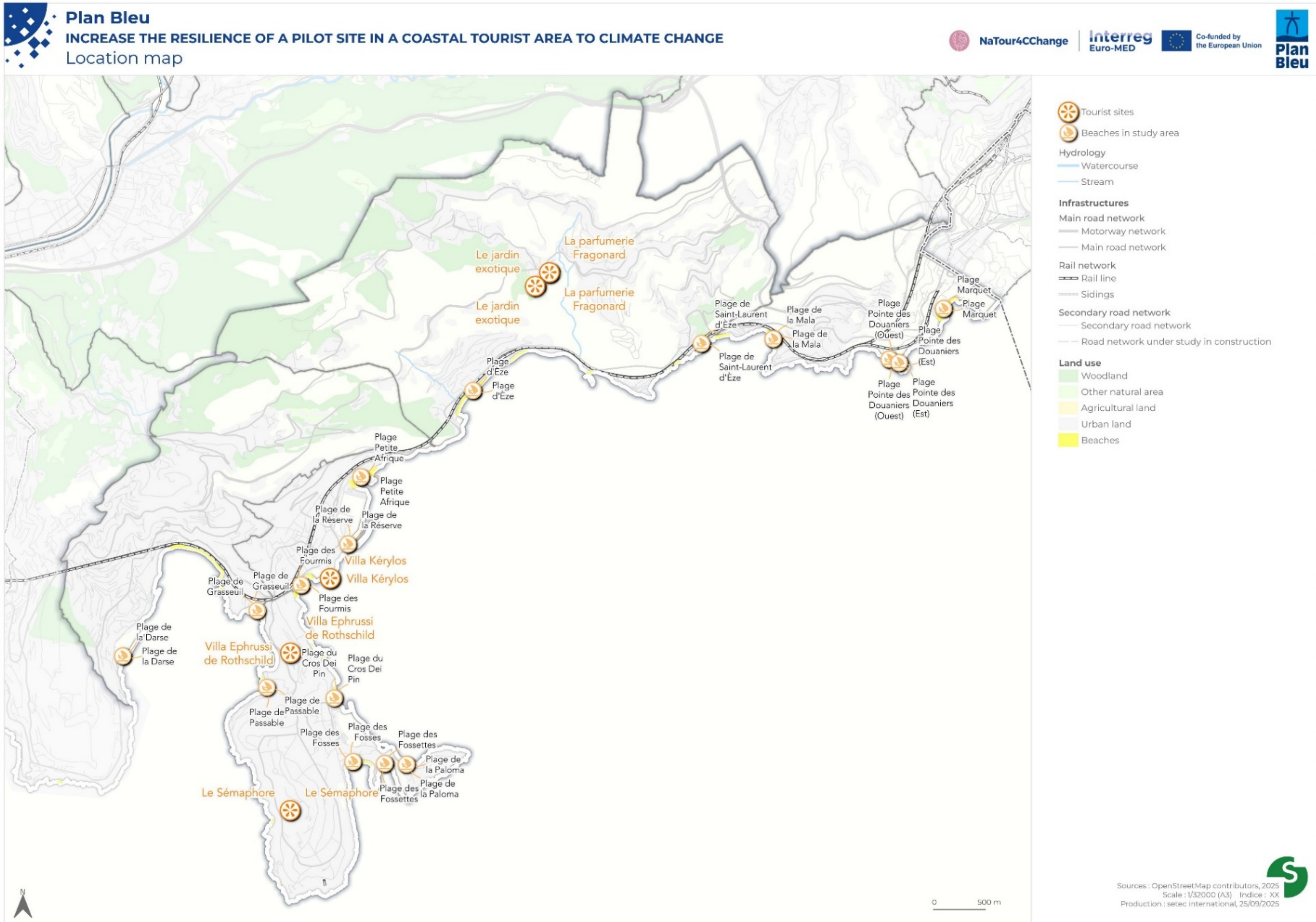
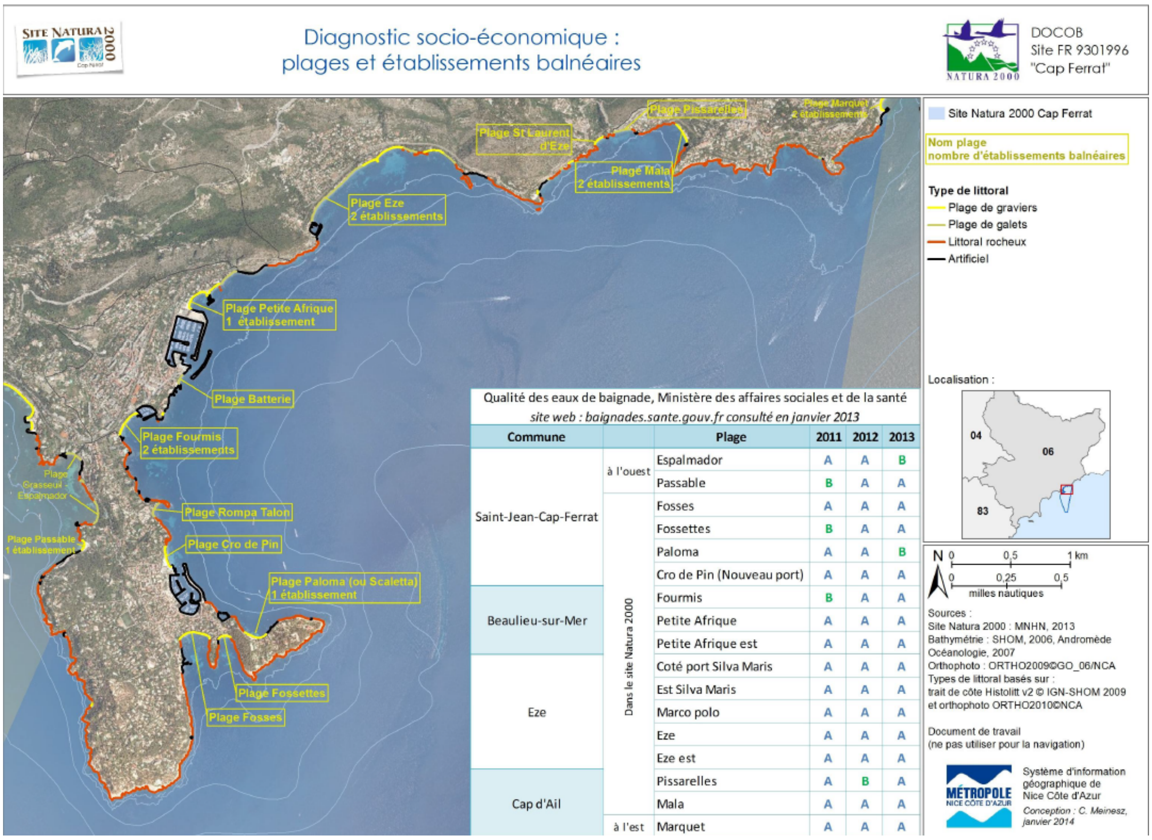


FIGURE 1: MAP SHOWING THE LOCATION OF THE STUDY AREA, BEACHES AND TOURIST SITES. SOURCE: SETEC INTERNATIONAL.



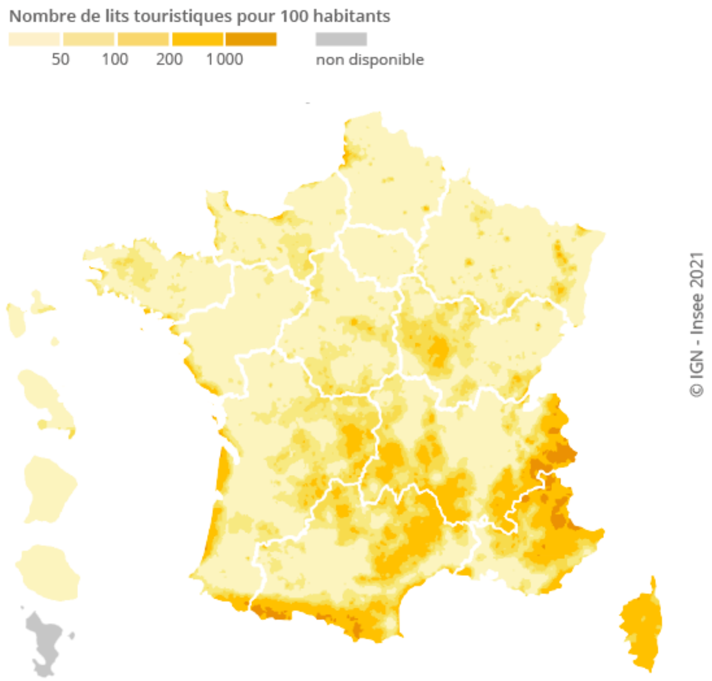
Qualité des eaux de baignade, Ministère des affaires sociales et de la santé
site web : baignades.sante.gouv.fr consulté en janvier 2013

Commune		Plage	2011	2012	2013
Saint-Jean-Cap-Ferrat	à l'ouest	Espalmador	A	A	B
		Passable	B	A	A
	Dans le site Natura 2000	Fosses	A	A	A
		Fossettes	B	A	A
		Paloma	A	A	B
		Cro de Pin (Nouveau port)	A	A	A
Beaulieu-sur-Mer		Fourmis	B	A	A
		Petite Afrique	A	A	A
		Petite Afrique est	A	A	A
Eze		Coté port Silva Maris	A	A	A
		Est Silva Maris	A	A	A
		Marco polo	A	A	A
		Eze	A	A	A
		Eze est	A	A	A
Cap d'Ail		Pissarelles	A	B	A
		Mala	A	A	A
	à l'est	Marquet	A	A	A

FIGURE 40: BEACHES AND TOURISM ESTABLISHMENTS AROUND THE MPA. SOURCE: DOCOB, 2015. (SOCIO-ECONOMIC DIAGNOSIS: BEACHES AND TOURISM ESTABLISHMENTS // CAP FERRAT NATURA 2000 SITE // NAME OF BEACH, NUMBER OF TOURISM ESTABLISHMENTS // TYPE OF COASTLINE //SANDY BEACH // SHINGLE BREACH // ROCKY COASTLINE // ARTIFICIAL // SEA WATER QUALITY, FRENCH HEALTH MINISTRY WEBSITE: BAIGNADES.SANTE.GOUV.FR VIEWED IN JANUARY 2013 // TO THE WEST // IN THE NATURA 2000 SITE // TO THE EAST)

3.1.3 TOURISM

The Alpes-Maritimes coastal area is characterised by **high tourist intensity**. The two maps below reveal **a high density of tourist beds per square kilometre** and **high tourist pressure in relation to the local population**, with several hundred beds per 100 inhabitants. These indicators reflect the area's strong appeal to tourists compared with the rest of France. There is a high degree of homogeneity between the municipalities.



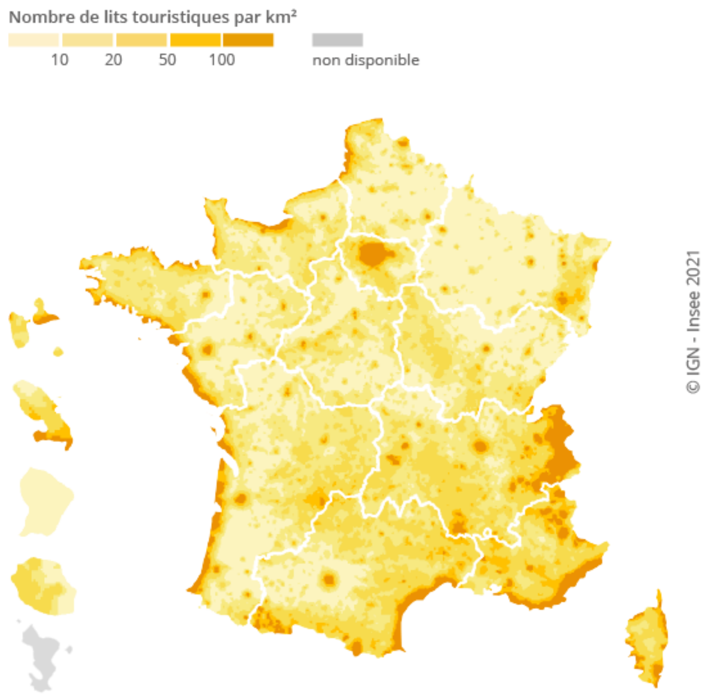
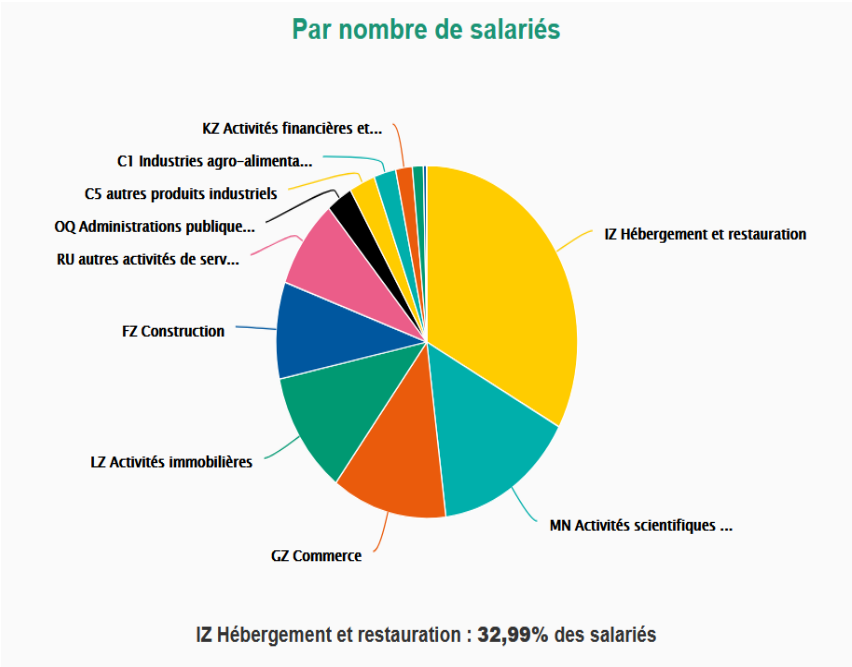


Figure 41: Maps illustrating the tourist function rate (top) and tourist density in France (bottom). Source: INSEE, 2021.

(Number of tourist beds per 100 inhabitants // Number of tourist beds per km^2)

The study area boasts a **primarily upmarket tourism offering**, with many large hotels with a high star rating. There are around forty hotels and tourist accommodation establishments in the area, along with around one hundred restaurants (source: INSEE).

These activities have significant economic weight, with more than **1,000 employees in the hospitality and food service sectors** (source: URSSAF). By way of comparison, the number of employees in the **Tourist Accommodation and Food Service sector represents 32.99% of employees across all 5 municipalities studied**, whereas in France as a whole, this proportion amounts to only 6.46% (Figure 42). These figures clearly illustrate the economic importance of tourism in these 5 municipalities.



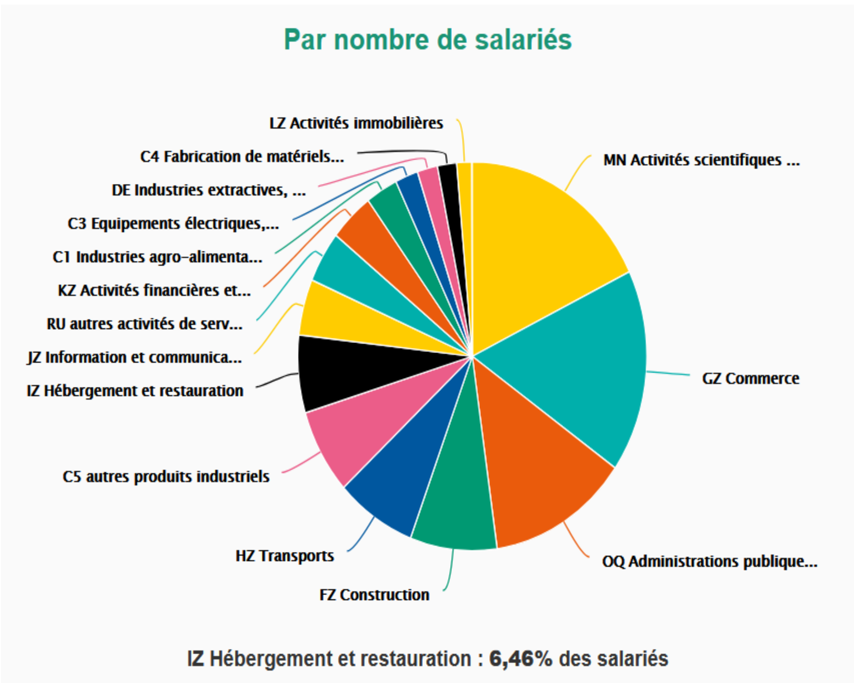


FIGURE 42: GRAPHS SHOWING THE NUMBER OF EMPLOYEES BY SECTOR IN THE STUDY AREA (BOTTOM) AND IN FRANCE AS A WHOLE (TOP). SOURCE: URSSAF DATABASE.

(By number of employees // KZ Finance and... // C1 Food and agriculture // C5 Other industrial production // OQ Government administration // RU Other service sector // FZ Construction // LZ Real estate // GZ Commercial // MN Science sector // IZ Hospitality and food service sector // IZ Hospitality and food service sector: 32% of employees // C4 Equipment manufacture // DE Mining // C3 Electrical equipment // J2 IT and telcoms // HZ Transport)

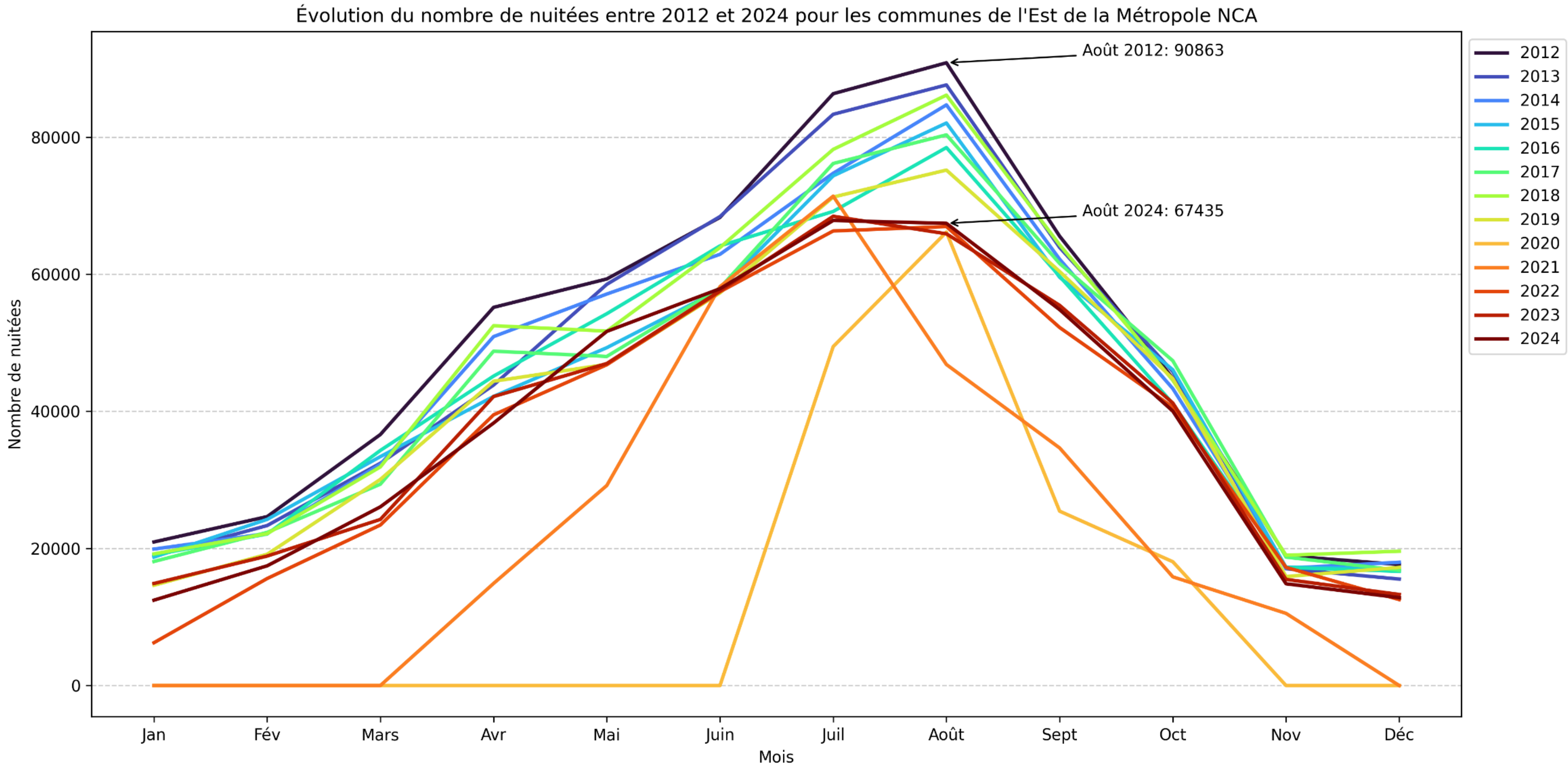


FIGURE 43: CHANGE IN THE NUMBER OF OVERNIGHT STAYS BETWEEN 2012 AND 2024 FOR MUNICIPALITIES TO THE EAST OF THE NCA METROPOLIS. SOURCE: INSEE AND CÔTE D'AZUR FRANCE TOURISME.

(CHANGE IN THE NUMBER OF OVERNIGHT STAYS BETWEEN 2012 AND 2024 FOR MUNICIPALITIES TO THE EAST OF THE NCA METROPOLIS // NUMBER OF OVERNIGHT STAYS)

Measuring the number of overnight stays in municipalities to the east of the Nice Côte d'Azur Metropolis (Beaulieu-sur-Mer, Cap d'Ail, Èze, Saint-Jean-Cap-Ferrat, La Trinité, Drap, Villefranche-sur-Mer), shows a strong interest in this area from April to October, with a peak in visitor numbers in August. Figure 43 illustrates this **strong seasonality of tourism** in the areas studied. Visitor numbers are more volatile, with shorter stays.

To complete this tourist profile, an analysis of data relating to tourist accommodation in the five municipalities studied reveals trends that are broadly consistent with the appeal of the Côte d'Azur coastline. **Villefranche-sur-Mer** is clearly distinguished by the **high number of furnished tourist accommodation options**, reflecting a strong presence of short-term rentals (Figure 44). The **occupancy rate** of accommodation remains relatively **balanced between municipalities**, fluctuating between 33% and 46%, with Villefranche-sur-Mer in the lead (Figure 45). However, there was a **slight decline in visitor numbers between 2023 and 2024** in all municipalities, with the exception of Saint-Jean-Cap-Ferrat, which appears to be maintaining its appeal. For traditional hotels, the **highest capacity** in number of beds is concentrated in **Villefranche-sur-Mer, Beaulieu-sur-Mer** and **Saint-Jean-Cap-Ferrat**, confirming their central role in structured tourism (Figure 46). This information highlights the diversity of accommodation available in the area, ranging from furnished tourist accommodation to hotels, and provides a basis for thinking about forms of tourism and their local impact.

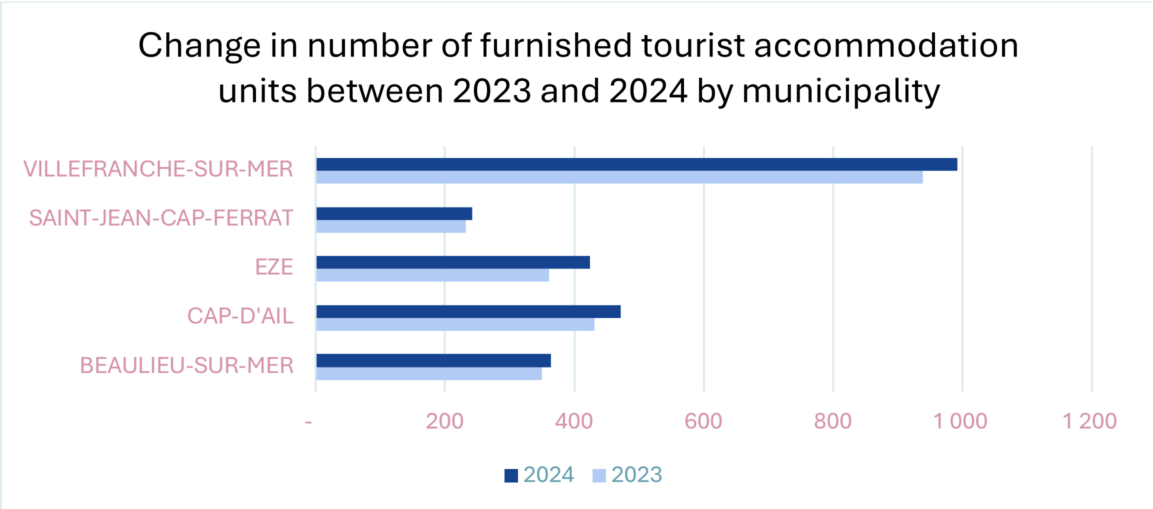


FIGURE 44: CHANGE IN NUMBER OF FURNISHED TOURIST ACCOMMODATION UNITS BETWEEN 2023 AND 2024 BY MUNICIPALITY. SOURCE: NICE COTE D'AZUR METROPOLIS TOURIST OFFICE AND TRANSPARENT LIGHTHOUSE.

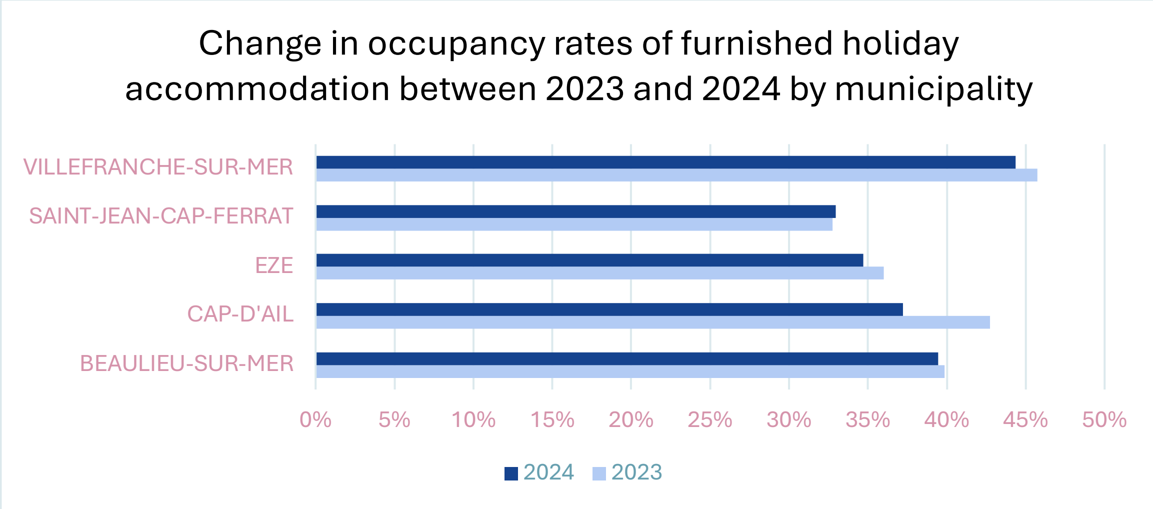


FIGURE 45: CHANGE IN OCCUPANCY RATES OF FURNISHED TOURIST ACCOMMODATION BETWEEN 2023 AND 2024 BY MUNICIPALITY. SOURCE: NICE COTE D'AZUR METROPOLIS TOURIST OFFICE AND TRANSPARENT LIGHTHOUSE.

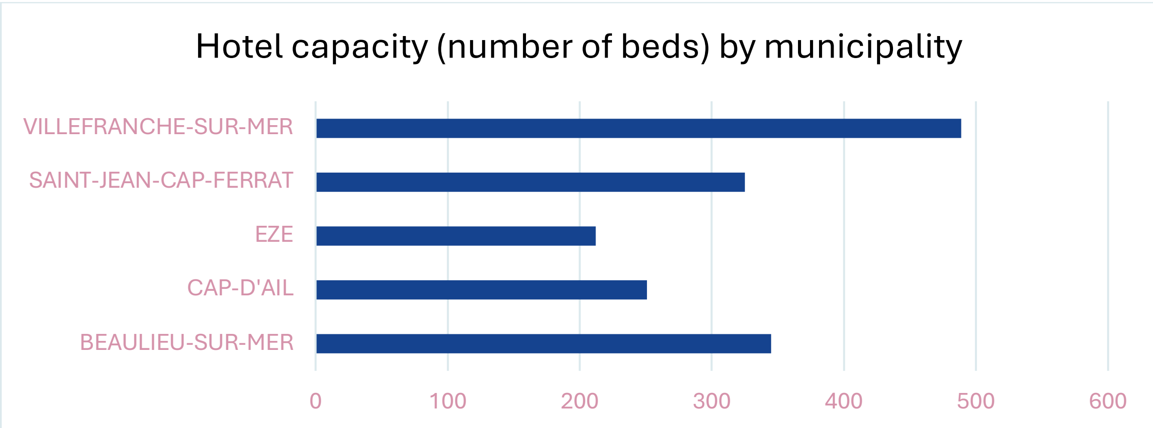


FIGURE 46: GRAPH SHOWING THE NUMBER OF HOTEL BEDS BY MUNICIPALITY. SOURCE: INSEE, 2024.

In France's South Provence-Alpes-Côte d'Azur region, a new tourism strategy dubbed "**Winter is the new summer**" is emerging. Its aim is to promote the winter season by showcasing its attractions, such as the mild climate, in order to attract visitors outside the summer months. This approach seeks to extend the tourist season to support the local economy throughout the year.

The Cap Ferrat MPA enjoys a **favourable environment for tourism**. The surrounding municipalities offer a wide range of sea-related activities, including scuba diving, pescatourism, boat trips and boat hire.

In principle, tourist flows circulate between the sites, with no single site concentrating all the flows. In addition to the beaches, these flows combine heritage and cultural visits.

Cap d'Ail attracts business travellers from Monaco.

There has been a recent, albeit marginal, interest in biodiversity. Since 2024, mentions of the Pelagos Sanctuary and Natura 2000 site have been included in tourist brochures and guides.

Saint-Jean-Cap-Ferrat has a nature trail and 6 observation points, but this is not yet a real driver of tourism.

There has been an increase in the number of visitors to hiking trails, although demand for this type of tourism product is still marginal.

Scattered initiatives for more virtuous tourism practices can also be identified, including an initiative in Beaulieu-sur-Mer for a “carbon neutral” private beach (with the installation of solar panels, the use of furniture made from natural materials, rainwater recovery for showers, etc.), or activities on a solar-powered boat (the SEAZEN boat, with the “High Quality Whale Watching” label for the observation of marine mammals.

The area is also rich in **heritage sites** including **Villa Ephrussi de Rothschild** in Saint-Jean-Cap-Ferrat, **Villa Kérylos** in Beaulieu-sur-Mer, and the architectural heritage of the Belle Époque. Other examples include the **semaphore in Saint-Jean-Cap-Ferrat, the Fragonard perfumery and the Jardin Exotique d’Èze botanical gardens**. The area’s appeal is further strengthened by the many beaches, including some renowned ones, along with the **hiking trails.** The region’s proximity to major hubs like Nice and Monaco also explains its appeal.

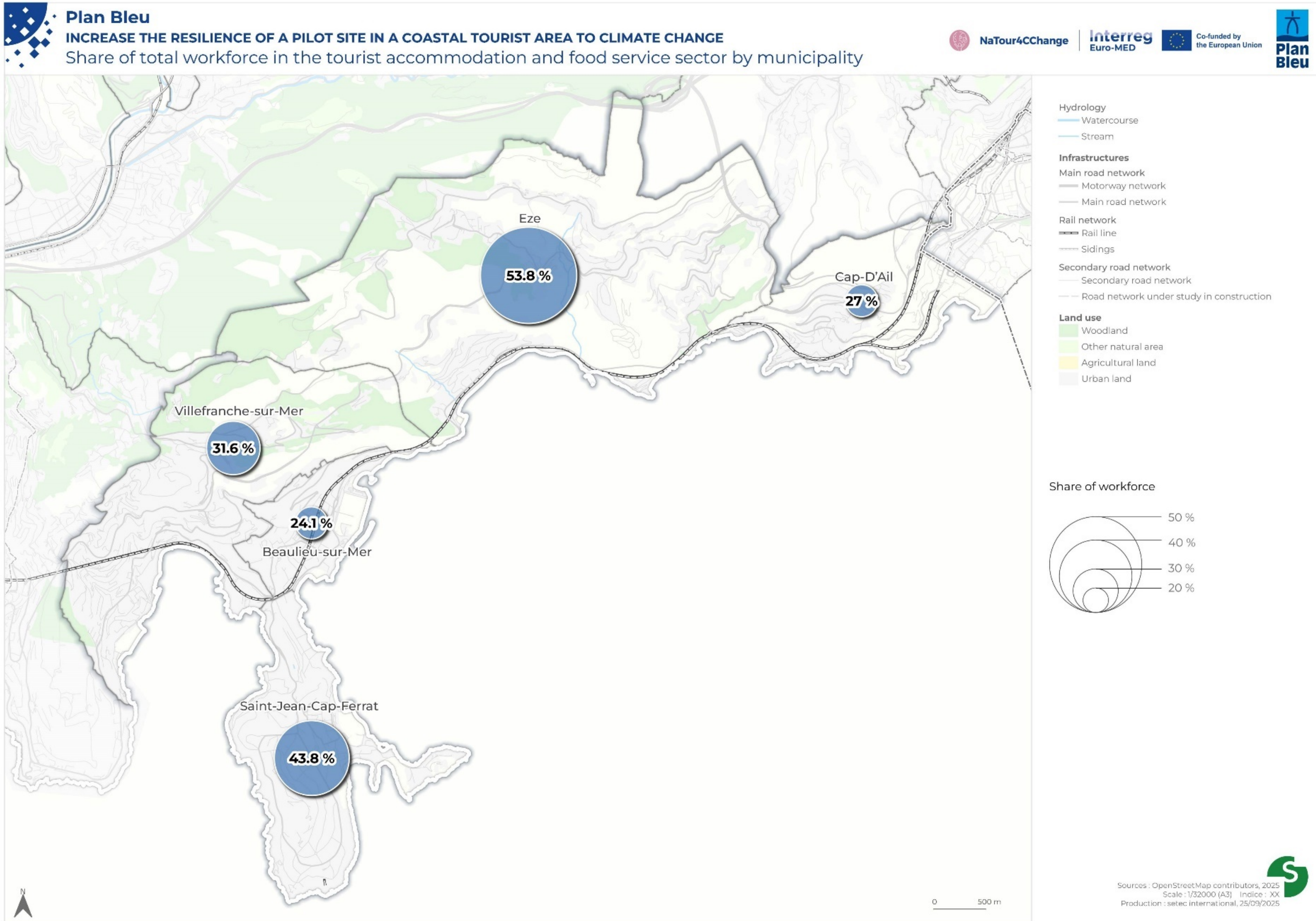


FIGURE 47: MAP OF THE SHARE OF THE WORKFORCE WORKING IN THE FOOD SERVICE AND TOURIST ACCOMMODATION SECTOR BY MUNICIPALITY. SOURCE: URSAFF (DATA), SETEC INTERNATIONAL (MAP).

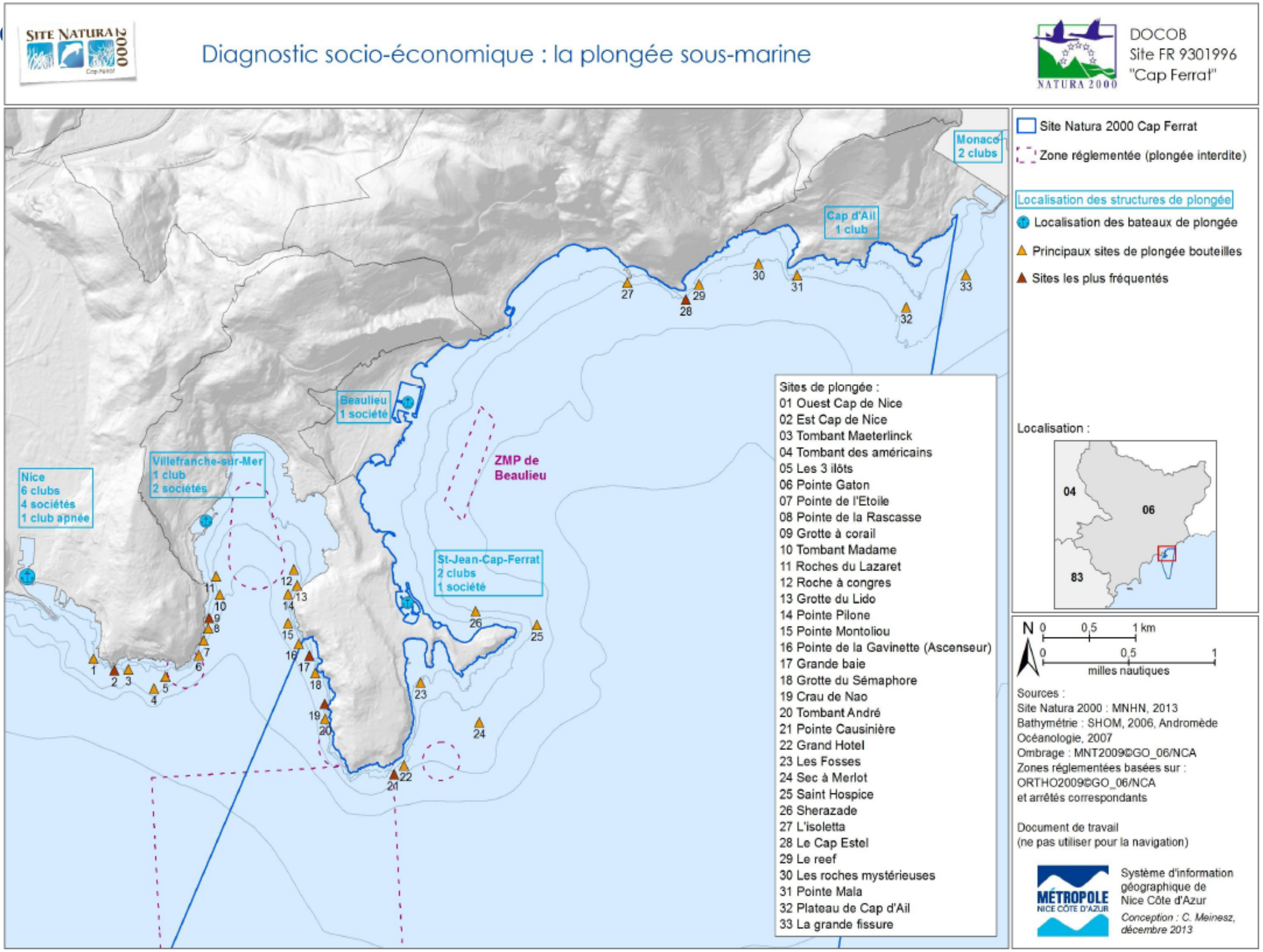


FIGURE 48: SCUBA DIVING SITES. SOURCE: DOCOB.

(SOCIO-ECONOMIC DIAGNOSIS: SCUBA DIVING // CAP FERRAT NATURA 2000 SITE // CONTROLLED AREA (SCUBA DIVING PROHIBITED) // LOCATION OF SCUBA DIVING STRUCTURES // LOCATION OF SCUBA DIVING BOATS // MAIN SCUBA DIVING SITES // MOST FREQUENTED SITES // SCUBA DIVING SITES)

3.1.4 Biodiversity

3.1.4.1 A Marine Protected Area rich in biodiversity

The Cap Ferrat MPA also plays an essential role in preserving biodiversity, with 13 habitats of community interest (including the Posidonia seagrass beds and coralligenous reefs) and 2 species of community interest: the bottlenose dolphin and the loggerhead turtle. To preserve these ecosystems, the MPA is taking several actions, with various regulations, particularly a 25-hectare marine protected area in Beaulieu-sur-Mer prohibiting any mooring, diving and fishing activity. With the same regulations, the Cap d'Ail fisheries area covers 244 hectares. Monitoring, public awareness, habitat monitoring and mooring usage initiatives are also in place.

Marine biodiversity provides numerous ecosystem services. Posidonia seagrass beds play an important role in this respect, stabilising the seabed, improving water transparency, providing a nursery for fauna, mitigating swell, producing oxygen and protecting from erosion thanks to the dead leaves of the Posidonia plant.

It is therefore essential to preserve these habitats. According to the Andromède report[27] (2022), the ecological status of the *Posidonia Oceanica* meadows near Cap d'Ail and Èze is assessed as average, comparable to what is observed in the rest of the region. Generally speaking, these meadows have declined markedly in recent decades, particularly in shallow areas, leading to a reduction in their spread.

In view of the services provided by these ecosystems, which go far beyond Posidonia alone, protecting them is an obvious priority.

3.1.4.2 Recreational boating places direct pressure on marine ecosystems

When the MPA was established, observations demonstrated that the pressure exerted by the intensity of mooring on habitats of community interest was also a threat to this biodiversity. Figure 52 illustrates the distribution of large yachts (boats over 24 metres). AIS data should be treated with caution, as not all vessels are equipped with this system, and the figures may not be representative of all recreational boats in the area and may underestimate small boats. There is a high concentration of large boats in the Villefranche area, on the edge of the MPA perimeter, where tourist cruises have stopovers. Small and medium-sized boats are more evenly distributed across the bay of Beaulieu-sur-Mer, in Anse de la Scaletta and Baie des Fourmis.

[27] ANDROMEDE. (2022). *Surveillance biologique dans la région Est de la Provence-Alpes-Côte d'Azur – Analyse des données 2022 – Réseau TEMPO de suivi des herbiers de posidonie* (217 p.).

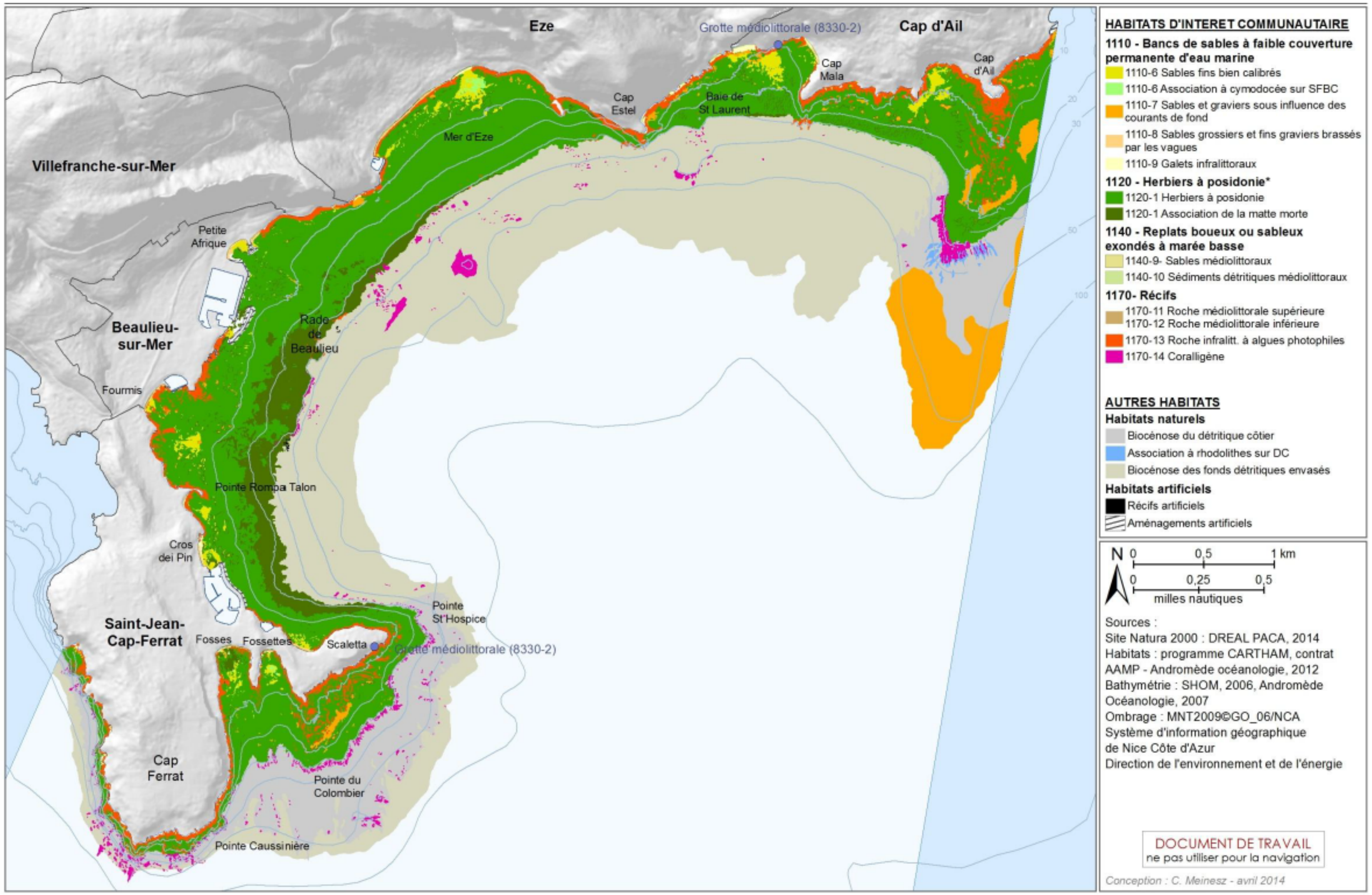


FIGURE 49: MAP OF HABITATS IN THE MARINE PROTECTED AREA. SOURCE: DOCOB CAP FERRAT, 2014

(HABITATS OF COMMUNITY INTEREST // 1110- SANDBANKS WHICH ARE SLIGHTLY COVERED BY SEA WATER ALL THE TIME // 1110-3 WELL-GRADED FINE SANDS // 1110-4 ASSOCIATION WITH CYMODOCEA ON WELL-GRADED FINE SANDS // 1110-7 SANDS AND GRAVELS UNDER THE INFLUENCE OF DEEP CURRENTS // 1110-8 COARSE SANDS AND FINE GRAVELS MIXED BY WAVES // 1110-9 INFRALITTORAL SHINGLE // 1120 - POSIDONIA MEADOWS // 1120-4 ASSOCIATION OF DEAD MATTE // 1140 - MUDDY OR SANDY FLATS EXPOSED AT LOW TIDE // 1140-1 INFRALITTORAL SANDBANKS // 1140-10 MEDIOLITTORAL DETRITIC SEDIMENTS // 1170 – REEFS // 1170-11 UPPER MEDIOLITTORAL ROCK // 1170-12 LOWER MEDIOLITTORAL ROCK // 1170-13 INFRALITTORAL ROCK WITH PHOTOPHILIC ALGAE // 1170-14 CORALLIFEROUS // OTHER HABITATS // NATURAL HABITATS // COASTAL DETRITIC BIOCENOSIS // ASSOCIATION WITH NOBILITIES ON COASTAL DETRITIC // BIOCENOSIS OF MUDDY DETRITIC BOTTOMS // ARTIFICIAL HABITATS // ARTIFICIAL ROCKS //ARTIFICIAL STRUCTURES)

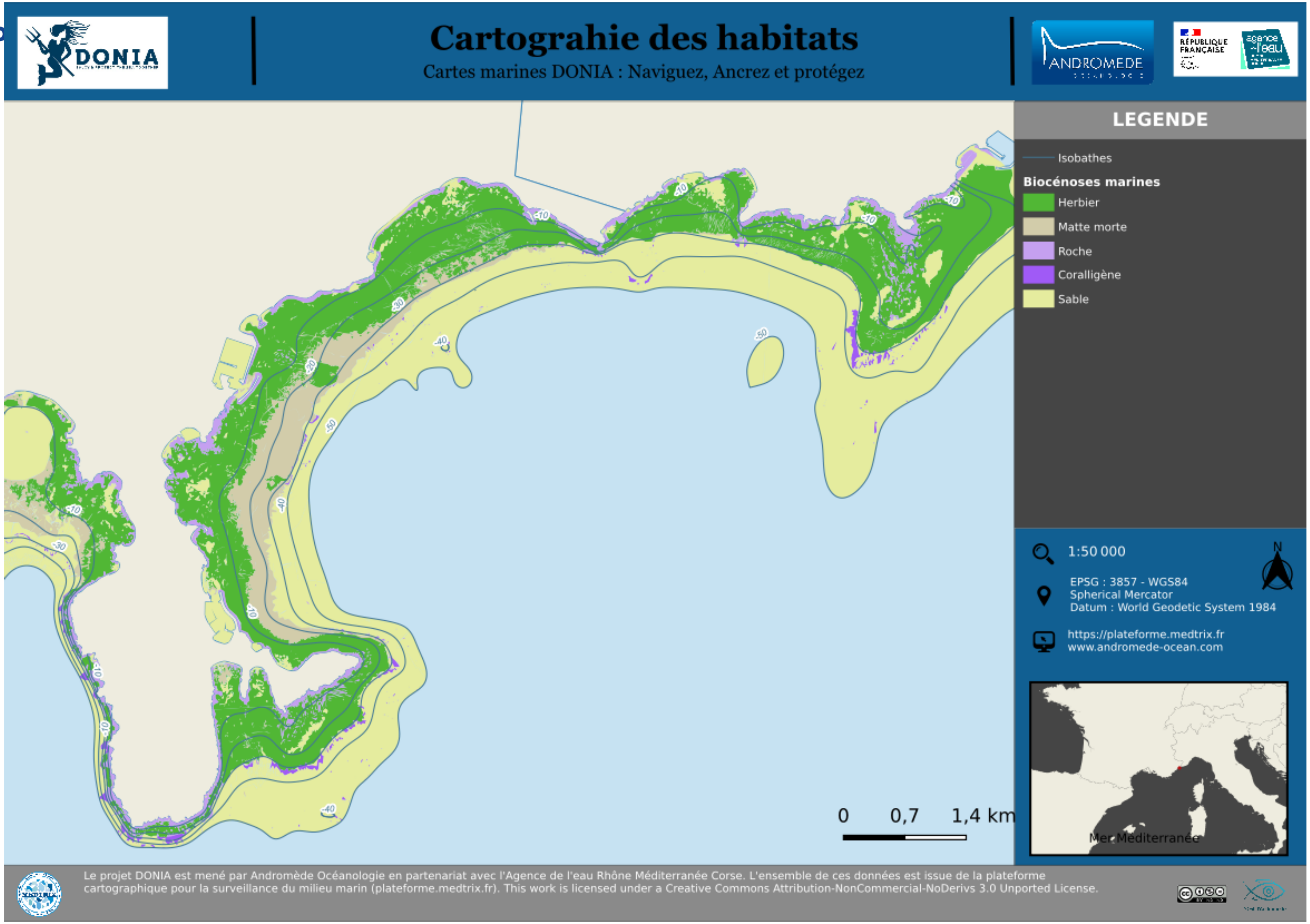
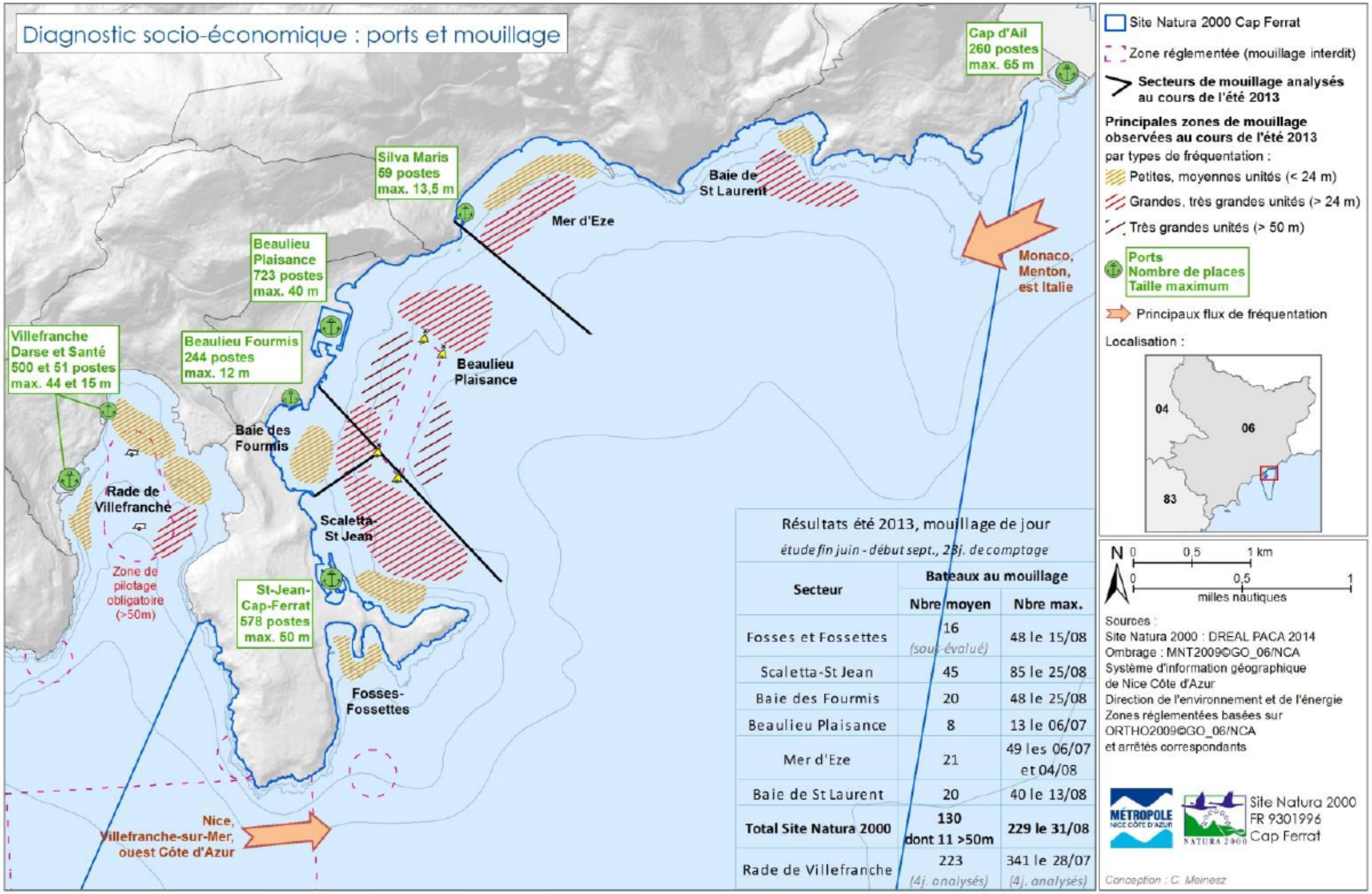


FIGURE 50: MAP OF HABITATS IN THE MPA. SOURCE: DONIA, JUNE 2022 - DATA CONSULTED ON THE MEDTRIX MONITORING PLATFORM (*HTTPS://PLATEFORME.MEDTRIX.FR*).
(HABITAT MAP // DONIA MARINE MAPS: NAVIGATE, MOOR AND PROTECT // ISOBATHS // MARINE BIOCENOSES // MEADOW // DEAD MATTE // ROCK // CORALLIFEROUS // SAND)



Résultats été 2013, mouillage de jour
étude fin juin - début sept., 28j. de comptage

Secteur	Bateaux au mouillage: Nbre moyen	Bateaux au mouillage: Nbre max.
Fosses et Fossettes	16 *(sous-évalué)*	48 le 15/08
Scaletta-St Jean	45	85 le 25/08
Baie des Fourmis	20	48 le 25/08
Beaulieu Plaisance	8	13 le 06/07
Mer d'Eze	21	49 les 06/07 et 04/08
Baie de St Laurent	20	40 le 13/08
Total Site Natura 2000	**130 dont 11 >50m**	**229 le 31/08**
Rade de Villefranche	223 *(4j. analysés)*	341 le 28/07 *(4j. analysés)*

FIGURE 51: MAP OF THE MAIN PORTS AND MOORINGS IN THE MPA. SOURCE: DOCOB CAP FERRAT, 2014

(SOCIO-ECONOMIC DIAGNOSIS: PORTS AND MOORING // CAP FERRAT NATURA 2000 SITE // CONTROLLED AREA (MOORING PROHIBITED) // MOORING SECTORS ANALYSED DURING THE SUMMER OF 2013 // BY TYPES OF FREQUENTATION // SMALL AND MEDIUM UNITS (< 24 M) // LARGE AND VERY LARGE UNITS (> 24 M) // VERY LARGE UNITS (> 50 M) // PORTS // NUMBER OF SPACES // MAXIMUM SIZE // MAIN FLOW OF FREQUENTATION // SUMMER 2013 RESULTS, DAYTIME MOORING // STUDY FROM END JUNE TO EARLY SEPT, 28 COUNTING DAYS // SECTOR // MOORED BOATS // AV. NUM. // MAX. NUM.)

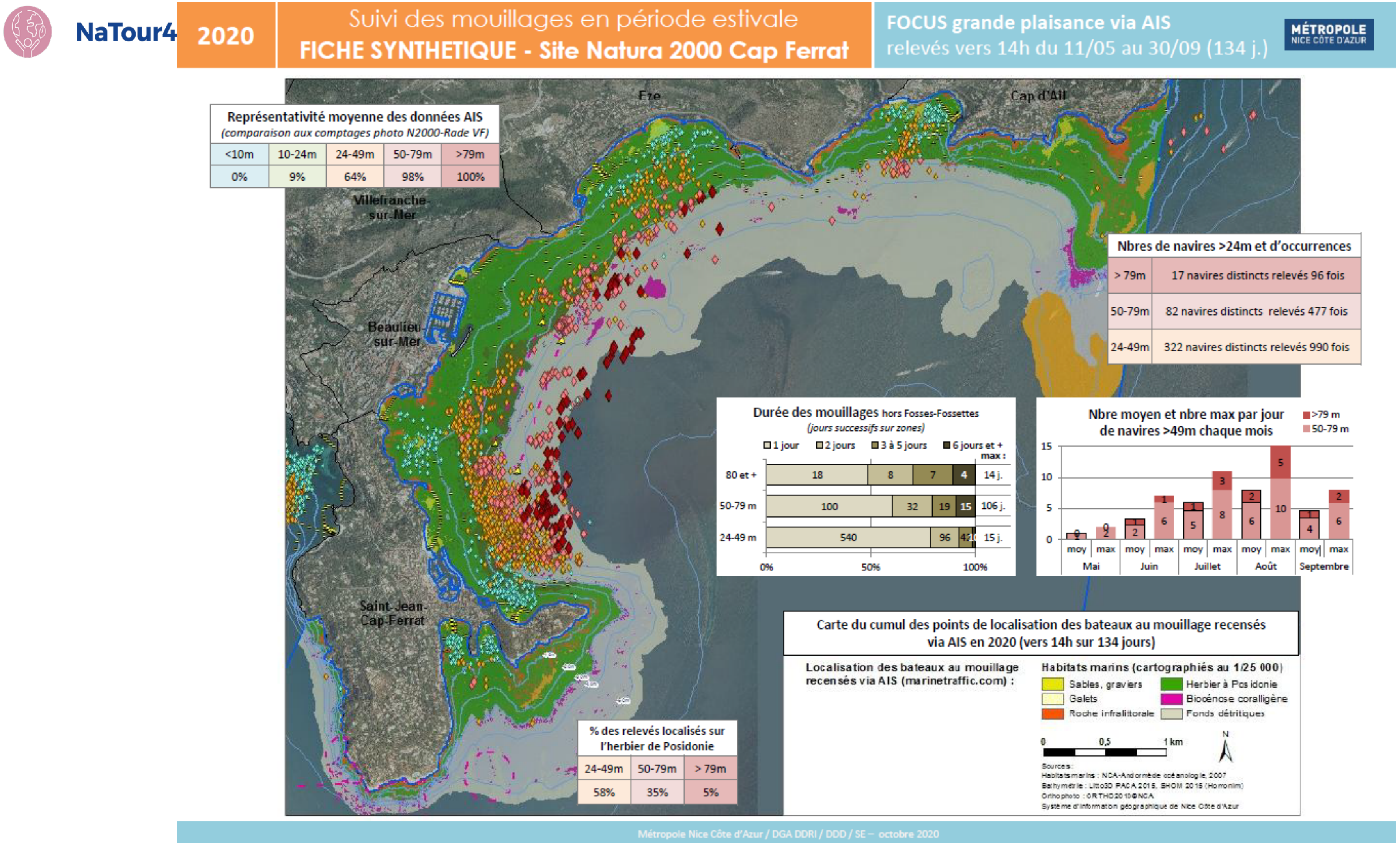


FIGURE 52: MONITORING OF MOORING IN THE SUMMER PERIOD, USING AIS DATA FROM 2020 - DATA FROM NICE CÔTE D'AZUR METROPOLIS.

(MONITORING OF MOORING IN THE SUMMER PERIOD // SUMMARY FORM – CAP FERRAT NATURA 2000 SITE // LARGE YACHTS FOCUS VIA AIS DATA // (RECORDED AROUND 2PM FROM 11/5 TO 30/09 (134 DAYS)) // NUMBER OF VESSELS > 24M AND OCCURRENCES // 17 DISTINCT VESSELS RECORDED 96 TIMES // 84 DISTINCT VESSELS RECORDED 477 TIMES // 522 DISTINCT VESSELS RECORDED 990 TIMES // DURATION OF MOORINGS OUTSIDE FOSSES-FOSSETTES (SUCCESSIVE DAYS ON ZONES) // 1 DAY // 2 DAYS3 // 3 TO 5 DAYS // 6 DAYS AND ABOVE // 80 AND OVER // AV. NUM. AND MAX. NUM. PER DAY OF VESSELS > 49M EACH MONTH // MAP SHOWING CUMULATIVE POINTS OF MOORED VESSEL LOCATIONS RECORDED VIA AIS IN 2020 (AROUND 2PM OVER 134 DAYS) // LOCATION OF MOORED VESSELS RECORDED VIA AIS (MARINETRAFFIC.COM) //MARINE HABITATS (MAPPED AT 1:25,000) // SANDS AND GRAVELS // SHINGLE // INFRALITTORAL ROCKS // POSIDONIA MEADOWS // CORALLINE BIOCENOSIS //DETRITIC BOTTOMS)

To the east of Cap Ferrat, maps of the seabed reveal numerous mooring marks between 15 and 30 metres deep (Figure 53). These marks are visible as brown lines, corresponding to areas of degraded or even dead Posidonia resulting from the repeated mooring of yachts and other recreational boats. AIS data confirms this anthropogenic pressure, in correlation with the areas most affected (Andromède[28], 2024).

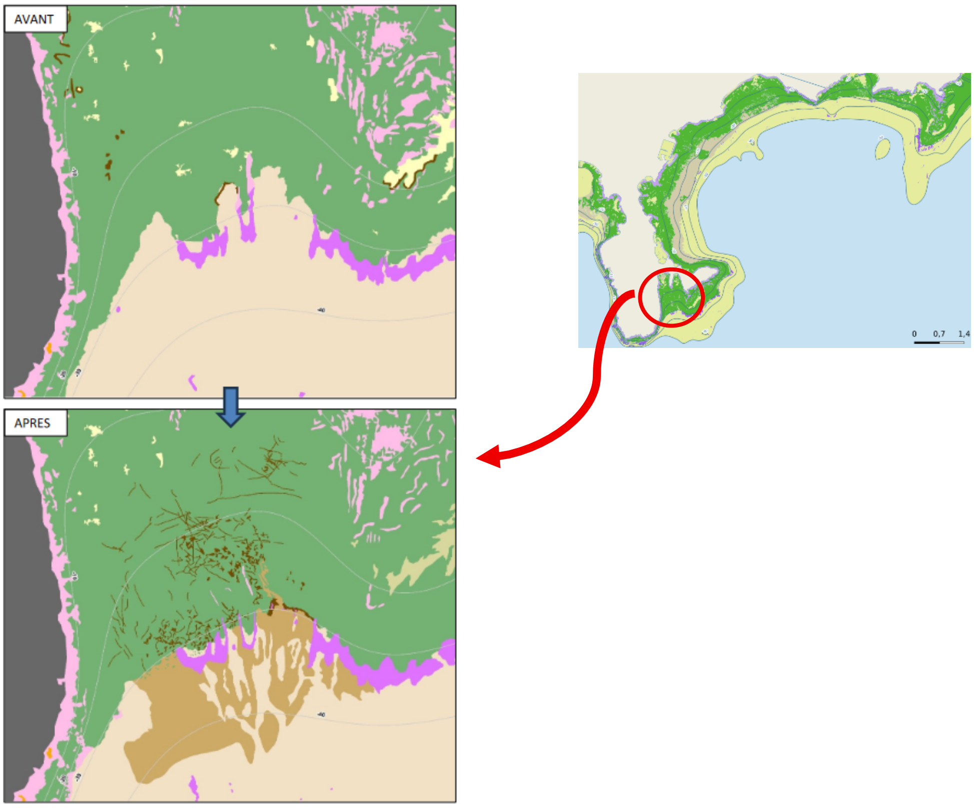


FIGURE 53: COMPARISON OF MAPS OF MARINE BIOCENOSES TO THE EAST OF CAP FERRAT BEFORE AND AFTER THE 2020 UPDATE. SOURCE: ANDROMÈDE REPORT, 2024.
(BEFORE // AFTER)

Another illustration of the pressure exerted by mooring on marine ecosystems is provided by the Andromède report (2022). The report indicates that one Posidonia monitoring site, whose state had been stabilising since 2004, showed a marked deterioration in 2019, making it difficult to recognise. This deterioration was mainly due to traces of mooring and trawling. This observation bears witness to the brutality and direct impact, which is often almost irreversible, of human pressures on marine habitats.

More generally, the report produced by Andromède[29] in 2019 presents the **loss of 37 hectares of seagrass meadow** between 2010 and 2018 (Figure 54).

Climate change is exerting additional pressure and accentuating these impacts. Faced with these accumulated pressures, there is a **strong need to preserve biodiversity.**

[28] Andromède Océanologie (2024). *Réseaux de surveillance surfacique des habitats marins (SURFSTAT) – Poursuite de la mise à jour en Région Sud (2020-2021)* (300 p.).
[29] Andromède Océanologie. (2019). *Impact des grands navires au mouillage en Méditerranée française.* (Cahier n°6). Medtrix. https://medtrix.fr/wp-content/uploads/2019/09/cahier6.pdf.

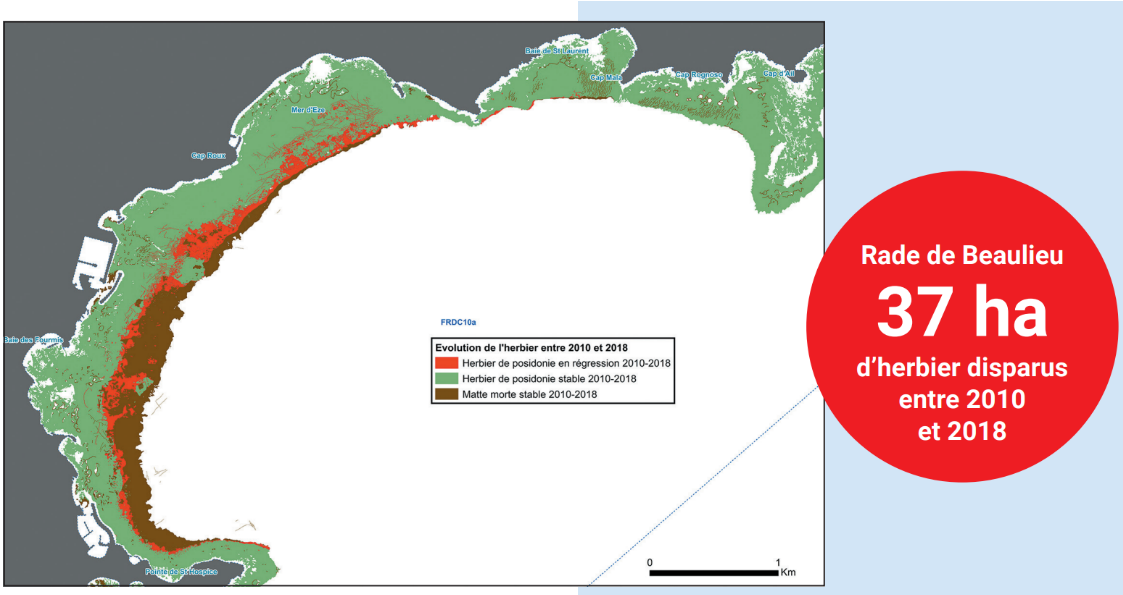


FIGURE 54: POSIDONIA MEADOW REGRESSION BETWEEN 2010 AND 2018. SOURCE: CAHIER ANDROMÈDE 2019.
(RADE DE BEAULIEU: 37 HA OF MEADOW LOST BETWEEN 2010 AND 2018 // CHANGES TO THE MEADOW BETWEEN 2010 AND 2018 // POSIDONIA MEADOW IN REGRESSION 2010-2018 // STABLE POSIDONIA MEADOW 2010-2018 // STABLE DEAD MATTE 2010-2018)

3.2 ASSESSMENT OF THE CURRENT IMPACTS OF CLIMATE CHANGE ON TOURISM

A number of lessons can be drawn from the triangulation of interviews, quantified analyses and hazards.

Tourism today is still mainly focused on seaside tourism, based on nautical activities linked to the sea, **which is not currently especially impacted by the various climate hazards.**

When asked about **rising temperatures and heat waves**, the stakeholders interviewed do not indicate any particular impact and report that it is relatively well tolerated by local populations and tourists. There was little observed impact on visitor numbers during the heat waves of 2019 and 2022, as the appeal of the Côte d'Azur remains strong, where coastal areas with access to the sea are more appealing to tourists than the hinterland. Thermal discomfort is alleviated by hotel air-conditioning, with a shift towards air-conditioned areas such as heritage sites in the heat of the day, and a shift in the time of day for some activities, as noted by tourist office representatives.

However, analysis of tourist numbers over the last 10 years is illustrated in Figure 43, revealing **a slight decline in the number of overnight stays in general and in the summer period in particular** in recent years. It is difficult to correlate this fall with the rise in summer temperatures, as the causes are almost certainly multi-factor.

The **Fires** hazard is not very prevalent at the moment, with one historic fire mentioned in Èze. There is little specific concern about it, beyond the regulations in force.

One of the impacts most frequently cited by tourist offices and beach managers is the **recession of beaches**, caused by storms (e.g. Storm Alex in 2020 was often mentioned during interviews). Direct damage was observed on some tourist infrastructure, such as seaside restaurants and coastal paths. In response to this phenomenon, a number of actions have been implemented, including beach nourishment and regular monitoring of the coastline. These actions entail a significant cost to maintain the beaches at their current level.

The beaches are an important attraction, with economic activity linked to beach restaurants, but also for the general appeal of the area, and their decline is a source of concern for tourism operators.

Sudden weather events such as **intense rain and storms** also raise some concerns. These phenomena, which occur infrequently in the area, can be surprising in terms of their intensity and unpredictability. CATNAT sources show that storms and intense rainfall can have a significant impact on restaurants. Impacts have also been observed on footpaths.

The **rising sea temperature** is also cited by stakeholders. This increase has a positive effect on swimming comfort. But at the same time, a rise in sea temperature can lead to an influx of jellyfish, which can have an impact on swimming. Jellyfish prevention nets have been installed in certain areas.

Climate change is exacerbating existing pressures on **Mediterranean marine ecosystems**, while also generating new ones. These disruptions have direct and indirect consequences on the tourist appeal of coastal areas.

As mentioned above, Posidonia plays a key role in stabilising beaches and underwater biodiversity, and is trying to adapt to warmer waters by migrating to greater depths. However, its range is limited to 40 metres, which makes it particularly vulnerable. Its disappearance is accelerating **beach erosion**, reducing bathing and recreational areas.

Another worrying phenomenon is **the spread of exotic species** along with **algae and cyanobacteria blooms, and jellyfish blooms**, which can put tourists off swimming. In particular, **Ostreopsis ovata,** a micro-organism that grows on algae and rocks during temperature peaks, produces a toxin that can cause respiratory problems in humans. Its frequency has risen sharply in the Mediterranean in recent decades. The latest samples from 2020 collected in Villefranche-sur-Mer and published by Accord RAMOGE demonstrate the presence of Ostreopsis bloom. In Provence-Alpes-Côte d'Azur, little is known about this phenomenon. A striking example is **the closure of a beach in Villefranche-sur-Mer in August 2013**, officially linked to pollution, but in reality, caused by an Ostreopsis bloom. Global warming is suspected of boosting these blooms, although no definitive scientific proof has yet been established. (GREC SUD,2022)

For diving professionals, the **degradation of underwater habitats** is causing a gradual decline in biodiversity. Although this is not yet apparent to the general public, feedback from fishers indicates a drop in fish stocks in summer, linked to the rise in water temperature.

SUMMARY OF CURRENT CLIMATE IMPACTS ON TOURISM

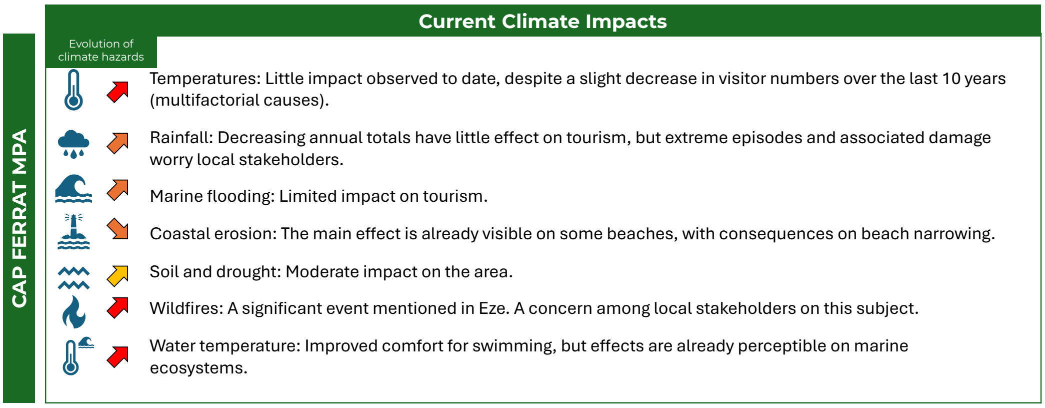


Figure 55: Summary of current climate impacts on tourism. Source: Setec International

3.3 FUTURE DEVELOPMENTS

To assess the vulnerability of tourism in the five municipalities studied, an approach based on three key dimensions was adopted: **exposure**, **sensitivity** and **adaptative capacity**. By combining these three dimensions according to the formula presented in Figure 56, a vulnerability score is assigned to each municipality. This method is used to monitor changes in tourism vulnerability over time, at different time periods: current status, 2050 and 2100.

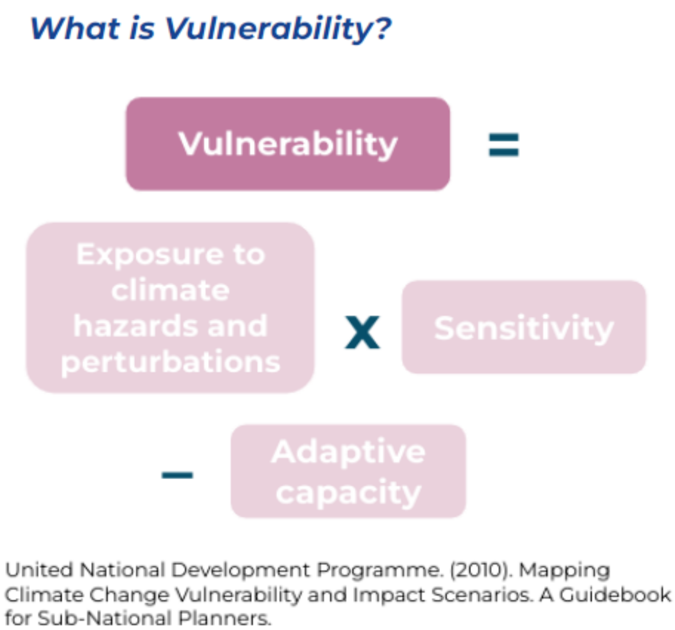


FIGURE 56: EQUATION FOR CALCULATING VULNERABILITY. Source: Methodological frameworks for Region and Destination, NT4CC.

Indicators have been identified to reflect the local characteristics of each municipality. The exposure and sensitivity indicators and their scores are presented below, followed by projected results for the three time periods. Only indicators relating to temperature rise, erosion and flooding have been scored, according to the data available. The scores shed light on the level of vulnerability in each municipality. Future impacts will be described for all hazards.

3.3.1 INDICATORS OF EXPOSURE TO HAZARDS

3.3.1.1 SCORE OF EXPOSURE TO HAZARDS LINKED TO TEMPERATURE RISE

For indicators such as the number of very hot days, the number of days of heat waves and the number of hot nights, the scoring thresholds were established on the basis of data provided by the ClimaDiag tool. ClimaDiag provides four values for each municipality: the reference value, the median value, and the high and low values. In order to define relevant thresholds, a quartile approach was adopted. This method consists of dividing all the available data (reference, median, high and low values) into four exposure categories for a graduated assessment.

Scores were based on the median value.

3.3.1.1.1 NUMBER OF VERY HOT DAYS (TEMPERATURE >35°C)

TABLE 6: SCORING SCALE FOR THE NUMBER OF VERY HOT DAYS INDICATOR

Level of exposure		Description of level of exposure
4	High	More than 5 days with temperatures above 35°C
3	Medium	Between 4 and 5 days with temperatures above 35°C
2	Low	Between 2 and 3 days with temperatures above 35°C
1	Negligible	Between 0 and 1 days with temperatures above 35°C

3.3.1.1.2 NUMBER OF DAYS OF HEAT WAVES

TABLE 7: SCORING SCALE FOR THE HEAT WAVE INDICATOR

Level of exposure		Description of level of exposure
4	High	More than 11 days of heat waves
3	Medium	Between 8 and 11 days of heat waves
2	Low	Between 3 and 7 days of heat waves
1	Negligible	Between 0 and 2 days of heat waves

3.3.1.1.3 NUMBER OF HOT NIGHTS

TABLE 8: SCORING SCALE FOR THE NUMBER OF HOT NIGHTS INDICATOR

Level of exposure		Description of level of exposure
4	High	More than 103 nights with temperatures above 25°C
3	Medium	Between 89 and 103 nights with temperatures above 25°C
2	Low	Between 75 and 88 nights with temperatures above 25°C
1	Negligible	Between 0 and 74 nights with temperatures above 25°C

3.3.1.1.4 MARINE FLOODING AND DAMAGE CAUSED BY THE MECHANICAL IMPACT OF WAVES

For exposure to marine flooding, in the absence of quantified data on sites and beaches, we propose an approach based on a combination of physical characteristics and observed land damage caused by marine flooding. It is based on the assessment of failures observed during site visits, interviews about coastal infrastructure (including economic activities) and the coastal strip (beach, cliff, etc.), along with the number of events recorded in the CATNAT decrees.

In the absence of precise future projections, it is assumed that exposure to marine flooding will increase as a result of future changes in sea level rise. This assumption results in a one-level increase in the exposure score for the 2050 and 2100 time periods for all municipalities.

TABLE 9: SCORING SCALE FOR EXPOSURE TO MARINE FLOODING

Level of exposure		Description of level of exposure
4	High	Permanent or extensive damage requiring major and immediate repairs to the coastal strip (infrastructure or natural shoreline).
3	Medium	Widespread damage to local infrastructure/natural shoreline, and disruption to services (e.g. road access) requiring rapid moderate repairs.
2	Low	Relatively limited beach area, with some localised disruption to local infrastructure/natural shoreline (e.g. with multiple CATNAT orders). No permanent damage. Some minor restoration work is required.
1	Negligible	High point or cliff, not subject to damage to local infrastructure/natural shoreline.

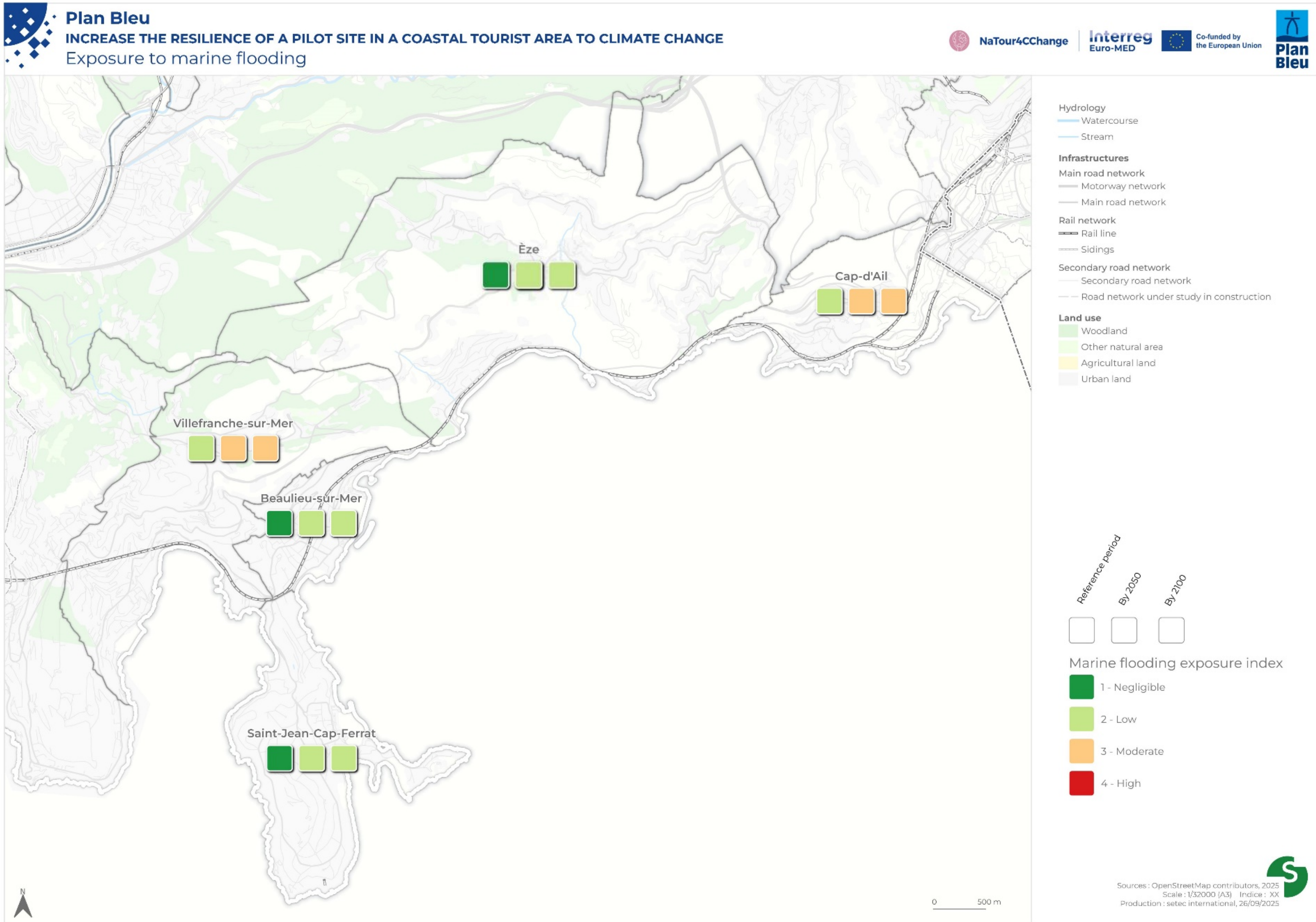


FIGURE 57: MAP SHOWING THE EXPOSURE OF MUNICIPALITIES TO THE MARINE FLOODING HAZARD AND PROJECTED CHANGES FOR 2050 AND 2100. SOURCE: SETEC INTERNATIONAL.

3.3.1.2 EROSION - RECEDING COASTLINE

This indicator reflects the multi-year dynamics of coastline retreat observed to date and in the future. It also includes the erosion effects of "storm" events that cause episodic erosion of the study area's coastline. Limited data in this area has led to the creation of a mixed indicator (chronic and one-off dynamics) with similar observable consequences. The study area is characterised by narrow strips of coastline with many socio-economic factors at play behind them.

The descriptions of the level of exposure are taken from the usual values of the CEREMA national coastal erosion indicator maps. In the future, exposure levels will increase slightly compared with the reference period, for the 2050 and 2100 time periods. These phenomena will tend to intensify with the consequences of climate change. In the absence of precise future projections and more detailed modelling of the coastline, it is assumed that exposure to erosion will increase as a result of future changes in sea level rise. This assumption results in a one-level increase in the exposure score for the 2050 and 2100 time periods for all municipalities.

TABLE 10: SCORING SCALE FOR EXPOSURE TO COASTLINE EROSION

Level of exposure		Description of level of exposure
4	High	Significant beach nourishment, the national coastline indicator shows erosion. Strong physical exposure noted in the field depending on the configuration of the beaches (orientation, slope, etc.).
3	Medium	Regular beach nourishment, the national coastline indicator shows erosion. Moderate exposure noted in the field depending on the configuration of the beaches (orientation, etc.).
2	Low	Regular beach nourishment, but the national coastline indicator does not show any significant erosion. Low exposure noted in the field depending on the configuration of the beaches (orientation, slope, etc.).
1	Negligible	The national coastline indicator shows no erosion. Very low exposure noted from field visits (rocky coastline, etc.) No retreat observed

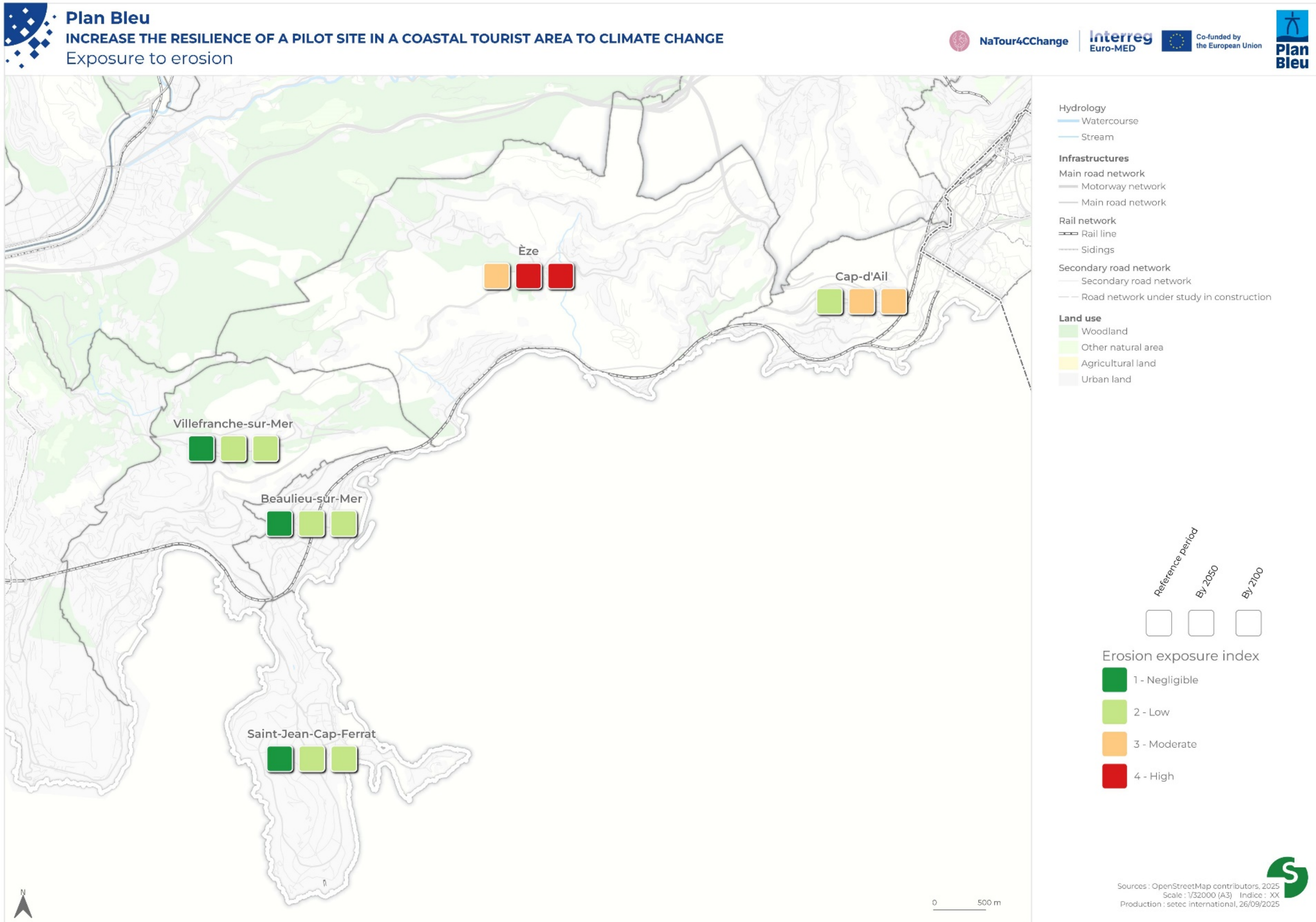


FIGURE 58: MAP SHOWING THE EXPOSURE OF MUNICIPALITIES TO THE EROSION HAZARD AND PROJECTED CHANGES FOR 2050 AND 2100. SOURCE: SETEC INTERNATIONAL.

3.3.1.3 SUMMARY OF EXPOSURE BY MUNICIPALITY

The table below summarises the exposure scores by municipality and by hazard.

TABLE 11: SUMMARY OF EXPOSURE INDICATORS

	Level of exposure by risk								
	Number of very hot days (>35°C)			Number of heatwave days			Number of warm nights		
	Reference	2050	2100	Reference	2050	2100	Reference	2050	2100
Beaulieu-Sur-Mer	1	2	4	1	2	4	1	1	3
Cap-D'Ail	1	2	3	1	2	3	1	2	4
Eze	1	2	4	1	2	4	1	1	3
Saint-Jean-Cap-Ferrat	1	2	3	1	2	3	1	3	4
Villefranche-Sur-Mer	1	2	4	1	2	4	1	1	3

	Marine flooding			Coastal erosion		
	Reference	2050	2100	Reference	2050	2100
Beaulieu-Sur-Mer	1	2	2	1	2	2
Cap-D'Ail	2	3	3	2	3	3
Eze	2	3	3	3	4	4
Saint-Jean-Cap-Ferrat	1	2	2	1	2	2
Villefranche-Sur-Mer	2	3	3	1	2	2

3.3.2 TOURISM SENSITIVITY INDICATORS

As part of the assessment of the sensitivity of tourism to climate hazards in the coastal municipalities of the MPA, several indicators were selected on the basis of available information and data.

3.3.2.1.1 SHARE OF WORKFORCE IN THE TOURIST ACCOMMODATION AND FOOD SERVICE SECTOR AS A PROPORTION OF THE TOTAL WORKFORCE IN THE MUNICIPALITY

As mentioned above, this indicator is used to estimate the relative weight of tourism in the local economy. A high number of employees in these sectors reflects the municipality's strong economic dependence on tourism, making it more sensitive to variations in visitor numbers, which might be linked to the impact of climate hazards (heat waves, beach erosion, etc.). In the event of climate disruption, jobs in these sectors may be affected in the short term. In the long term, tourist numbers could fall.

In France, employment in the tourist accommodation and food service sector represents on average around 6% of total salaried employment (Source: France Stratégie). This national figure is used as a reference to establish sensitivity thresholds. The threshold for **high sensitivity was set at 30%**, based on the case of ski resorts, where the local economy is based almost exclusively on tourism, and where the share of employees in these sectors reaches or exceeds this level.

TABLE 12: SCORING SCALE FOR THE SENSITIVITY INDICATOR RELATING TO THE SHARE OF WORKFORCE IN THE TOURIST ACCOMMODATION AND FOOD SERVICE SECTOR

Level of sensitivity		Description of level of sensitivity
4	High	More than 30% of the workforce
3	Medium	Between 20% and 30% of the workforce
2	Low	Between 10% and 20% of the workforce
1	Negligible	Less than 10% of the workforce

3.3.2.2 TOURIST ACCOMMODATION CAPACITY INDICATOR

The tourist capacity gives an initial estimate of the volume of tourists that the municipality can house, and therefore indirectly provides trends in visitor numbers, in the absence of actual visitor numbers.

TABLE 13: SCORING SCALE FOR THE SENSITIVITY INDICATOR RELATING TO TOURIST ACCOMMODATION CAPACITY

Level of sensitivity		Description of level of sensitivity
4	High	More than 300 tourist accommodation places
3	Medium	Between 200 and 300 tourist accommodation places
2	Low	Between 100 and 200 tourist accommodation places
	Negligible	Less than 100 tourist accommodation places

3.3.2.3 QUALITATIVE INDICATORS OF THE SENSITIVITY OF TOURISM-RELATED SOCIO-ECONOMIC ISSUES BY MUNICIPALITY

The aim of this indicator is to incorporate the sensitivity of the issues identified during the interviews and field observations, in order to reflect them in our study. This is a qualitative indicator, based on what the stakeholders in the area have to say.

TABLE 14: SCORING SCALE FOR THE SENSITIVITY INDICATOR OF SOCIO-ECONOMIC ISSUES.

Level of sensitivity		**Description of level of sensitivity**
4	High	Tourism is based on a single beach (in danger of disappearing), with no possibility of moving inland. The municipality is mainly focused on seaside tourism, with visitors concentrated in the high summer season.

3	Medium	The tourism offering is focused on the summer period, but the municipality is beginning to diversify by offering activities with staggered opening periods.
2	Low	The municipality's tourism offering is spread over several seasons, reducing its dependence on the summer period alone.
1	Negligible	The municipality has a varied and well-adapted tourism offering, including a wide range of activities, air-conditioned facilities, more greenery in public spaces, and a review of seasonal variations and opening periods.

3.3.2.4 WHY THESE SENSITIVITY INDICATORS?

Overall, these indicators make it possible to estimate the economic weight of tourism in the municipalities studied, and therefore their **sensitivity to the "indirect" impacts of climate change**. Tourist accommodation and restaurants are not directly exposed to climate hazards, but their activities can be indirectly affected by the deterioration of the local environment (erosion of the coastline, disappearance of beaches, episodes of extreme heat), which can reduce the appeal of the destination.

For a more refined analysis, it would be useful to include more precise data, such as the actual number of visitors to tourist establishments, beaches and sites of interest (number of sea activity providers, etc.). This data would give a better idea of the sensitivity of these areas to variations in visitor numbers.

3.3.2.5 SUMMARY OF SENSITIVITY BY MUNICIPALITY

The first sensitivity indicator corresponds to the sum of the score linked to the share of workforce in tourist accommodation and food service and the score linked to the total accommodation capacity.
The second sensitivity indicator is the qualitative indicator.

TABLE 15: SUMMARY OF SENSITIVITY INDICATORS BY MUNICIPALITY

Tourism sensitivity level

		Total tourist accommodation capacity	Share of workforce in the hospitality sector in the municipality	**Sum of the two indicators**
Indicator 1	Beaulieu-Sur-Mer	3	3	6
	Cap-D'Ail	2	3	5
	Eze	3	4	7
	Saint-Jean-Cap-Ferrat	3	4	7
	Villefranche-Sur-Mer	2	4	6

		Qualitative indicator of socio-economic sensitivity
Indicator 2	Beaulieu-Sur-Mer	3
	Cap-D'Ail	2
	Eze	3
	Saint-Jean-Cap-Ferrat	2
	Villefranche-Sur-Mer	4

For this second indicator, the score given to the municipalities is justified as follows:

Beaulieu-sur-Mer	Mainly summer tourism activity. Although the municipality has several beaches, the offering remains focused on the warm season, with little visible diversification or adaptation.
Cap d'Ail	Tourism activity is split between summer beach tourism and business tourism, which limits dependence on the summer season. Reduced sensitivity thanks to this diversification.
Èze	Summer tourism is focused on a single beach, which increases vulnerability. The lack of alternatives or diversification means that the municipality is vulnerable to climate hazards.
Saint-Jean-Cap-Ferrat	Relatively diversified tourism offering, with a focus on adaptation. The beaches are less threatened with disappearance than in other neighbouring municipalities
Villefranche-sur-Mer	Seaside tourism, concentrated in the high summer season. Beaches, particularly those with beach restaurants, are in danger of disappearing, with no real possibility of retreating inland. Little thought given to adaptation.

3.3.3 Adaptative capacity

Adaptative capacity is the capacity to respond and make adjustments to practices and activities in order to cope with climate change and its impacts. In the absence of quantified data from field surveys, a qualitative approach has been chosen based on two assumptions tested in a workshop in July 2025.

Two assumptions were discussed:

- **The agility of small businesses:**

Smaller businesses (gites, beach restaurants, etc.) can recover after a shock (e.g. flooding) and/or grow more quickly, by adapting their range of tourist services. These businesses are more responsive and flexible to changes in tourism or crises.

In comparison, large businesses appear to be slower at repositioning themselves, due to their structural complexity and larger property assets.

- **Economic strength of larger businesses:**

Larger businesses (hotel groups, restaurant chains, etc.) have more financial resources so they can invest in transformation and adaptation to climate change.

Conversely, small businesses are limited by a lower cash flow and smaller investment capacity.

Workshop findings:

The discussions identified a preference for the second assumption, illustrated by a concrete example: a 3-star hotel that took advantage of its heat adaptation process to move upmarket and obtain a 4-star rating.

However, other factors have added nuance to this interpretation. It has emerged that the adaptative capacity depends not only on the size of the businesses, but also on other factors, such as insurance cover.

One particular point emphasised during the workshop concerned the local roots of small businesses. This rootedness encourages their desire to **stay put and adapt locally**, rather than de- or relocate. This local connection represents significant leverage for resilience, and should be taken into account when considering how to adapt the tourism sector.

3.3.4 Potential future impacts

In the short term, the study areas do not appear especially vulnerable to the effects of climate change. However, this situation could change significantly in the medium and long term, due to a change in **climate hazards, which will become more intense (average temperatures, heat waves, intense rainfall, marine flooding (medium-to-low confidence) and more frequent (number of days with higher susceptibility to fires, number of days with temperatures above 35°C)**. The intensification of extreme phenomena, such as heat waves or prolonged droughts, could weaken the current balance, particularly in coastal areas and natural spaces that are very popular with tourists.

An increase in climate indicators such as average temperatures, the number of summer days, tropical nights and heat waves could **profoundly alter the region's appeal as a tourist destination**.

For the short term, the GREC-SUD territorial report (2021) stresses that hot countries still remain appealing and that "the future of tourism in the metropolitan area will of course depend on climate change, but also on the tourism offering, the effectiveness of advertising, social media and trends, etc." The GREC-SUD (2024) thematic report on tourism also states that the effects of climate change (intensification of heat waves, droughts and fire risks) will lead to the increased use of coastal areas in summer, by visitors searching for relative coolness. The coastline of the Provence-Alpes-Côte d'Azur region could therefore **see an increase in visitor numbers, to the detriment of urban centres or the hinterland, exerting even more pressure on ecosystems.**

In the longer term, longer and hotter summer periods are likely to make summer stays less enjoyable, particularly for families or the elderly, while putting additional pressure on water resources and increasing the need for air conditioning.

On the other hand, these developments could lead to **increased visitor numbers either side of the high season**, with **a demand for different activities** (hiking trails, heritage sites, etc.).

The potential increase in forest fires, exacerbated by factors such as drought and high temperatures, represents a direct threat to the tourism sector and will probably require greater vigilance in the future. The Forest Fire Weather Index (FWI) is an indicator used by Météo France to assess future risk, which is set to increase in the future. The number of days with conditions conducive to outbreaks of fire are set to increase, as described above. These fires can lead **to the closure of natural sites (hiking trails) and damage the destination's image**, particularly in high season.

The gradual rise in sea water temperature is having a profound effect on coastal ecosystems, directly threatening biodiversity. This warming is contributing to the death of emblematic species such as gorgonian corals, Posidonia seagrass meadows and coralligenous formations, which play an essential role in structuring marine habitats. Rising temperatures can also contribute to the spread of jellyfish, whose blooms may become more frequent and more massive.

These transformations will directly affect sea discovery activities, such as scuba diving or whale watching trips. Degradation of the seabed is reducing the visual and biological appeal of diving sites. In the long term, these developments could compromise the sustainability of these tourist activities, which are invaluable for raising awareness of the need to preserve the marine environment.

Another impact that has not yet been mentioned is **the spread of mosquitoes**, in particular the tiger mosquito (*Aedes albopictus*), **whose period of activity is lengthening under the effect of climate change.** Earlier springs and milder autumns are favourable to their presence over a longer period, coinciding with periods of high tourist numbers and outdoor activities. This nuisance, amplified by urbanisation and transport, can make certain destinations less appealing. In addition, the risk of transmission of vector-borne diseases such as dengue fever, chikungunya or, more rarely, malaria, is increasing, and could pose a public health issue in the coming years. (GREC SUD, 2022)

SUMMARY OF FUTURE CLIMATE IMPACTS ON TOURISM

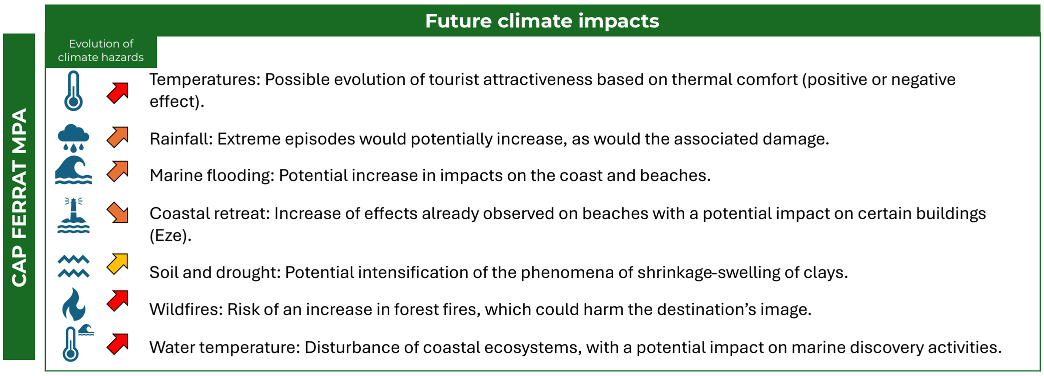


FIGURE 59: SUMMARY OF FUTURE CLIMATE IMPACTS ON TOURISM. SOURCE: SETEC INTERNATIONAL

3.3.5 LEVELS OF VULNERABILITY BY MUNICIPALITY

Here, it is interesting to note that the five municipalities have a relatively similar vulnerability to the hazards associated with heat and marine flooding. Èze is more vulnerable to erosion-related hazards.

All municipalities will see their level of vulnerability to heat-related hazards increase in the future.

TABLE 16: TABLE OF RESULTS: COMPARISON OF EXPOSURE WITH SENSITIVITY INDICATOR NO. 1 (SHARE OF WORKFORCE IN THE FOOD SERVICE AND HOSPITALITY SECTOR)

	Number of very hot days (>35°C)			Number of heatwave days			Number of warm nights		
	Reference	2050	2100	Reference	2050	2100	Reference	2050	2100
Beaulieu-Sur-Mer	6	12	24	6	12	24	6	6	18
Cap-D'Ail	5	10	15	5	10	15	5	10	20
Eze	7	14	28	7	14	28	7	7	21
Saint-Jean-Cap-Ferrat	7	14	21	7	14	21	7	21	28
Villefranche-Sur-Mer	6	12	24	6	12	24	6	6	18

	Marine flooding			Coastal erosion		
	Reference	2050	2100	Reference	2050	2100
Beaulieu-Sur-Mer	6	12	12	6	12	12
Cap-D'Ail	10	15	15	10	15	15
Eze	14	21	21	21	28	28
Saint-Jean-Cap-Ferrat	7	14	14	7	14	14
Villefranche-Sur-Mer	12	18	18	6	12	12

Possible results

X		Exposure level			
		1	2	3	4
Sensitivity level	2	2	4	6	8
	3	3	6	9	12
	4	4	8	12	16
	5	5	10	15	20
	6	6	12	18	24
	7	7	14	21	28
	8	8	16	24	32

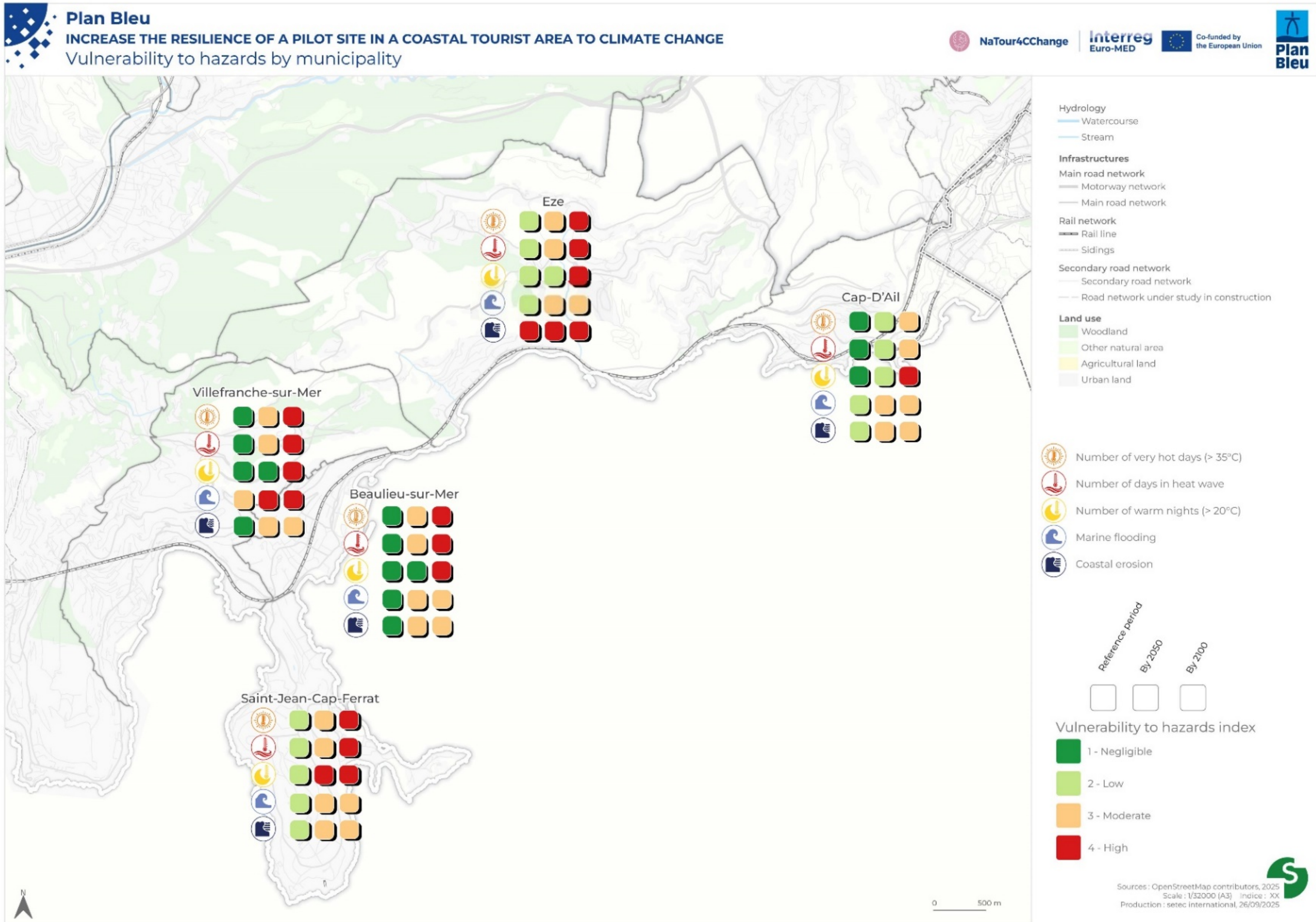


FIGURE 60: MAP OF VULNERABILITY TO HAZARDS IN 2050 AND 2100. SOURCE: SETEC INTERNATIONAL.

TABLE 17 : TABLE OF RESULTS: COMPARISON OF EXPOSURE WITH SENSITIVITY INDICATOR NO. 2 (SENSITIVITY LINKED TO THE SOCIO-ECONOMIC CHARACTERISTICS OF MUNICIPALITIES)

	Number of very hot days (>35°C)			Number of heatwave days			Number of warm nights		
	Reference	2050	2100	Reference	2050	2100	Reference	2050	2100
Beaulieu-Sur-Mer	3	6	12	3	6	12	3	3	9
Cap-D'Ail	2	4	6	2	4	6	2	4	8
Eze	3	6	12	3	6	12	3	3	9
Saint-Jean-Cap-Ferrat	2	4	6	2	4	6	2	6	8
Villefranche-Sur-Mer	4	8	16	4	8	16	4	4	12

	Marine flooding			Coastal erosion		
	Reference	2050	2100	Reference	2050	2100
Beaulieu-Sur-Mer	3	6	6	3	6	6
Cap-D'Ail	4	6	6	4	6	6
Eze	6	9	9	9	12	12
Saint-Jean-Cap-Ferrat	2	4	4	2	4	4
Villefranche-Sur-Mer	8	12	12	4	8	8

Possible results					
X		Exposure level			
		1	2	3	4
Sensitivity level	1	1	2	3	4
	2	2	4	6	8
	3	3	6	9	12
	4	4	8	12	16

GENERAL RECOMMENDATIONS AND ACTION PLAN (Act.2.5)

Various courses of action were presented during the workshop and through discussions with the Metropolis departments.

At this stage, two or three types of action have been identified:

- Actions to preserve Posidonia seagrass meadows and coralligenous formations - maintaining Posidonia with manual cleaning (e.g. a proposal for Beaulieu), a limited mooring area (ZMEL) (e.g. near Paloma / Anse Scaletta), a no-mooring area (ZIM), local plan for ecological restoration (STERE), active restoration, replanting Posidonia and coral,
- Actions for the participatory monitoring of the impacts of climate change, such as climate monitoring or participatory science, with a focus on raising tourist awareness: - development of sites for observing changes in the impacts of climate change (monitoring Posidonia, etc), implementation of erosion monitoring systems

- A third series of actions focuses on improving thermal comfort for tourists - development of cool zones in communities, or “climate refuges”, etc.

These ideas will be explored in greater depth and prioritised in the subsequent stages.

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ANNEXES

INSEE AND URSSAF DATA ON TOURIST ACCOMMODATION CAPACITY BY MUNICIPALITY AND THE SHARE OF WORKFORCE EMPLOYED IN THE ACCOMMODATION AND FOOD SERVICE SECTOR BY MUNICIPALITY.

Transparent Lighthouse

	Capacité d'hebergement total	Part d'effectif salarié dans le secteur hébérgement et restauration par commune (%)
Source	INSEE (2024)	URSAFF (2024)
Beaulieu	345	24,1%
Cap-D'Ail	251	27,0%
Eze	212	53,8%
Saint-Jean-Cap-Ferrat	325	43,8%
Villefranche-Sur-Mer	489	31,6%
Total	1622	

DATA FROM THE NICE COTE D'AZUR METROPOLIS TOURIST OFFICE AND TRANSPARENT LIGHTHOUSE ON OCCUPANCY RATES AND THE NUMBER OF FURNISHED TOURIST ACCOMMODATION UNITS IN 2023 AND 2024.

EXPLORE NICE CÔTE D'AZUR TOURISME & CONGRÈS

Bilan annuel littoral est de Nice

Commune	Taux occupation meubles touristiques 2023 (%).	Taux occupation meubles touristiques 2024 (%).	Nombre de meubles touristiques 2023.	Nombre de meubles touristiques 2024.
BEAULIEU-SUR-MER	40%	39%	350	364
CAP-D'AIL	43%	37%	431	472
EZE	36%	35%	361	424
NICE	**52%**	**49%**	**16 611**	**18 370**
SAINT-JEAN-CAP-FERRAT	33%	33%	232	242
VILLEFRANCHE-SUR-MER	46%	44%	939	992
METROPOLE NCA	**47%**	**44%**	**18 924**	**28 016**

Number of overnight stays in the municipalities east of the NCA Metropolis from 2012 to 2024.

Nuité

Hôtels + Résidences		Janvier	Février	Mars	Avril	Mai	Juin	Juillet	Août	Septembre	Octobre	Novembre	Décembre	ANNEE
Nuitées	**2012**	20947	24645	36621	55176	59320	68304	86349	90863	65563	44818	18938	17653	**589196**
	2013	18856	23340	32434	43839	58532	68428	83348	87631	63914	45805	17040	15532	**558698**
	2014	19906	22184	32284	50908	57121	62917	74745	84722	62205	43317	17115	17984	**545410**
	2015	18732	24240	33399	42186	49292	57779	74365	82073	59567	46070	17259	17046	**522008**
	2016	19058	22104	34302	45150	54249	64149	69171	78494	59706	41140	17226	16660	**521410**
	2017	18095	22343	29372	48783	48016	58014	76169	80343	61585	47385	18734	16811	**525649**
	2018	19209	22158	31900	52500	51707	63910	78227	86143	64309	44538	19007	19596	**553204**
	2019	14632	19148	30071	44394	46857	57292	71272	75207	60409	44785	15899	17232	**497197**
	2020							49453	66153	25442	18060			
	2021					14895	29183	58200	71400	46842	34666	15857	10526	
	2022	6248	15612	23418	39498	46802	57458	66325	66966	52240	40611	17240	12533	**444950**
	2023	14890	18889	24236	42165	46982	57592	68469	65911	55474	41223	15485	13287	**464604**
	2024	12454	17465	26072	38294	51667	57899	67854	67435	54843	40036	14848	12817	**461686**

Source : Insee et Côte d'Azur France Tourisme
Champ : Communes du littoral Est de la Métropole Nice Côte d'Azur