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Region of Crete

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

Project Information	
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Project Priority	#2: A Greener Med



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Project Overview

The Mediterranean region is one of the most vulnerable hotspots in the current biodiversity and climate crises, warming 20% faster than the global average and being the second biodiversity hotspot in the world. The increase of severe climate events are also likely to influence the choice of destinations and time to travel 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 ensure the long-term engagement of the private sector and citizens. Indeed, ecosystem-based management is considered a good practice to effectively deal with these threats as it considers the different stakeholders and factors affecting ecosystems and the mechanisms involved, in order to find solutions.

NaTour4CChange builds on and capitalises 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 set common methods to allow participating regions to assess their tourism-related climate adaptation and mitigation priorities, and take climate action via plans and strategies, supported by cooperative governance.

In coastal destinations, cross-sector teams will deliver specific tourism 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 participating regions and destinations, to achieve common methods and to compare the different tested plans and solutions, leading to lessons, best practices, and policy.



Glossary

Climate Change Adaptation (CCA) means anticipating the adverse effects of climate change and taking appropriate measures to prevent or minimise the damage they may cause, or to take advantage of the opportunities that may arise.

Climate Change Mitigation (CCM) means making the impacts of climate change less severe by reducing the sources of emission of greenhouse gases (GHG) into the atmosphere or by improving the storage of these gases.

Ecosystem Services (ES) are the benefits that an ecosystem brings to society and that improve people's health, economy, and quality of life.

Ecosystem-based Approaches (EbA) focus on managing biodiversity and ecological systems in a holistic way to maintain and enhance ecosystem services benefits and functions.

Nature-based Solutions (NbS) encompasses all actions that rely on ecosystems and the services they provide to respond to various societal challenges such as climate change, food security, resource management, or disaster risk.



1. INTRODUCTION :

Crete's economy and identity are deeply tied to tourism, with rapid growth but sustainability challenges. Its diverse landscapes and climate support both biodiversity and renewable energy projects. Demographic stability contrasts with seasonal population surges from tourism.

1.1 REGION OF CRETE – DEMOGRAPHY

- Population : 624,408 (2021 estimate), making it Greece's 5th most populous region .
- Main Cities :
 - Heraklion (capital, pop. ~144,442): Largest city and economic hub.
 - Chania (~53,910): Cultural and historical center.
 - Rethymno (~32,468): Blend of Venetian and Ottoman heritage.
 - Agios Nikolaos (~12,000): Coastal town in Lasithi.

Human Development index HDI (2022) : 0.882 (ranked 3rd in Greece), reflecting high life expectancy, education, and income levels. Economy : Tourism dominates (~47% of GDP), alongside agriculture (olives, wine) and renewable energy initiatives.

1.2 REGION OF CRETE – BIOCLIMATE & NATURAL ASSETS

Geography is Mountainous (e.g., Mount Ida, 2,456m), with gorges (e.g., Samariá Gorge), plateaus (e.g., Lasithi Plateau), and 1,046 km of coastline. Climate : is typically Mediterranean (dry summers, mild winters). Key features:

- Rainfall : 400–700 mm/year (lowlands); up to 2,000 mm in mountains.
- Temperature : Avg. 18.5–19°C; southern Crete is Greece's warmest region.
- Natural Assets :
 - Biodiversity : Maquis shrubland, cypress forests, and endemic species like the Cretan wild goat (*kri-kri*).
 - Protected Areas : Samariá Gorge (UNESCO Biosphere Reserve), Natura 2000 sites.
 - Renewable Energy : 25% of energy from renewables (solar, wind), with plans for "Renewable Energy Valleys".

1.3 REGION OF CRETE – TOURISM SECTOR

- Tourist Arrivals :
 - 6.5 million visitors (2024) , a 60% increase since 2019 .
 - 2025 Trends : 1.9 million air arrivals (Jan–Jun 2025), up 4.7% YoY.
- Key Attractions :



- Cultural : Minoan palaces (Knossos), Venetian harbors (Chania), Byzantine monasteries.
- Nature : Beaches (Elafonissi, Balos), hiking (E4 trail), ecotourism (Zakros Gorge).
- Nightlife : Malia and Hersonissos (popular with British youth).
- Trends & Challenges :
 - Luxury Growth : 20,000 new five-star hotel beds planned by 2030.
 - Seasonal Peaks : 80% arrivals in summer; efforts to promote winter tourism (cultural/trekking).
 - Overtourism : Density of 4,120 bed-nights/km² (2023), straining infrastructure.

1.4 ROLE OF TOURISM IN THE REGIONAL ECONOMY

Region of Crete is one of the most prosperous areas in Greece. One of the key sectors of economic development in the island is tourism. According to eurostat GDP (2021) datasets in Crete 80% belongs to tertiary sector, 10% to secondary and 10% to primary sector of economy, More specifically:

TABLE 1: REGIONAL ECONOMIC SECTORS

Sector	% of GDP	% of Employment	Sources
Tourism	25-30%	30,00%	SETE (2023), ELSTAT
Agriculture	15-20%	20,00%	ELSTAT, Eurostat
Trade & Retail	15-20%	20,00%	Enterprise Greece
Shipping & Ports	5-10%	5,00%	Hellenic Ports Association
Construction	5-8%	10,00%	Bank of Greece Reports
Renewable Energy	~3-5%	2,00%	Greek Ministry of Energy
Education & Research	~5%	8,00%	University of Crete, FORTH
Other		5,00%	

Tourism requires balanced policies to address seasonality, environmental costs, and equitable rural development. Diversification into sustainable and year-round tourism is critical for long-term resilience. Tourism dominates, especially in peak seasons, but can



fluctuate also due to external factors¹. Agriculture remains vital, with Crete being a top producer of olive oil and Mediterranean products. Trade/Retail and Construction are closely tied to tourism and EU funding (e.g., infrastructure projects). Shipping benefits from Crete's strategic location. Renewables are growing but still limited by grid connectivity issues.

1.5

1.6 IMPACTS OF TOURISM IN THE LOCAL ENVIRONMENT

Tourism has brought significant economic benefits, but it has also led to visible environmental impacts, some of which threaten the island's natural ecosystems and long-term sustainability. Below are listed most relevant effects:

- Infrastructure carrying capacity. Large touristic volumes require large waste (biological) treatment infrastructures that underperform with small local population, this seasonally creates unpleasant odors in local communities when the touristic volumes are low or zero. Similarly other important infrastructures are affected by the seasonality.
- Water scarcity especially in high seasons, when the touristic volume is very high can affect other communities as it consumes large quantities of water, straining local supplies, especially during the dry summer months. Also water diverted to tourism can reduce availability for farming, impacting local food systems and rural communities. Over-pumping in dry areas leads to saltwater intrusion
- Urban sprawl. Vast areas are developed only for seasonal use and large touristic volumes. This factor reduces settlements continuity, disrupts local village heritage and leads to loss of agricultural lands. It contributes to the fragmentation of natural habitats and therefore to the loss of biodiversity.
- Coastal degradation. Construction of hotels, resorts, and beach facilities close to the shoreline disrupts natural sand movement and can accelerate erosion. Pollution generated by tourism affecting sea life and water quality
- Disturbance to Natural Parks and sensitive ecosystems. Massive tourism can affect negatively important habitats due to high traffic and noise levels

As we will see in the following chapters, major impacts are visible in the north part of Crete where touristic development is high.

1.7 REGULATORY FRAMEWORKS

Crete's climate and tourism policies align with EU Green Deal objectives but require stricter local enforcement. Priorities include water conservation, renewable energy, and tourism carrying capacity. Below are summarized national, regional and sectorial planning regulations in the fields of climate change, tourism and biodiversity conservation

¹ Seasonal heat waves, diseases, economic stability



National level

In May 2022, the first climate law² was passed in Greece, establishing, among other things, the framework for the adaptation to climate change and the gradual mitigation of anthropogenic greenhouse gas emissions. In order to achieve the long-term objective of carbon neutrality by 2050, intermediate emission reduction targets are set for the years 2030 and 2040 (a reduction of 55% and 80%, respectively) relative to 1990 levels.

Regional level

The same year was approved³ the Regional Plan of adaptation in climate change (PEPSKA Kritis) in order to mitigate the climate change effects in the region. Basic targets of the Regional plan are:

1. Systematization and improvement of the process of making (short-term and long-term) decisions related to adaptation and their implementation in the actions of the Region's bodies
2. Linking adaptation with the promotion of a sustainable development model
3. Promoting adaptation actions and policies in all sectors of the economy with emphasis on the most vulnerable
4. Creation of a mechanism for monitoring, evaluating and updating adaptation actions and policies
5. Informing and raising awareness of society

This plan is analyzing in short, middle and long term period (2021-2040, 2041-2060, 2081-2100) 2 Representative Concentration Pathway scenarios (RCP 4.5 and RCP 8.5) in the region of Crete in the following sectors :

1. Agricultural and livestock production
2. Forests and reforested areas
3. Biodiversity – Ecosystems
4. Fisheries and Aquaculture
5. Water resources (in terms of their availability)
6. Rivers (in terms of flooding phenomena)
7. Coastal uses
8. Tourism
9. Energy
10. Transport infrastructure (road network, port and airport infrastructure)

² Law 4936/2022 (FEK 105/A)

³ ΑΔΑ: ΨΔ507ΛΚ-ΞΕΣ



11. Health

12. Built environment

13. Cultural heritage

More detailed informations about the tourism and ecosystems resulting scenarios are illustrated in the following chapters (2.2)

Region of Crete approved Tourism Strategic Planning & Operational Plan 2024 – 2028 with the following targets :

Developing Crete's tourism in Space, Time and Manner through the diversification of its tourism product. Focusing on the visitor's experience, through the promotion of alternative forms of tourism and the promotion of the authenticity of the destination & experiences to visitors.

- Shielding the destination with resistance to economic, social, etc. global crises through its differentiated product & incomparable hospitality.
- Tourism development in balance with the well-being of the residents. Improving the lives of locals through the social dimension of tourism, so as to allow the achievement of harmonious social and economic life and development.
- Sustainability and tourism. Strengthening the implementation of sustainable practices throughout the destination's tourism chain & adaptation to Climate Change.
-
- Collection, analysis, management and dissemination of data and information that will help all beneficiaries in decision-making. Full acceptance of the saying: "If you can't measure, you can't manage!"
- Education, information and provision of all kinds of support and assistance to those involved in tourism of other local authorities, bodies and organizations and all kinds of people related to it, even indirectly (Schools).
- Formation and strengthening in every appropriate way, the tourism consciousness in local authorities of Crete, bodies, businesses, employees and residents and transmission of the concept and value to future generations.

In regional level is also operational from 2017 the Regional Spatial Plan of Crete that delegates⁴ regulations in spatial development in all sectors for the region of Crete.

Finally, today from since 2021, has been is under development the Sectorial National Spatial Plan for tourism development that categorizes municipalities in various level of touristic development with the respective policy goals and restrictions. In the following map are illustrated the level of touristic development from most developed (A) to less

⁴ To local spatial development plans



developed (E) and the respective policies and restrictions (mostly for the overdeveloped areas) :

TABLE 2: REGULATIONS SUMMARY

Regulation Level	National	Regional
Non Spatial regulations/directives	Law 4936/2022 (FEK 105/A/2022) (FEK 974/B/2001) 99605/3719 National Action Plan to against desertification	Tourism Strategic Planning & Operational Plan 2024 - 2028
Spatial regulations	Tourism National Spatial Plan	Regional Spatial Plan of Crete (2017) Regional Plan of adaptation in climate change (2022)

From the following maps we can see the most developed touristic areas (in red), in where restrictions are applied restrictions (in regional spatial plan). In tourism national spatial plans are also identified in the same areas with intensive touristic development. These areas are situated mostly in the north part of the island

The following table describe with numbers major touristic characteristics in Crete:

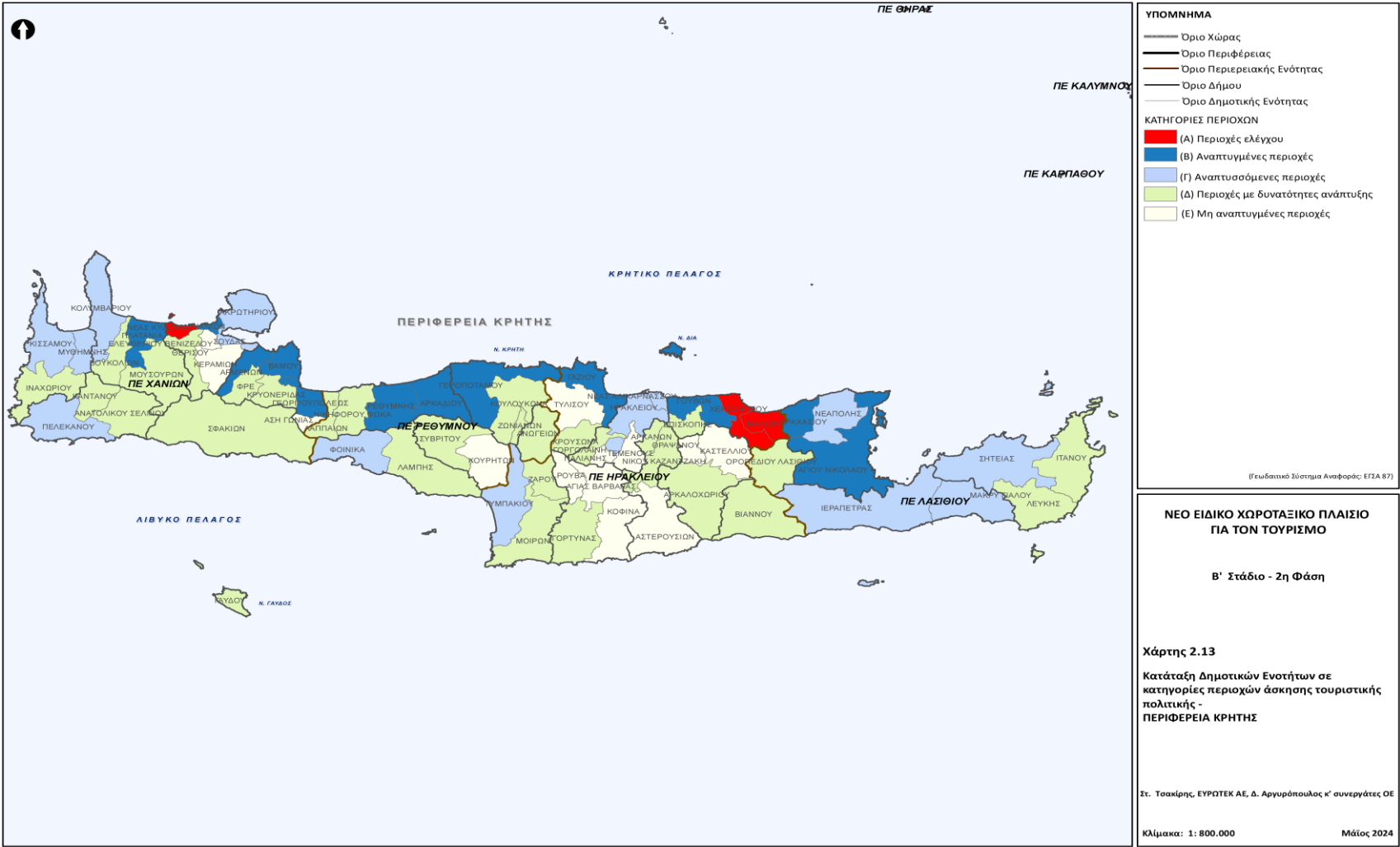
Lasithi	Heraklion	Rethimno	Chania	Crete
Hotels				
202	509	339	593	1643
Rooms				
13942	39757	18362	27531	99592
Beds				
27985	80618	36357	51917	196877
Ports				
1	1	1	1	4
Airports				
1	1	0	1	3

As we can see the most developed provinces are Hrakleio and Chania and less developed is Lasithi. The results are visible in the following map with red colors :

FIGURE 1: REGIONAL SPATIAL PLAN OF CRETE (2017)



FIGURE 2: TOURISM NATIONAL SPATIAL PLAN (UNDER DEVELOPMENT)





The map above divide Crete in touristic development areas :

- RED – Overdeveloped areas
- LIGHT BLUE – Developing areas
- DARK BLUE – Developed areas
- GREEN – Underdeveloped areas

As we can see northern parts of Crete are overdeveloped and the south-coast mostly underdeveloped

2. COLLECTION AND ANALYSIS OF HISTORICAL CLIMATE DATA

2.1 DESCRIPTION OF DATA COLLECTION METHODS

Crete's climate risks include worsening droughts, extreme heatwaves, coastal erosion from rising seas, destructive flash floods, biodiversity loss from desertification, and economic impacts on tourism. The region urgently needs improved water management, coastal defenses, and climate-smart agriculture to adapt.

Datasets were collected from different national and international sources according availability and scale. More specifically datasets are collected from:

- GIS Database of Greek Minister for the Environment (YPEN)
- GIS Database of Region of Crete
- GIS Database of Decentralized Administration of Crete
- Hellenic National Meteorological Service (EMY)
- Natural Environment & Climate Change Agency – AdaptiveGreece⁵ Hub
- European Environmental Agency GIS database (EEA)
- Copernicus EU

For the analysis are used public authorities data and local observations for the private sources that were available in the fields of interest.

Different types of stakeholders are involved in the process. More specifically are involved public sector stakeholders like region of Crete and Sitia Geopark authority and private sector stakeholders like profesional in the sector of tourism from Ierapetra and Sitia.

Regional datasets are provided for without any issues, although local (destination) datasets are missing or are collected partially due to lack of detailed information about

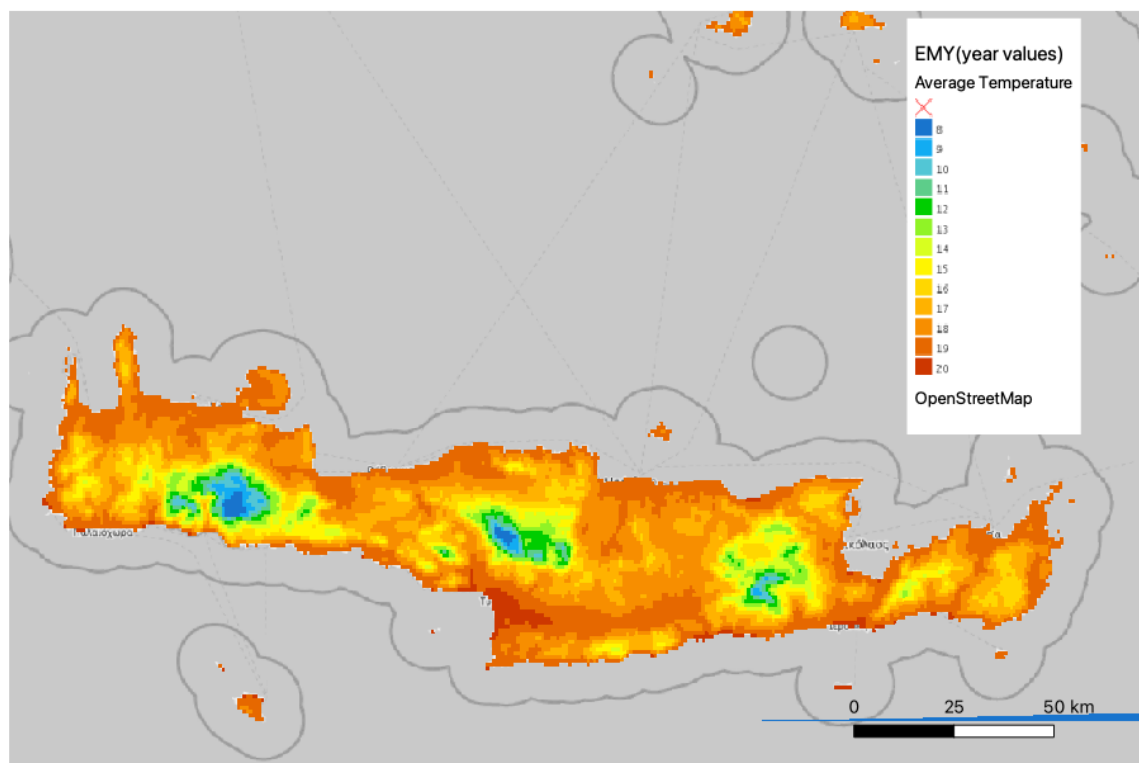
⁵ <https://ofypeka.dotsoft.gr/>



specific arguments. There are also some datasets⁶ reliable only at national level. Finally dataset uniformity issues⁷ are observed among different reference (spatial) levels

2.2 STATE OF THE ART OF CLIMATE ACTION PLANNING AND ASSESSMENT

For the Region of Crete we have an increase of temperature $\sim 1.5^{\circ}\text{C}$ since pre-industrial times, and more intense droughts. Generally are Increased heatwaves. In the following maps we can see national official measurements from climate atlas (1971-2000):



In the following maps we see average and max temperatures in C. As we can see max temperatures are mostly in south Crete (in red) and lower temperatures (in blue) in the mountains of Crete

⁶ Example: sea level rise

⁷ Measurement units

FIGURE 4: MAX ANNUAL TEMPERATURE CRETE (EMY)

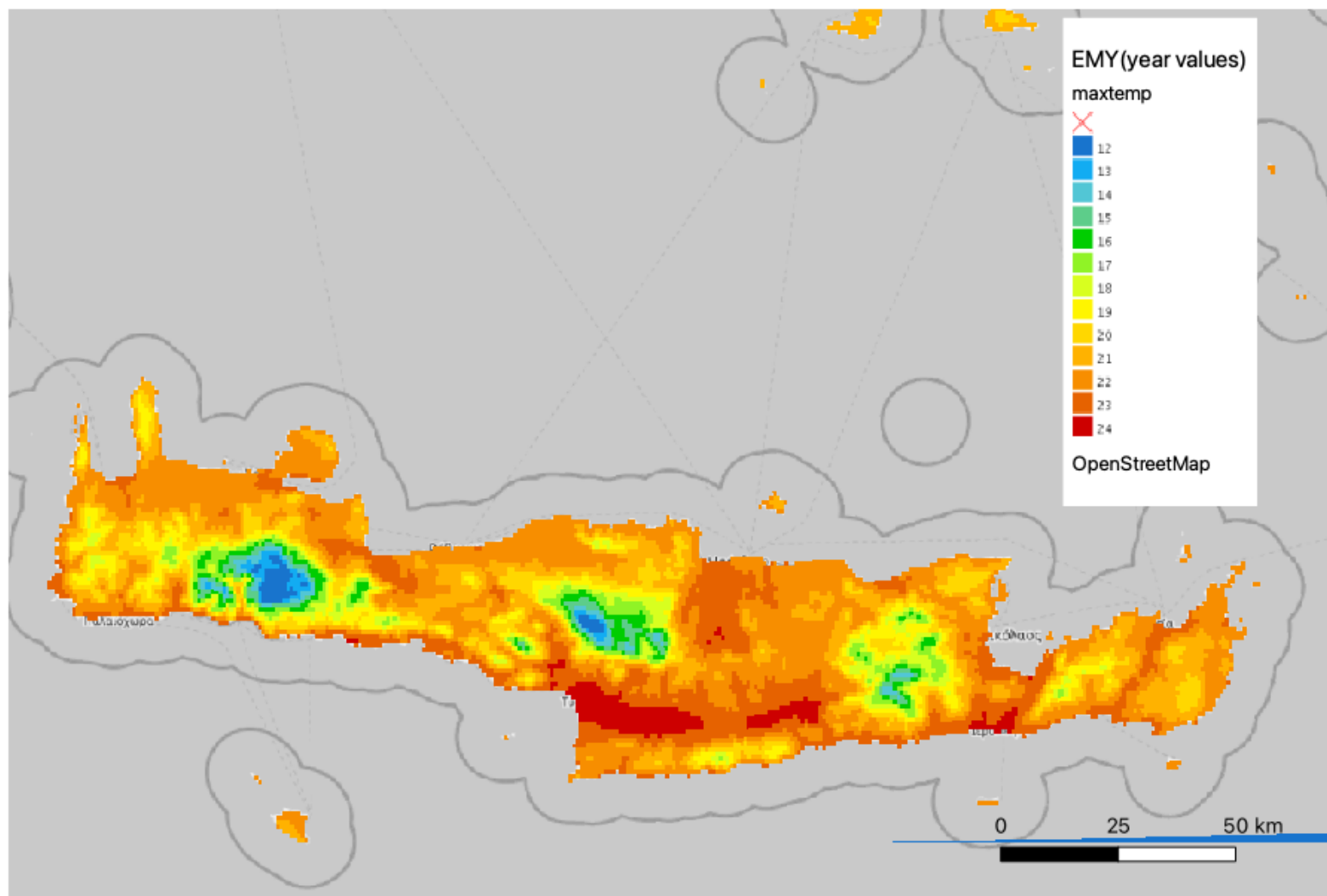
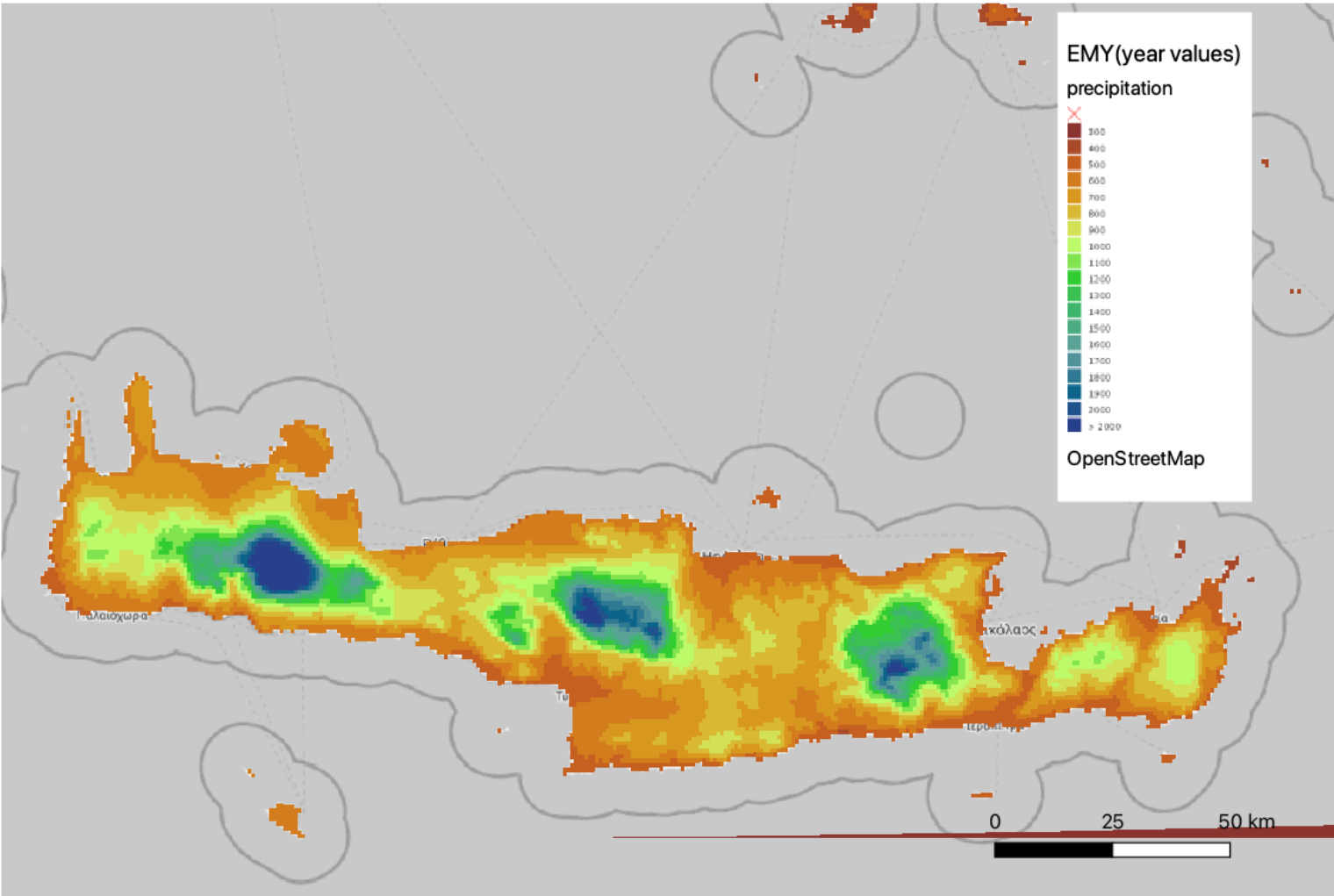


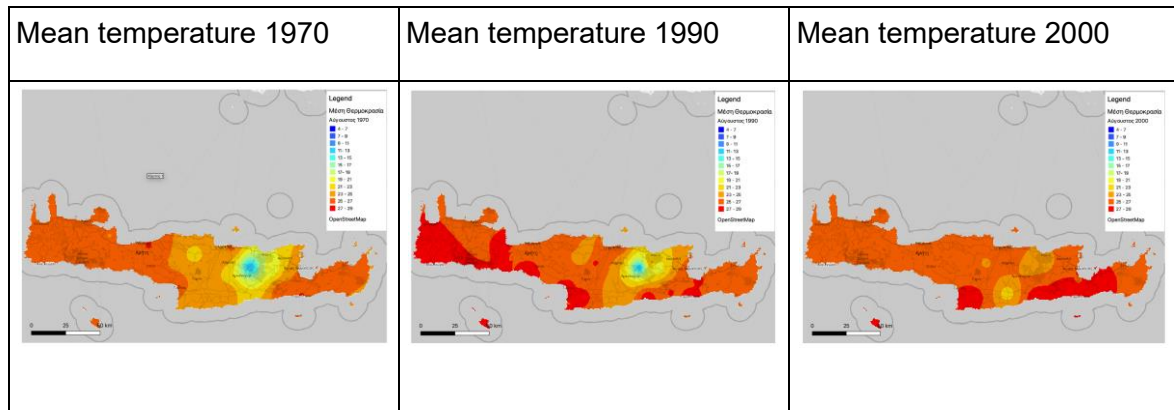
FIGURE 5: PRECIPITATION CRETE (EMY)





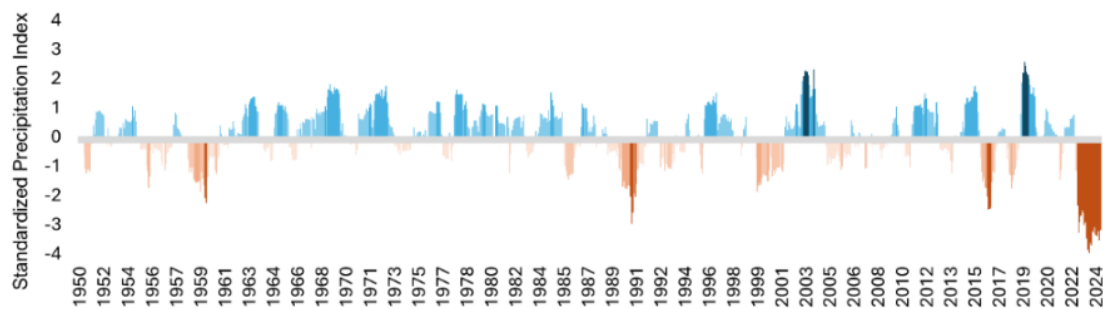
Yearly Precipitation in mm of rainfall from different stations

As mention before major issues for the region of Crete are: increase of temperature, and more intense droughts. The mean annual temperature⁸ is 16.7 considered as base.



In the maps above we see high temperatures (in red) and low temperatures (in blue)

Analyzing the precipitation trend⁹ for the last 70 years we see rainfall deficit in 1959, 1991, 2017 and 2024. Generally precipitation differs in the years.



As mentioned, Crete from 2022 has adopted Regional Plan of adaptation in climate change. For the Region of Crete, based on the A1B scenario of the IPCC's 4th Assessment Report, an increase in the average annual temperature is predicted, ranging from 1.4°C for the period 2021-2050 to 3.1°C for the period 2071-2100.

According to the EMEKA Report (2011), a significant percentage reduction in the average annual rainfall is also predicted, which during the period 2021-2050 will approach 15%. The predicted increase in temperature and the decrease in rainfall are expected to lead to an increase in the duration of dry periods, especially in the northern Chania-Rethymno-Heraklion Region where 20 additional days of drought are expected during the period 2021-2050 and up to 40 additional days during the period 2071-2100.

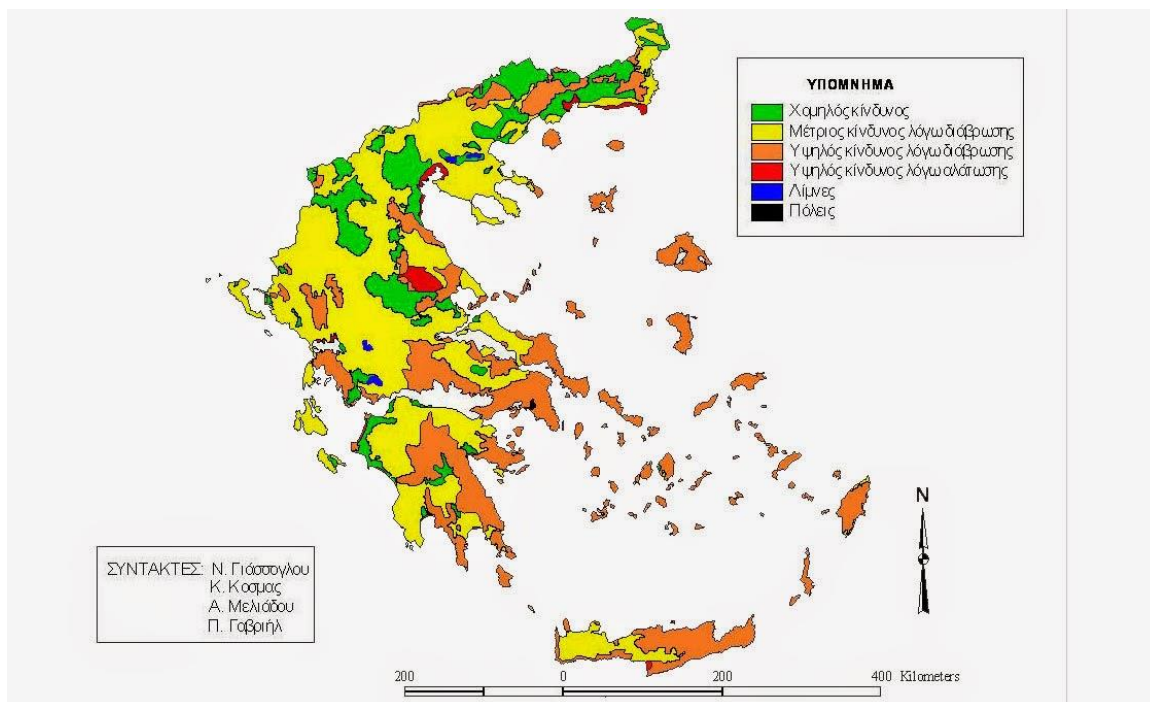
⁸ Measurements from 1950-2023, although 1971-2000 is 15.3

⁹ Climaax - Climate risk assessment report - Crete 2025



With the increase in temperature and the increase in dry periods, the number of fires during the summer period is expected to increase, as well as the total burned area, while on the contrary, a reduction in the interval between two consecutive fires is predicted. The forests of Crete, along with those of the southern mainland, are expected to be most affected by forest fires. (source: Regional Plan of adaptation in climate change, 2022)

Climate change effects are desertification risk, because the majority of Crete is under desertification threat (orange):



To address climate change effects in urban environment, elementary European measuring indicators are adopted to follow the mitigation process. More specifically with the Law 5037/2023 with article 177 a specific target was established in order to increase green cover in urban areas. More specifically the target is to increase trees (in urban environments) to 10% within 2050. The target is measured by Copernicus - Leaf Area Index (LAI) by ministry of environment. As mentioned before an action plan has been adopted in Regional level for the mitigation of climate change.

Until now there are not specific resilience measures in tourism sector except Tourism Spatial plan¹⁰, although some touristic taxes are introduced¹¹ this year in Santorini and Mykonos island's in order to reduce large volumes of cruise touristic flows, especially in high seasons.

¹⁰ Tourism Spatial Plan is a planning national tool in order to organize the touristic spatial development in Greece in order to mitigate overdeveloped tourism areas in the island

¹¹ In 2025 Minister of Tourism was introduced a new tax on cruise visitors (20€ / person) in order to address large cruising visitors in some islands



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2.3 ANALYSIS OF PAST EXTREME WEATHER EVENTS

According to National Observatory of Athens register of extreme weather events in the region of Crete for the period 2000-2023 :

FIGURE 8: HEAT WAVES CRETE 2000-2023

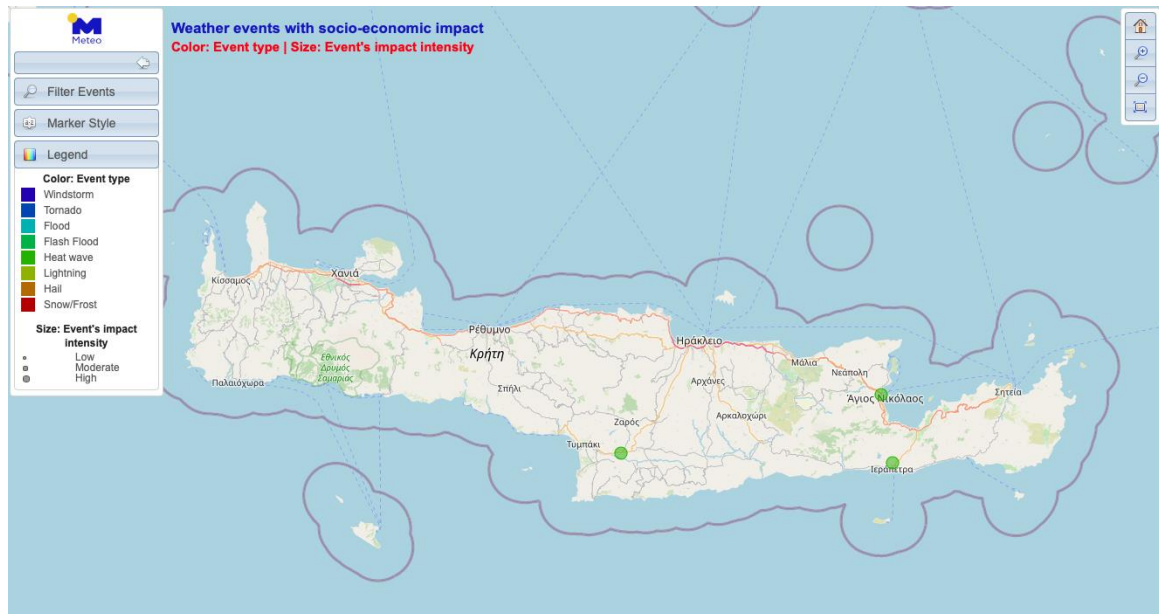


FIGURE 9: FLASH FLOODS CRETE 2000-2023



FIGURE 10: EXTREME EVENTS CRETE 2000-2023





TABLE 3: EXTREME EVENTS CRETE

Heat waves	3 events
Wind storms	33 events
Flash floods	57 events
All extreme events	109 events

Although heat waves and wind storms extreme events have the major impacts in term of intensity. According to stakeholders major impacts in tourism are represented by heat waves. Detailed informations about extreme events in Greece are available with interactive maps in : <https://stratus.meteo.noa.gr/events>



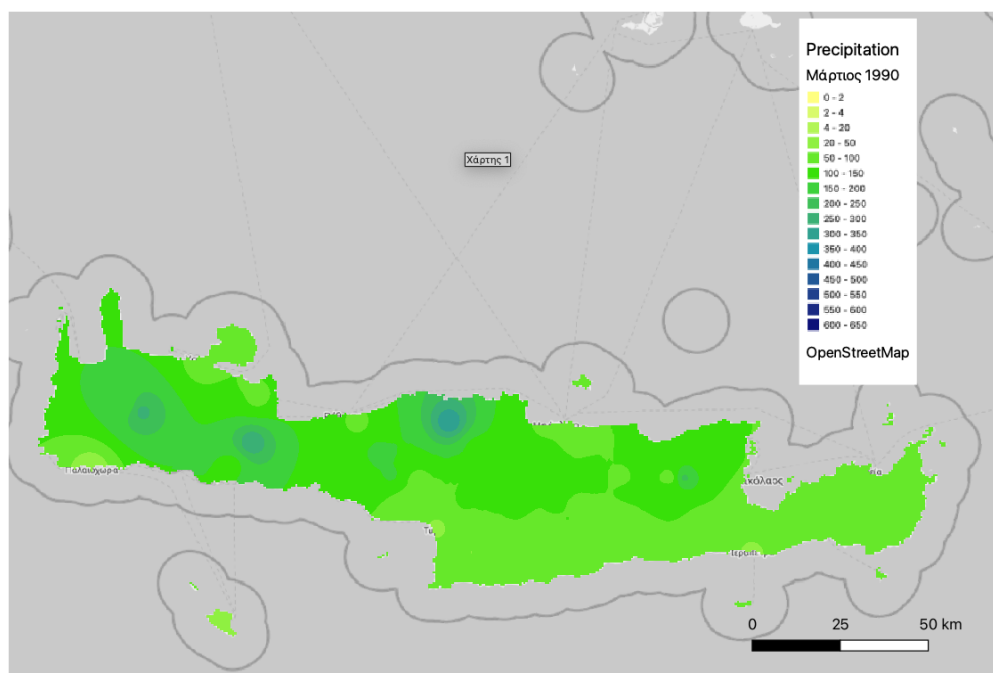
3. IDENTIFICATION OF VULNERABILITIES

3.1 EXPOSURE OF TOURISM TO CLIMATE HAZARDS

Tourism exposure to climate hazards is relatively high compared to other sectors. Sea-level rise, coastal erosion, extreme weather events, and higher temperatures contribute to reduced appealing destinations and minimize touristic attraction. Drought and water scarcity increase competition of tourism with agriculture sectors. Extreme wind events disrupting sea transportation networks.

Following some maps from Decentralized administration of Crete :

FIGURE 11: PRECIPITATION IN MM MARCH 1990



Increased temperatures and reduced rainfall resulting key factors for touristic development as we see by comparing tourism-related areas.



FIGURE 12: MAX TEMPERATURE AUGUST 1990

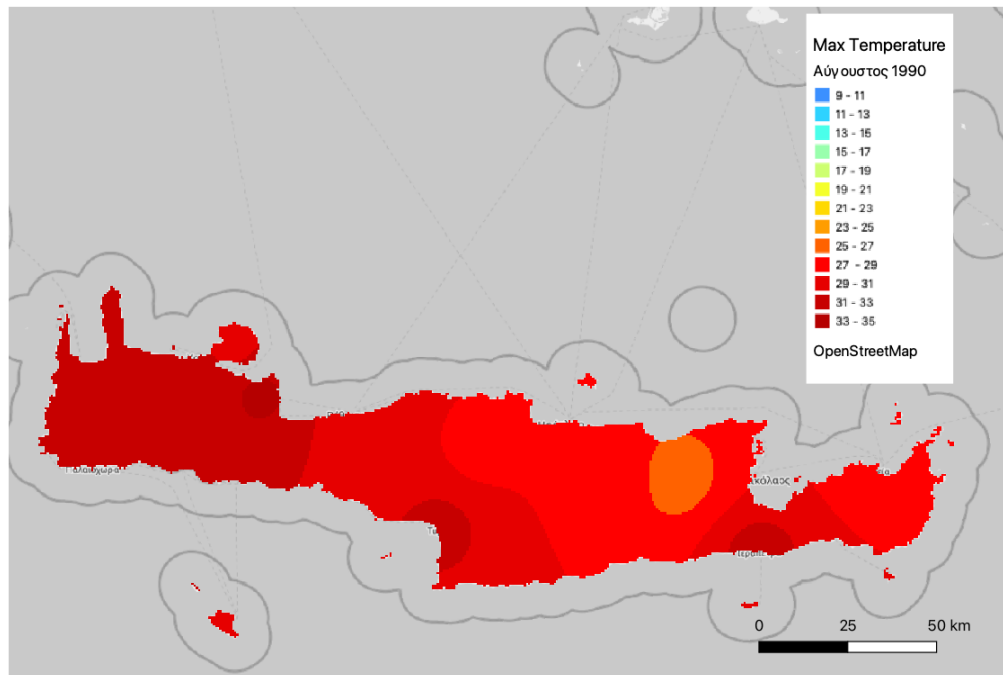


FIGURE 13: PRECIPITATION MARCH 1950

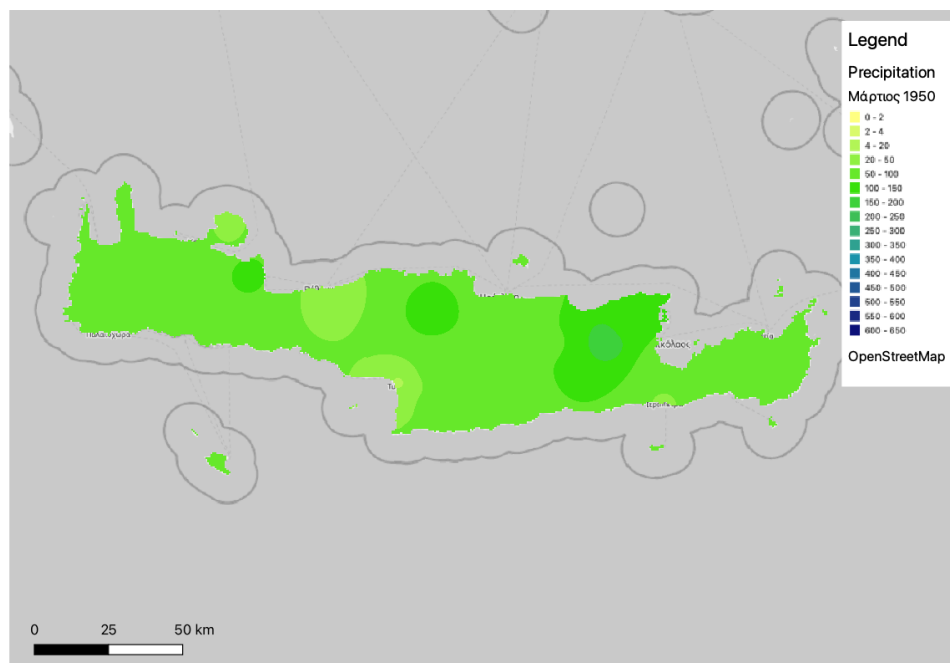
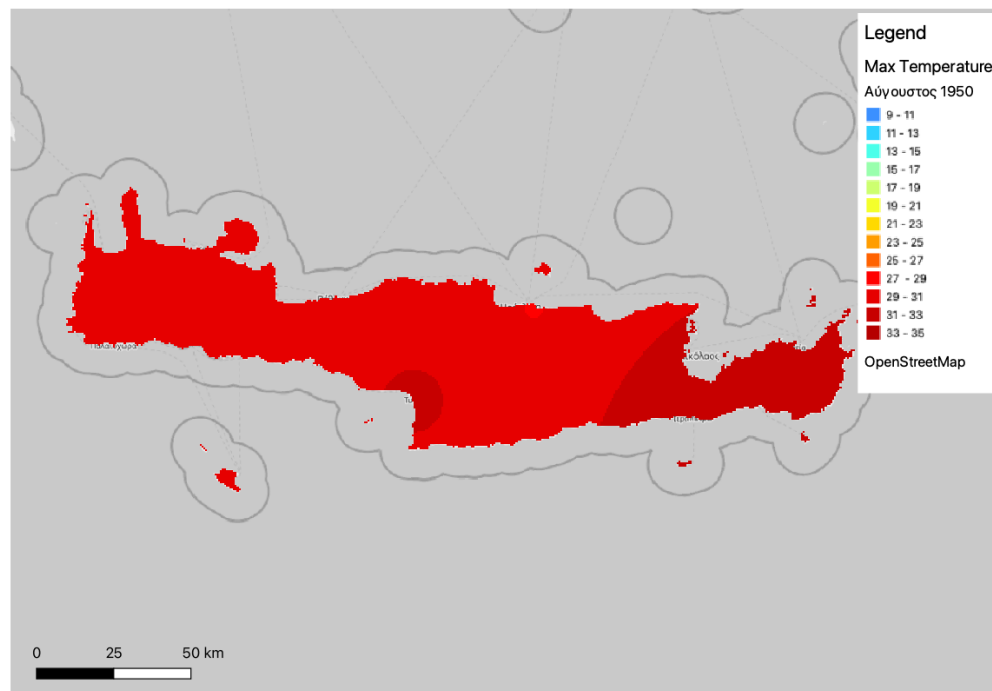


FIGURE 14: MAX TEMPERATURE AUGUST 1950 (SOURCE: REGION OF CRETE DATABASE)



These maps show the precipitation level (Green low - Blue high) and maximum temperatures level (orange low - red high) from 1950 to 1990. Values are fluctuate temporally and locally.

In order to verify the resulting areas according to Long term average soil moisture and soil moisture trends, 2000-2019 EEA we have the following map. Areas with lower soil moisture content together with decreasing tendency in the soil moisture are in risk of losing their land functions of supplying ecosystem services. These are measurements from Copernicus covering the last 20 years that showing drought sensitivity through soil moisture level trends. Soil moisture plays a key role in determining **drought sensitivity** because it directly affects water availability for plants and ecosystems. When soil moisture is low, plants struggle to access water, leading to stress, reduced growth, and even mortality in severe cases. Drought sensitivity increases when Soil moisture storage is limited (e.g., sandy soils drain quickly), precipitation deficits persist, depleting soil water reserves and high evaporation rates (due to heat or wind) accelerate drying. Low soil moisture (e.g., arid climates) or degraded soils are more vulnerable to drought impacts. Conversely, healthy soils with good organic matter retain moisture longer, buffering against drought. Monitoring soil moisture helps predict and manage drought risks in agriculture, forestry, and water resources.

These conditions may affect the touristic development due to water scarcity and long term drought resulting less attractive destination.

FIGURE 15: AVERAGE SOIL MOISTURE 2000-2019 (EEA)

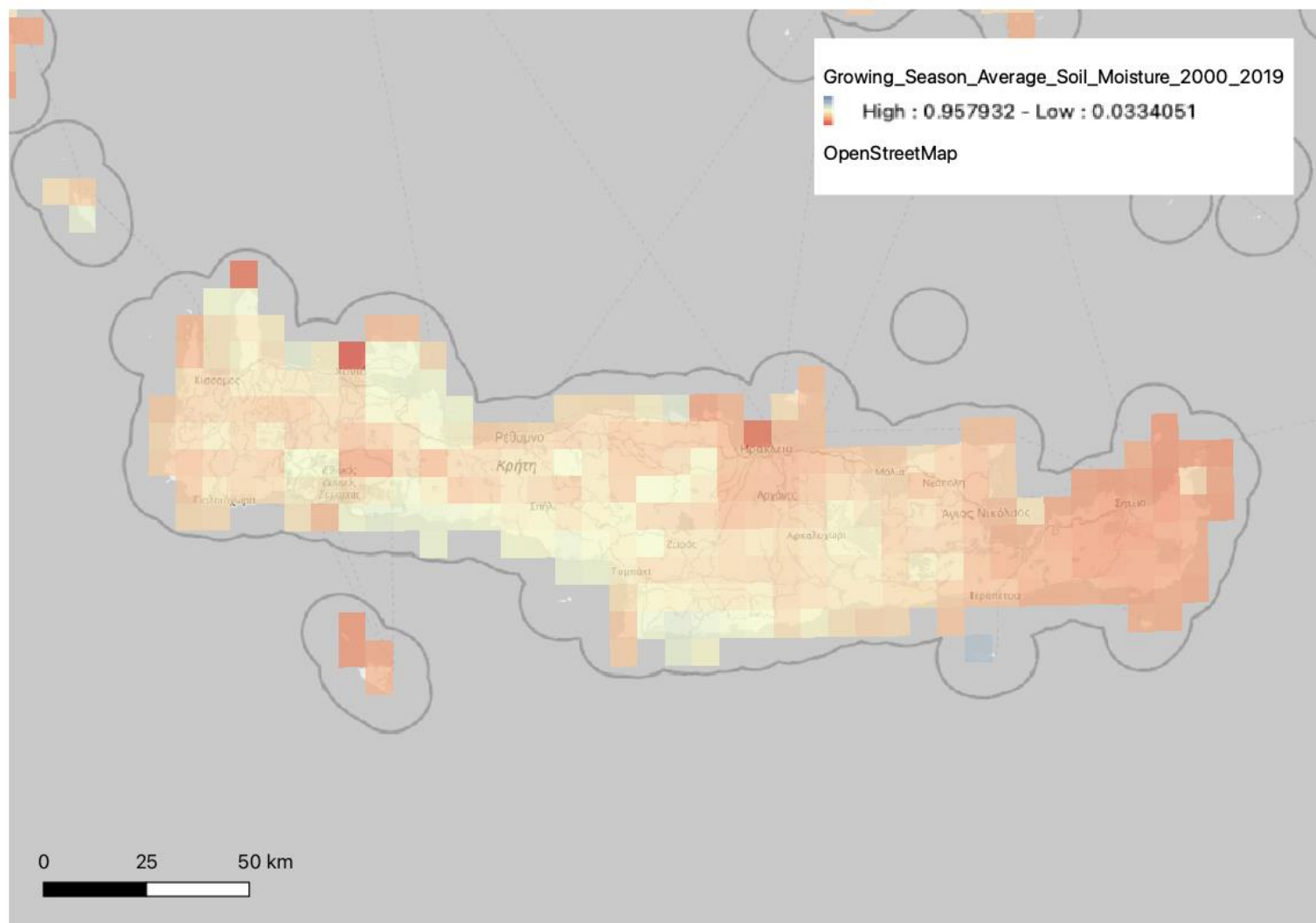
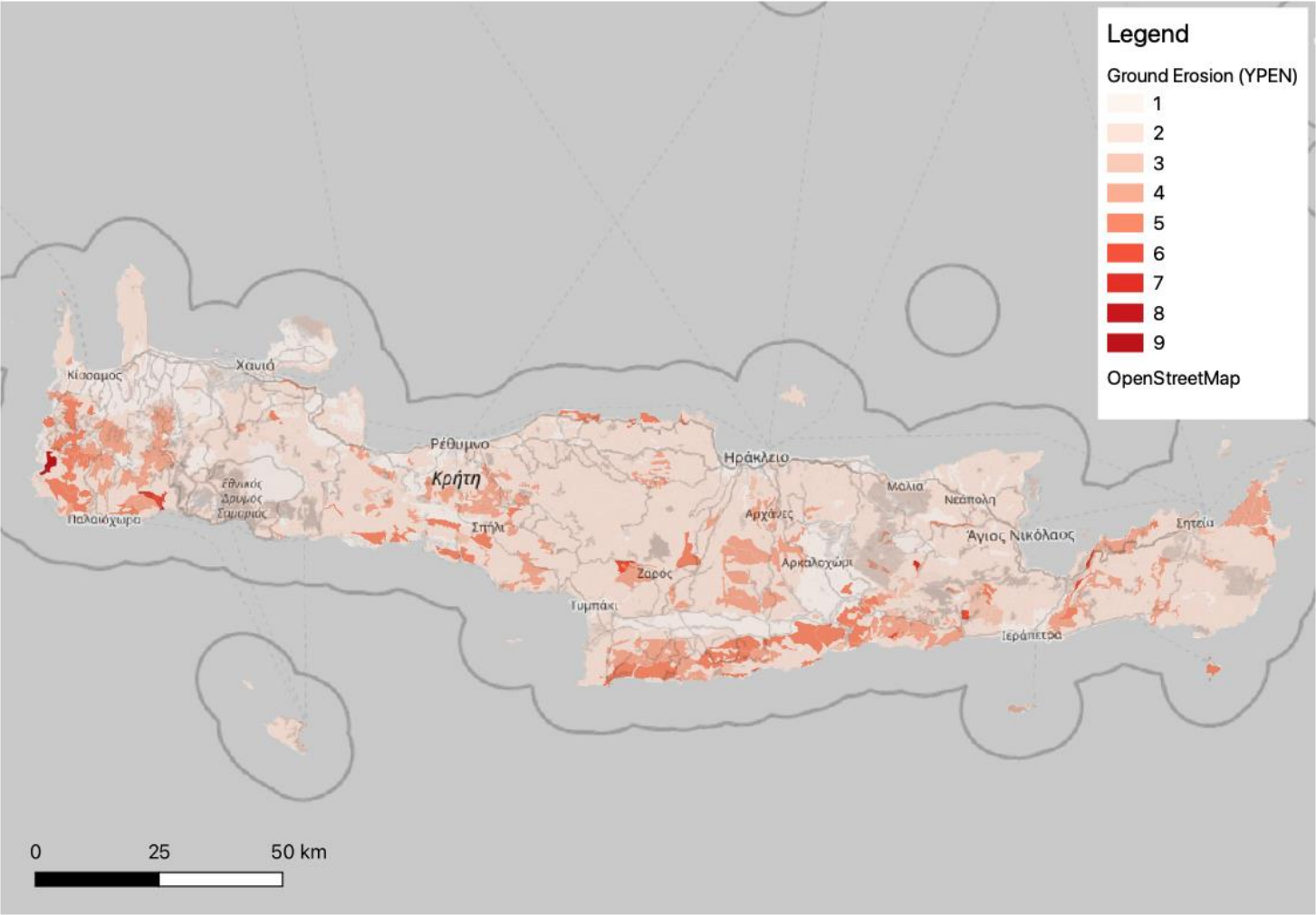


FIGURE 16: GROUND EROSION 1997 (SOURCE: YPEN)





Lower soil moisture, specially in eastern Crete increase ground erosion and leads to desertification (see figure 7 at national level) .

TABLE 4: SOIL MOISTURE

Location	value	
Sitia	0.3	low
Georgioupoli	0.53	high
Chania & Heraklion (cities)	0.13-0.18	very low

TABLE 5: GROUND EROSION (1997, SOURCE: YPEN)

Location	Value (index)	
Moxos	7	Very high
Koufonisi	5	High
Arkaloxori	1	Low



3.2 ASSESSMENT OF CURRENT IMPACTS ON TOURISM

In order to perform a qualitative spatial assessment, vulnerability and sensitivity zones are created based on the datasets presented before. More specifically based on the following assessment principles :

TABLE 6: VULNERABILITY TABLE

	High precipitation	Low precipitation
High (max) Temperature	Low vulnerability	High vulnerability
Low (max) Temperature	Low vulnerability	Low vulnerability
	Volume of extreme events	
Vulnerability	High	Low
	Touristic development exposure	
Vulnerability	High	Low

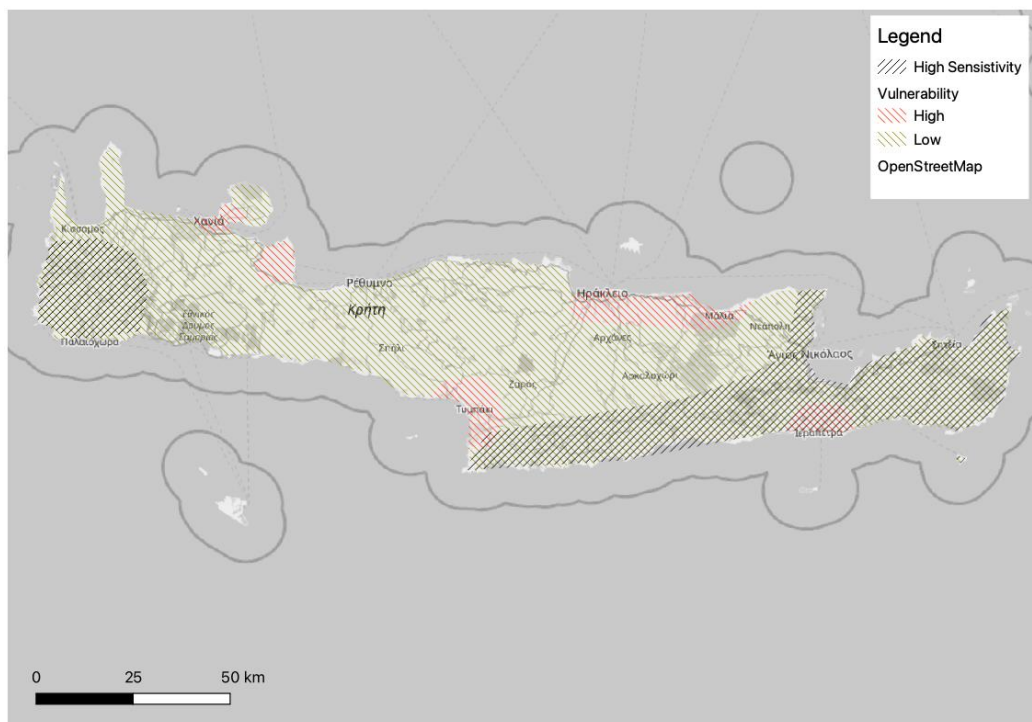
Hence the vulnerability map has developed based on precipitation, max temperature, extreme weather events and touristic development. Furthermore a sensitivity map has developed based on ground moisture and erosion in order to define ground loss hazard. More specifically :

TABLE 7: SENSITIVITY TABLE

	Low moisture	High moisture
Low erosion	Low sensitivity	Low sensitivity
high erosion	High sensitivity	Low sensitivity

Based on these factors we have the following zones that can describe climate change hazards in the region of Crete.

FIGURE 17: VULNERABILITY & SENSITIVITY CRETE



Vegetation is a key indicator and enhancer of adaptive capacity, but its effectiveness depends on management, conservation, and integration with broader climate adaptation strategies.

1. Role in Ecosystem Resilience. Vegetation helps stabilize ecosystems by:
 - Reducing soil erosion (roots hold soil together).
 - Regulating water cycles (forests and wetlands absorb rainfall, reduce flooding, and recharge groundwater).
 - Mitigating extreme temperatures (shade from trees lowers urban heat islands).
2. Climate Adaptation Benefits,
 - Carbon sequestration (forests and plants absorb CO₂, reducing climate impacts).
 - Buffering against disasters (mangroves protect coastlines from storms; vegetation reduces landslide risks).
 - Supporting biodiversity, which enhances ecosystem stability.
3. Socioeconomic Adaptive Capacity
 - Food security (crops, forests, and grasslands provide resources for communities).
 - Livelihood support (agriculture, forestry, and ecotourism depend on healthy vegetation).
 - Cultural and health benefits (green spaces improve mental health and community resilience).



Limitations:

- Vegetation alone is not sufficient for adaptation—it must be combined with other measures (e.g., infrastructure, policies).
- Some areas may face challenges like droughts or deforestation that reduce vegetation's adaptive role.

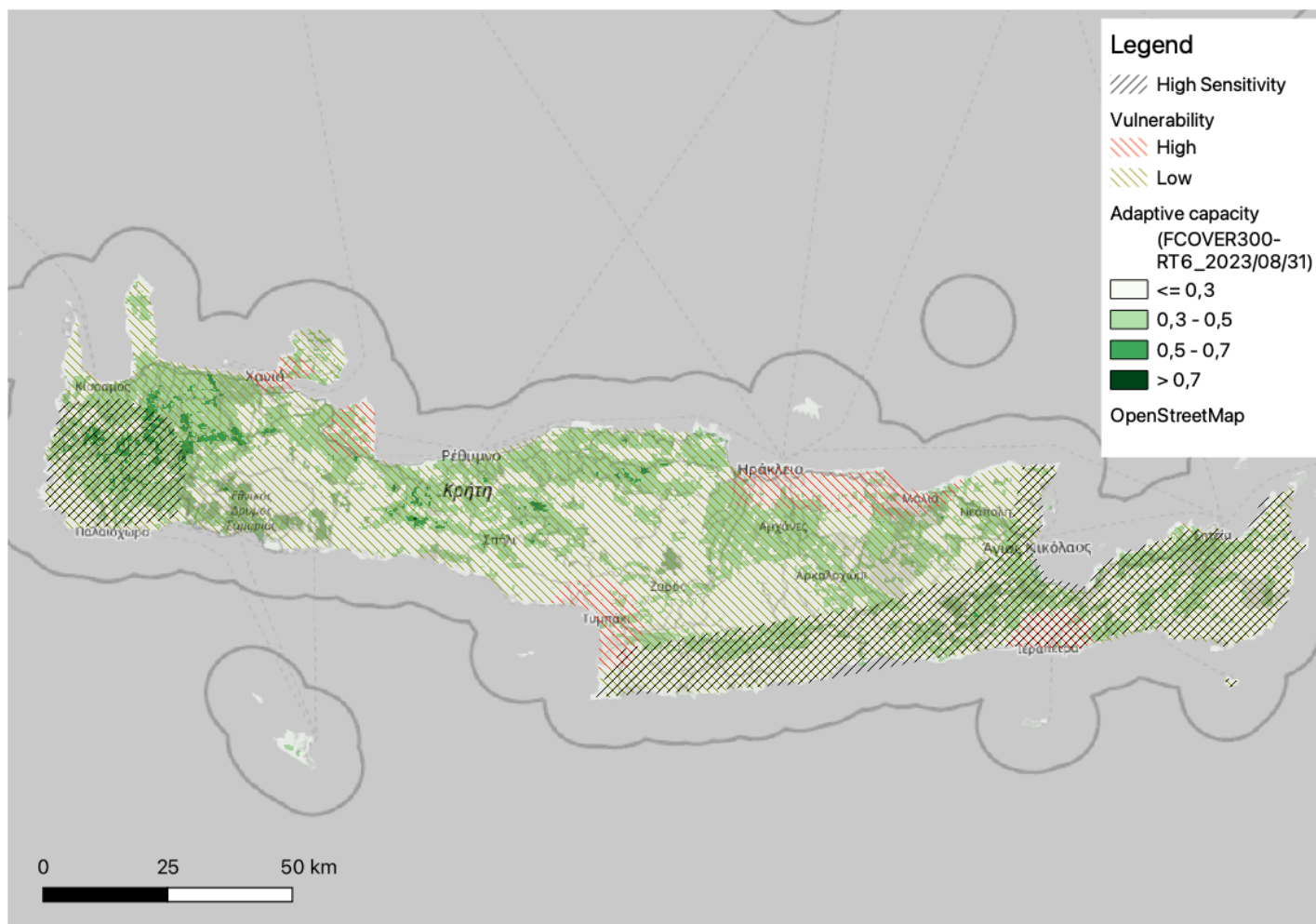
Adopting vegetation as an effective **indicator of adaptive capacity** in Crete, from copernicus (fraction of green vegetation index) :

Mapping the results of vulnerability, high risk locations are Heraklion, Chania, Tympaki, Ierapetra. More sensitive area is the eastern Crete due to drought and soil erosion. These results are produced due to :

- High touristic flows
- Numerous extreme events
- Sensible environment
- Degradation predisposition (drought, soil erosion)

These factors can effect negatively touristic destinations in short and long term as presented in the following chapter.

FIGURE 18: EXPOSURE TO CLIMATE HAZARDS X SENSITIVITY - ADAPTIVE CAPACITY





3.3 FUTURE PROJECTIONS AND ANTICIPATED RISKS

As mentioned before regional plan for the adaptation in climate change is adopted in order to mitigate climate change effects. From this plan we present some aspects and future projections for tourism:

“The geographical analysis of tourism vulnerability revealed that in the short term (until 2040) in both the intermediate and adverse scenarios, all of the areas examined in the Region of Crete show moderate vulnerability to climate change. The greatest vulnerability is seen in the Regional Administrative Regions of Lassithi and Heraklion. Higher vulnerability values are seen in tourism uses in the Municipalities of Archanes – Asterousia, Gortyna, Sitia, Ierapetra, Phaistos, Kissamos, Heraklion and Rethymno.

In the medium term (until 2060), in the intermediate and adverse scenarios, the areas with tourism uses in the Region of Crete are expected to show moderate and mainly high vulnerability. In fact, in the adverse scenario, all of the areas with tourism uses show high vulnerability. Tourism uses in the Regional Administrative Regions of Lassithi and Heraklion are expected to be more vulnerable. At the municipal level, tourism uses in the Municipalities of Archanes – Asterousia, Sitia, Ierapetra, Agios Vasilios, Gortys, Phaistos, Kissamos, Agios Nikolaos and Heraklion are more vulnerable.

Finally, in the long term (until 2100), the situation is expected to be even more difficult as the areas with tourism uses in the Region of Crete are expected to show high and mainly very high vulnerability. In fact, in the adverse scenario, all areas with tourism uses show very high vulnerability. Tourism uses in the Regional Administrative Region of Lassithi are more vulnerable. At the municipal level, tourism uses are most vulnerable in the municipalities of Sitia, Archanes - Asterousia, Ierapetra, Agios Vasilios, Agios Nikolaos, Sfakia, Gortynas, Lassithi Plateau, Rethymno, Phaistos and Heraklion.”

In the following maps we can see the vulnerability for tourism sector :

- Blue (insignificant)
- Green (low)
- yellow (moderate)
- orange (high)
- Red (very high)

In short term scenario RCP 4.5 for the period 2021-2040 and the long term scenario 2041-2060



FIGURE 19: FUTURE VULNERABILITY SHORT TERM (2021-2040 RCP4.5)

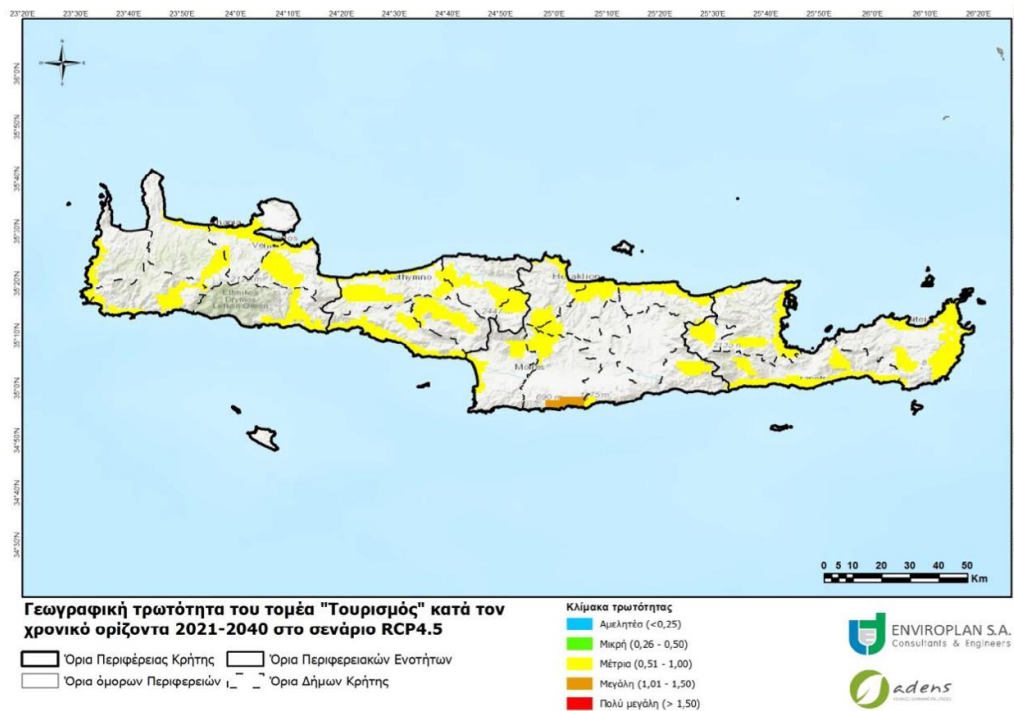


FIGURE 20: FUTURE VULNERABILITY MEDIUM TERM(2041-2060 RCP4.5)

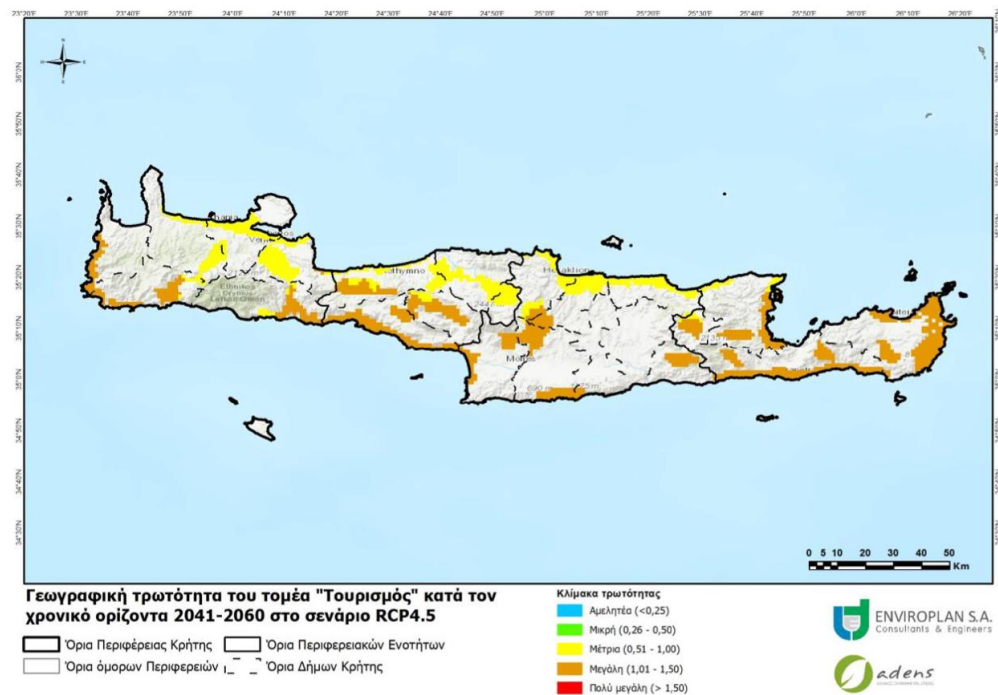


FIGURE 21: FUTURE VULNERABILITY LONG TERM (2081-2100, RCP8.5)

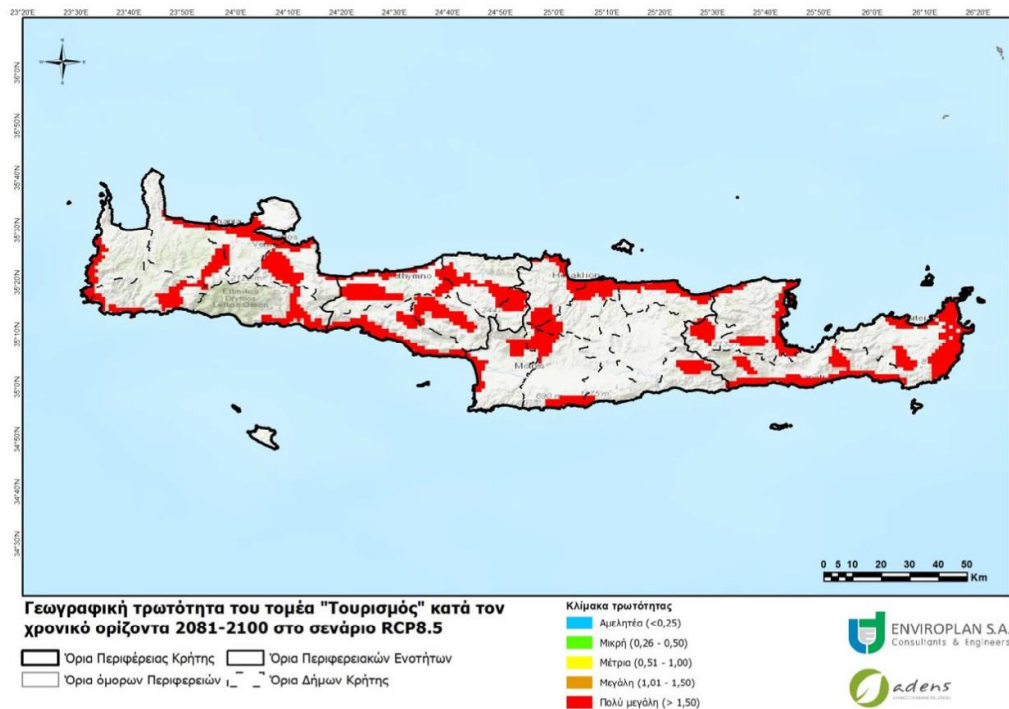


TABLE 8: VULNERABILITY FUTURE SCENARIOS

	Short term 2021-2040	Medium term 2041-2060	Long term 2081-2100
RCP 4.5 (moderate stabilization scenario, SSP2-4.5)	Medium vulnerability	Medium high vulnerability	
RCP 8.5 (very high emissions scenario, SSP5-8.5)		High vulnerability	Very high vulnerability

Representative Concentration Pathways (RCPs) are climate change scenarios used by the IPCC¹² to project future greenhouse gas concentrations and their impacts. They outline different trajectories based on radiative forcing levels (measured in watts per square meter, W/m²) by 2100:

RCP 2.6: Low emissions, strong mitigation ($\leq 2^{\circ}\text{C}$ warming), SSP1

¹² Intergovernmental Panel on Climate Change, United Nations

**RCP 4.5: Moderate stabilization¹³ (~2–3°C warming), SSP2**

RCP 6.0: Higher emissions, delayed action (~3°C warming).

RCP 8.5: Very high emissions, "business-as-usual" (≥4°C warming), SSP5.

RCPs inform climate models for assessing risks like sea-level rise, extreme weather, and ecosystem shifts, aiding policymakers in mitigation and adaptation planning. Newer scenarios (SSPs) now integrate socioeconomic factors, but RCPs remain foundational in climate research.

4. GENERAL RECOMMENDATIONS FOR THE CLIMATE ACTION PLAN (ACT.2.5)

In this section we will try to propose adaptation and mitigation actions in order to tackle the short and long term effects of climate change effects according to the vulnerabilities indemnified previously.

4.1 SELECTION OF KEY CRITERIA AND INDICATORS

The following indicators are selected to monitor adaptation and mitigation actions for the region of Crete:

Indicators:**1. Physical and Environmental Indicators**

- Ind 1.1 Change in Annual Temperature
- Ind 1.2 Number and Frequency of Hot Days
- Ind 1.4 Extreme Precipitation Days
- Ind 1.8 Water Availability per Inhabitant

2. Economic Indicators

- Ind 2.1 Tourism Revenue Variability

3. Sociocultural Indicators

- Ind 3.1 Tourist Satisfaction
- Ind 3.2 Local Community Attitudes

4. Governance and Policy Indicators

- Ind 4.3 Stakeholder Involvement

5. Biodiversity and Ecosystem Health Indicators

- Ind 5.2 Habitat Loss and Degradation

¹³ Today 2025 we are closest to the RCP4.5 (SSP2-4.5) trajectory



The selection of these indicators is made considering the following factors: reliability, availability and consistency.



4.2 ACTION PLAN RECOMMENDATION

As seen before major risks for the region of Crete is drouth, land and habitat degradation. To mitigate these risks monitoring actions are necessary. Use of renewable energy policies will reduce climate effects. Community involvement will improve resilience. Adaptation measures are necessary to reduce soil erosion and improve infrastructures for extreme events. The following table summarize possible adaptation and mitigation actions:

TABLE 9: ACTION PLAN

Criteria	Adaptation actions – Short term effects	Mitigation actions – Long term effects	indicator
Natural Evolution Monitoring	Observe extreme events	Create network of sensors and observation points	Ind 1.1 Change in Annual Temperature Ind 1.2 Number and Frequency of Hot Days Ind 1.4 Extreme Precipitation Days
Soft engineering solutions	Restore erosion with natural methods		5.2 Habitat Loss and Degradation
Renewable Energy Adoption		Increase the use of renewable energy sources such as solar, wind	
Sustainable Water Use	Implementing water conservation programs and incentives for reducing water use		
Stakeholder Collaboration		Facilitating regular meetings and communication channels for stakeholders	Ind 4.3 Stakeholder Involvement Ind 3.2 Local Community Attitudes
Removable and Flexible Infrastructures	Implementing infrastructure that can be easily adapted or relocated as needed		



4.3 MONITORING AND EVALUATION USING KEY INDICATORS

For the monitoring and evaluation of the proposed indicators and from the analysis of the previous chapters :

TABLE 10: AVAILABLE BASE INDICATORS

Indicator	Base (average value for region of Crete)
Annual Temperature	16.7 C
Number of Hot Days	3
Precipitation Days	76
Green Vegetation percentage	0.24%

The other indicators could be evaluated in qualitative scale “improved” or “deteriorated” due to lack of specific datasets.

Crete faces growing climate threats, including:

- Drought & Water Scarcity – Declining rainfall and rising temperatures strain freshwater supplies.
- Extreme Heat – More frequent heatwaves impact health, agriculture, and tourism.
- Coastal Erosion & Sea-Level Rise – Beaches and infrastructure are at risk from flooding and storms.
- Flash Floods – Intense rainfall events cause sudden flooding and soil erosion.
- Biodiversity & Agriculture Loss – Desertification spreads, threatening ecosystems and crops like olives.
- Tourism Disruptions – Heat, water shortages, and beach degradation harm the economy.

Key Adaptation Needs: Better water management, coastal protection, and climate-resilient farming.