



Estrategia local para la adaptación al cambio climático

(Local strategy for adapting to climate change)

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1.- Introduction

Climate change is a reality that jeopardizes the functioning of the planet's natural systems and threatens people's well-being, economic activity, and social cohesion and stability. In spite of this, neither local authorities, nor regional socioeconomic agents, nor society in general are giving the appropriate response.

In this context, the vulnerability of territories, public services, and economic activity is quite elevated. There is a clear risk of paralysis, collapse, or a serious reduction in economic activity and infrastructure which is increasing continuously. However, public and private investment towards adaptation remains rather scarce.

Faced with this, steps must be taken towards mitigating and avoiding the effects of climate change and reducing and eliminating the factors that cause it. On the other hand, considering that mitigation policies will have a medium and long-term effect, adaptation policies must be urgently established to reduce the impact and risks of global change, especially in the most vulnerable environments.

Two ideas that emerged from the assessment studies consolidated during the participatory process promoted by the LIFE-CLINOMICS project will be useful to give focus to climate adaptation policies:

- The actions that adaptation to climate change call for are opportunities for the sectors involved in the project, "with" and "without" climate change. In other words, they must be implemented for the economic viability and sustainability of the activities themselves.
- Synergies can be generated if working from a joint perspective of all sectors.

On the other hand, the effects of climate change, despite its global scope, are easily visible at a local scale. For this reason, a significant part of adaptation measures must be designed and implemented based on the characteristics of each territory and in accordance with its biophysical, social, and economic reality. Also, the local scale facilitates identifying the actors involved and agreeing upon measures by all of them. In short, planning and management at the local scale plays an important role in minimizing vulnerability to climate change. This does not preclude actions of a general scope that respond to the heterogeneous distribution of the population and natural resources in an area.

For all of the foregoing, it is necessary to adjust the management framework for the new climate adaptation circumstances to this local scale, working in coordination through a network, creating synergies, and always doing so in a manner that is consistent with the Climate Change Law of Catalonia and the Catalan Strategy for Adaptation to Climate Change (ESCACC), as well as with pertinent national and European legislation.

Planning, both locally and in other territorial perimeters, must be consistent with the provisions resulting from European directives and legislation, planning, and regulations by Spain and the Government of Catalonia and must respond more concretely to adaptation policies originating from local authorities.

An integrated, participatory, and transparent work approach has been proposed, with the joint objective of increasing the resilience of the territories and economic activities or sectors of activity faced with climate change impacts, which accomplishes the commitment by the institutions to put in motion the instruments

and transversal actions derived from this strategy and the advancement of the respective territorial and sector action plans.

For this, it will be necessary to establish different technical and economic mechanisms to support local entities, propose new models of governance, promote tax tools, and define territorial, urban, and economic development, taking into account the availability of natural resources such as water, energy, and land in each territory.

The strategy focuses on four major areas:

- Capacity-building: How can we raise awareness about the impacts of climate change that could affect our economic activities, and how can we learn to be able to act?
- Adaptation and resilience: how can we prepare ourselves to be less vulnerable to the effects of climate change?
- Promoting action by stakeholders: how can we support projects from companies, owners, or authorities?
- Governance: how can we organize ourselves to handle adaptation?

The strategy also takes into account five priority lines of work that must be reflected in the action plans:

- The impact assessment on the sectors: increasing knowledge, information, and awareness.
- Integration into policies: helping with decision making.
- Mobilizing the actors: promoting adaptation actions.
- Promoting public and private funding: pursuing the financial viability of investments and studying the return on investment.
- Promoting insurance as a strategy to minimize climate risks in primary activities.
- Monitoring evidence and alerts: identifying a simple and easy-to-build system of indicators which provides synthetic information about the adaptation process, in a way that can be managed by the observatory (this idea will be defined later).

The particular characteristics of climate change mean that any strategy aimed at reducing its effects must be based on adaptive management of the issue. In this context, it is essential to have stable management frameworks and to give continuity to mechanisms that are enabled to assess the evolution of impacts associated with climate change and the effectiveness of the adaptation measures taken, in addition to constantly reviewing the strategy and the action plan if appropriate.

2.- Objectives

The LIFE-CLINOMICS project responds to the need to put transversal adaptation policies on local governments' agenda, in the strategic and central place they deserve, thus preventing them from playing a secondary role compared to the mitigation efforts carried out.

LIFE-CLINOMICS intends to go beyond the Plans defined by the Covenant of Mayors. In their first phase, the Sustainable Energy Action Plans (SEAPs) did not include adaptation. In the second phase, the Sustainable Energy and Climate Action Plans (SECAPs) include adaptation, but this did not begin until towards the end of 2015. In addition, both the SEAPs and the SECAPs limited their actions to a more municipal and urban scope, leaving out, or insufficiently addressing, vulnerable and economically important sectors such as the primary sector or tourism.

The objective of CLINOMICS is to generate and apply knowledge on climate change by establishing a suitable local governance model regarding the issue and, through local adaptation actions, to increase the resilience of the territories and their economies with the intensity and speed the issue calls for, thus handling an issue not covered by the Action Plans directly derived from the Covenant of Mayors.

Specifically, CLINOMICS proposes intervention in three representative regions and in three vulnerable economic sectors (agroforestry, fishing, and tourism). The three regions in the project - Montseny, Alt Penedès, and Terres de l'Ebre - offer a wide spectrum of adaptation issues and situations which are quite representative of the rest of the country and of the Mediterranean geographic area in general, thus facilitating its application and replication.

Furthermore, LIFE-CLINOMICS will develop an investment experience at the local level that aims to be demonstrative, applicable, and mobilizing for a political and social process that entails a transformation of the local economy through basic knowledge crafted by earlier work.

The objectives of LIFE-CLINOMICS are fully harmonized and consistent with the Catalan Strategy for Adapting to Climate Change (ESCACC) promoted by the Government of Catalonia, from which LIFE-CLINOMICS has adopted its Strategic Objective: "To become less vulnerable to the impacts of climate change that, based on current knowledge, have occurred and will occur to the various natural systems and socioeconomic sectors over the course of this century".

In addition, the CLINOMICS Strategy also coincides with the ESCACC's general objectives:

1. To generate and transfer all knowledge on adapting to climate change.
2. To increase the adaptive capacity of sectors and/or systems through strengthening the capacity for resilience and reducing exposure for systems and sectors on the basis of social, environmental, and economic sustainability.

Finally, the specific objectives adopted by the CLINOMICS Strategy are those initially developed in the LIFE project:

- Draft adaptation action plans through social participation and foster the conditions for the material and financial implementation thereof to become a medium-term reality.
 - Action: Territorial and sector action plans (point 5.2, page 28)
 - Action: Funding methods (point 11.1, page 39)
- Incorporate climate adaptation in local authorities' agendas and provide municipalities with the tools enabling them to implement adaptation processes. Establish local planning models for adapting to climate change, including governance, which can be replicated in climate zones similar to those found in Catalonia.
 - Action: Governance of adaptation to climate change (point 4, page 24)
 - Action: Planning and implementation (point 5, page 27)
 - Action: Assessment and monitoring (point 6, page 32)
 - Action: Administrative and regulatory tools (point 9, page 36)
- Establish criteria and an appropriate framework encouraging investment and public-private cooperation in the field of climate adaptation and for local economies.
 - Action: Public-private cooperation (point 10, page 37)
 - Action: Funding methods (point 11.1, page 39)
- Modernize local economies to aid them in adapting to climate change, increasing their competitiveness and creating employment.
 - Action: Public-private cooperation (point 10, page 37)
 - Action: Funding methods (point 11.1, page 39)
- Promote demonstration activities for climate adaptation with a rigorous cost-benefit analysis.
 - Action: Pilot actions (point 5.3, page 32)
 - Action: Public-private cooperation (point 10, page 37)
- Generate, collect, and transfer knowledge and apply and replicate methodologies for adapting to climate change in local territorial areas.
 - Action: Communication and awareness (point 8, page 35)
- Train agents in the sectors involved so they can apply the most economically and socially beneficial actions for adapting to climate change (hereinafter ACC) to their activities. To this end, training will offer relevant technical and methodological resources.
 - Action: Territorial and sector training (point 7, page 34)
- Train people and raise awareness of the effects and risks associated with climate change. In particular, educate economic and social agents about the economic consequences of not taking adaptive measures.
 - Action: Territorial and sector training (point 7, page 34)

3.- Diagnosis

The Strategy puts forth lines of action that are based on the analysis that was carried out for the different territories and sectors involved in CLINOMICS.

CLINOMICS is being developed in three territories: the Montseny Biosphere Reserve, the Alt Penedès county, and in the Terres de l'Ebre (Baix Ebre, Montsià, Ribera d'Ebre, and Terra Alta) and in three economic sectors: agroforestry, fishing, and tourism.

The diagnosis carried out by CLINOMICS in the three territories and sectors was drafted based on existing information, the calculation of vulnerability indicators and the assessment by various economic agents on vulnerability, and the adaptive capacity of the sectors. ESCACC's definitions of risk and vulnerability were used as a reference, in addition to new evidence and updates to data on climate change included in the Third Report on Climate Change in Catalonia¹:

- Concerning air temperature, a significant average annual increase of +0.23°C per decade was recorded between 1950-2014.
- As for precipitation, a slight negative trend of -1.2% per decade was noted (not statistically significant, except in the Pyrenees and in summer).
- Variations in climate extremes were also noted, with an increase in warm days and nights, and a decrease in cold days and nights.
- An increase in the length of periods without precipitation was recorded, mainly in the south of the country.
- Regarding sea temperature, an increase at a rate of +0.3°C per decade since 1990 has been recorded, from the surface down to a depth of 50 m.

The data obtained through the diagnosis carried out under the CLINOMICS framework, though not exhaustive, are sufficient for action. The bibliographic review made in the three vulnerability studies and in the analysis of the indicators resulted in sufficient information at the local level, thus making it possible to define the strategic lines of intervention.

However, the need to delve deeper into data on the effects of climate change for the sectors and the integration of other aspects such as landscape, biodiversity, management models, economic costs, or the creation of quality jobs was noted.

¹ *Seguiment i avaluació de l'Estratègia Catalana d'Adaptació al Canvi Climàtic* (Monitoring and assessment of the Catalan Strategy for Adapting to Climate Change). ESCACC, Horitzó 2013-2020. Executive Summary March 2017. http://canvclimatic.gencat.cat/web/.content/home/politiques/politiques_catalanes/ladaptacio_al_canvi_climatic/ESCACC/docs/Resum-executiu_cat.pdf

3.1 - Vulnerability in the three territories

3.1.1 Montseny Biosphere Reserve

The vulnerability analysis² of the economic sectors to the different risks derived from the impact of climate change was carried out by means of qualitative criteria - expert judgement and insight from agents in the territory - and semi-quantitative criteria (the use of indicators). Together, the results obtained allowed the following conclusion to be made:

- The risks assessed as having the greatest degree of vulnerability across the entire Montseny Biosphere Reserve (MBR) are the water flow reduction in the rivers (with a vulnerability rating of 5 on a scale of 0 to 10) and the reduction of snow-covered surface area and/or duration (with a vulnerability rating of 6, affecting the livestock farming and tourist sectors). These risks are directly related to the changes in precipitation and temperature predicted by Horizon 2031-2050. The adaptive capacity of the economic sectors affected by these risks (the forestry, agricultural, and tourism sectors) is considered to be quite low overall.

The perception of the economic sector participants regarding their vulnerability to these risks, however, is generally low. The tourism sector, for example, perceives itself as having low dependency on snow and therefore not being vulnerable to the reduction of periods with snow cover. In fact, the economic sector participants even consider this risk as translating into lower pressure on specific areas of the territory, which could be positive for their activities.

- Based on the semi-qualitative assessment, the livestock farming sector shows medium to low vulnerability (rating between 2 and 3 on a scale of 0 to 10) to most of the identified risks. The vulnerability of this sector against the risk of decreasing water availability and the changes that are expected to occur across the types and the distribution of crops has been quantified with ratings between 2 and 3. These relatively low ratings are due to the characteristics of the crops (the predominance of dry farming crops and, in general, the variability of herbaceous crops, makes this sector's facing - and therefore the vulnerability - of the risks lower than in other areas of the territory) and also, in large part, to this sector having several instruments and tools for handling these changes (the use of more adapted species and/or varieties, the incorporation of more efficient growing techniques, changes in livestock production, etc.), some of which are already being developed at present.

The view by participants (with a rating of the perception of vulnerability on a scale of 1 to 4) from the livestock farming sector against the main risks threatening their activities, however, is generally higher.

² *Estudi dels efectes del canvi climàtic en el Montseny: diagnosi, impactes i vulnerabilitats* (Study of climate change effects in the Montseny: diagnosis, impacts and vulnerabilities). OCCC-Minuàrtia. December 2016. Life Clinomics. http://lifeclinomics.eu/wp-content/uploads/2017/04/Clinomics_Canvi-climatic-Montseny-A1_Memoria_Annexos-B.pdf

This may in part be related to concerns regarding observed trends that threaten the primary sector in general (the lack of generational renewal, the abandonment of activities, decreased purchasing power, etc.).

- Regarding the forestry sector, risks posing a major threat include changes in the distribution of species of interest for forestry - as a result of the loss of topo-climatic suitability of some of the species exploited at present (such as beech, fir, or oak) - and the risk of declining yields from forest exploitation. The vulnerability of this sector against these risks rates as medium-high (ratings around 4 on a scale of 0 to 10), partly due to the existence of tools facilitating good adaptive capacity in the long term (technical Plans for forestry improvement and management, etc.). The risk of an increase in invasive species, by contrast, implies a moderate impact on forestry activity (this sector's vulnerability rating against the risk is 1.25), mainly because sensitivity is estimated to be low (limited presence of invasive species within the MBR-NP), and actions have already been undertaken to deal with them (as a part of the Montseny Natural Park Conservation Plan).
- The assessment of the increase of forest fire risk differs according to the methodological approach. According to the semi-quantitative assessment, the vulnerability of the forest and livestock farming sectors against an increase in fire risk is medium-low (rating around 3). This is mainly due to the predominance - within the MBR - of forests with low sensitivity to fires, and to the availability of various municipal tools to handle fires such as the existence of Municipal Action Plans, Forest Defence Groups (ADFs), and so forth. However, both forestry and tourism sector participants agree with the assessment of the sector's vulnerability to increased fire risk as very high.
- The loss of biodiversity and landscape quality have an important impact, mainly on the tourism sector. According to the semi-quantitative assessment, the vulnerability of this sector to both risks rates as medium (with a rating of nearly 5 regarding the risk of biodiversity loss, and 3.49 regarding the risk of losing landscape quality). The existence of biodiversity planning and management tools (such as Montseny Natural Park's Conservation Plan or Land Stewardship Agreements) reduce the overall vulnerability rating in this case. At the same time, participants at meetings coincide in considering the tourist sector highly vulnerable to the loss of biodiversity (due to the interest a space may hold for certain research and education activities) and very vulnerable to the risk of losing landscape quality (as the landscape is one of the main attributes sought by people who visit the Montseny). By contrast, participants from the forestry sector neither consider the risk of biodiversity loss nor the impact it may have on the sector as relevant.
- The risk of decreasing water availability is also perceived as a risk that could substantially affect the tourism sector. However, this risk rates as medium-low with the indicators (with a rating of 2.18 on a scale of 0 to 10), mainly due the limited dependence on tourism for the municipalities in the MBR (with relatively low seasonal population rates) and a good availability of tourist accommodations (as an indicator of adaptive capacity).

- Other risks that could affect the tourism sector, such as changes in the patterns of tourism demand - both seasonally (in summer) and overall - or the worsening of climate comfort, were assessed as having low vulnerability (with indicators rating about 2). These risks, therefore, have a moderate impact on the tourism sector, partly because this sector has already begun certain actions for adapting to climate change (adhesion to the European Charter for Sustainable Tourism, etc.). The qualitative assessment carried out by expert criteria, however, indicates that the sector would fall between moderately and highly vulnerable to these risks. This perception may result from a more global view of climate change effects on the sector.

The summary tables below show the perception ratings and the indicator ratings for each sector, preceded by a table with the criteria followed by the vulnerability assessment.

Criteria for assessing vulnerability		
Rating	Assessment	Definition
4	Very high	The economic sector and the socioeconomic environment are deemed to have very high vulnerability.
3	High	The economic sector and the socioeconomic environment are deemed to have high vulnerability.
2	Low	The economic sector and the socioeconomic environment are deemed to have low vulnerability.
1	Very low	The economic sector and the socioeconomic environment are deemed to have very low vulnerability.

Annex 1 presents the diagnosis tables of the impacts detected as most significant and the table of uncertainties for each sector. This assessment is based on numerical data of the identified risks and opportunities, the results of vulnerability indicators, and perceptions by economic agents.

i. Forestry sector

Vulnerability perception table

PERCEPTION OF THE FORESTRY SECTOR'S VULNERABILITY		
RISK	MeTACC perception rating (1-4)	Indicator rating (0-10)
Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts)	4	2
Changes in the distribution of forest species	2	4
Decrease in the production of wood and other forestry products	3	4
Reduction in the flow of rivers and streams and a longer dry season	-	5
Increase in fire risk	4	3
Loss of biodiversity	3	5
Risk of more invasive species	2	1

ii. Tourism sector

Vulnerability perception table

PERCEPTION OF THE TOURISM SECTOR'S VULNERABILITY		
RISK	MeTACC perception rating (1-4)	Indicator rating (0-10)
Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts)	4	2
Reduction in the flow of rivers and streams and a longer dry season	-	5
Increase in fire risk	4	-
Reduced snow cover duration	2	6
Loss of biodiversity	3	2
Loss of landscape quality	4	3
Worsening of climate comfort	2	2
Changes in the patterns of tourism demand	3	2

iii. Livestock farming sector

Vulnerability perception table

PERCEPTION OF THE LIVESTOCK FARMING SECTOR'S VULNERABILITY		
RISK	MeTACC perception rating (1-4)	Indicator rating (0-10)
Changes in crop types	3	3
Changes in plant productivity	2	-
Increase in irrigation needs	3	2
Changes in the distribution of arable areas	4	2
Changes in livestock farming types	2	2
Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts)	3	2
Increase in fire risk	2	3
Reduced snow cover duration	2	6

3.1.2 Alt Penedès

The results from the indicators calculations and those from participant perceptions³ coincide in the degree of vulnerability and adaptive capacity gleaned from most of the risks analysed (8 of the 12 risks studied, approximately 67% of the risks). In turn, in the case of 4 risks, the vulnerability indicator calculated resulted in a lower rating than the vulnerability rating given by most participants. The reason why the results from these 4 cases differ is discussed as follows:

- The first difference in the perception of vulnerability is given by the forestry sector regarding the risk of decreasing water availability (increased evapotranspiration and increased frequency of droughts). In this case, the values obtained in the vulnerability indicators calculations were 2.23 and 2.19 on a scale of 1 to 10, deemed medium/low vulnerability, while the vulnerability ratings given by participants was higher, with ratings of 3 and 4 (on a scale of 1 to 4). This difference in results is thought to be due to the fact that these indicators are not very responsive in analysing the decrease in the county's water availability. The indicators use a sensitivity sub-indicator to analyse the sensitivity to drought of the forest species present in each municipality. Due to the fact that the largest proportion of forest species are white pine and holm oak (with much less presence) throughout all the county's municipalities, with a low sensitivity

³ Extracted from "Diagnosi de vulnerabilitat climàtica de l'Alt Penedès en el marc del projecte Life Clinomics (Diagnosis of climate vulnerability in the Alt Penedès in the framework of the Life Clinomics project)". Catalan Office for Climate Change (OCCC)-La Vola, May 2017. Life Clinomics. http://lifeclinomics.eu/wp-content/uploads/2017/05/Diagnosi_Alt_Pened%C3%A8s_CC_Clinomics_DEFINITIVA.pdf

rating for drought (compared to medium and highly sensitive species such as oak, black pine, and red pine, which are non-existent or have an insignificant presence in the Alt Penedès), the result of these two indicators is not deemed to adequately capture the true vulnerability of risk, which has been highlighted by participating agents.

- The second risk for which the results diverge is “Increase in fire risk” affecting the forestry sector. While participants assess this risk as high and very high (ratings of 3-4 on a scale of 1 to 4), the rating obtained from the vulnerability indicator (4.31 on a scale of 1 to 10) indicates medium vulnerability. This divergence is thought to be due to the low responsiveness of the indicator used to analyse this risk in the territory. The average vulnerability rating was obtained as a result of average adaptive capacity ratings in the majority of the municipalities, calculated based on the availability of municipal action measures in the event of a forest fire as well as involvement in a Forest Defence Group (ADF). The average vulnerability ratings are also due to the average sensitivity ratings of the indicator which combines the surface area of forest species (mostly white pine and holm oak to a lesser extent) with their level of sensitivity to fires (medium rating for white pine and low rating for holm oak).
- The third risk is the risk of biodiversity loss affecting the forestry sector. The vulnerability rating obtained in the calculation of the "Loss of biodiversity risk" indicator is 3.1 (on a scale of 0 to 10), which is deemed medium/low vulnerability, though participants rated the vulnerability as high, with ratings of 3 and 4 (on a scale of 1 to 4). Although there are no comments from the participants regarding the assessment of this risk associated with the forestry sector, it is thought that the differences in the results are due to the fact that this indicator calculated for the entire county used the total PEIN (Areas of Natural Interest Plan) protected area in the region and the total land area with Territorial Stewardship Agreements as sub-indicators, both with much lower surface area ratings compared to other counties in Catalonia, thus giving the indicator a low overall vulnerability rating for the entire county. Therefore, the rating obtained in the indicator does not indicate that overall vulnerability is low, but that it is low when compared to the vulnerability of other counties.
- The last risk with diverging results is “Variation in tourism demand”, which affects the tourism sector. Low vulnerability was the rating obtained in the calculation (1.3 on a scale of 1 to 10) though participants gave quite different ratings, from 1 to 4 (on a scale of 1 to 4), thus including low, medium, and high vulnerability. The differences in results are associated with different viewpoints of the indicator by participants in assessing the tourism sector's vulnerability. On one hand, the "Changes in the pattern of summer tourism demand" indicator takes into account the number of tourist accommodations in the area with the greatest fire risk as a sub-indicator of sensitivity and the number of visitors to *Enoturisme Penedès* (Penedès Wine Tourism) wineries and museums in relation to all wine routes in Spain as a sub-indicator of adaptive capacity. The low number of tourist accommodations in the area of greatest fire risk in most municipalities and the county's high adaptive capacity due to the substantial number of visitors to *Enoturisme Penedès* routes gives the sector a rather low final vulnerability rating in the county. On the other hand, it is thought that participants who rated the tourism sector's vulnerability as high took into account a possible future reduction in wine production, due to pests affecting crops for example, which could consequently affect wine tourism income and visitor numbers.

The summary tables below show the perception ratings and the indicator ratings for each sector, preceded by a table with the criteria followed by the vulnerability assessment.

Criteria for assessing vulnerability		
Rating	Assessment	Definition
4	Very high	The economic sector and the socioeconomic environment are deemed to have very high vulnerability.
3	High	The economic sector and the socioeconomic environment are deemed to have high vulnerability.
2	Low	The economic sector and the socioeconomic environment are deemed to have low vulnerability.
1	Very low	The economic sector and the socioeconomic environment are deemed to have very low vulnerability.

Annex 1 presents the diagnosis tables of the impacts detected as most significant and the table of uncertainties for each sector. This assessment is based on numerical data of the identified risks and opportunities, the results of vulnerability indicators, and perceptions by economic agents.

i. Forestry sector

Risk perception table

PERCEPTION OF THE FOREST SECTOR'S VULNERABILITY		
RISK	PERCEPTION RATING (1-4)	INDICATOR RATING (0-10)
Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts)	3-4	2
Reduction in the flow of rivers and streams and a longer dry season	1.3 and 4	6
Increase in fire risk	3-4	4
Loss of biodiversity	3-4	3

ii. Tourism sector

Vulnerability perception table

PERCEPTION OF THE TOURISM SECTOR'S VULNERABILITY		
RISK	PERCEPTION RATING (1-4)	INDICATOR RATING (0-10)
Loss of landscape quality	1-4	5
Variation in tourist demand	1-4	1

iii. Livestock farming sector

Vulnerability perception table

PERCEPTION OF THE LIVESTOCK FARMING SECTOR'S VULNERABILITY		
RISK	PERCEPTION RATING (1-4)	INDICATOR RATING (0-10)
Changes in crop types	1.3 and 4	5
Changes in wine productivity	2-4	4
Changes in the distribution of arable areas	1-3	4
Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts)	2-4	3
Increase in pests	1-4	-
Decrease in water quality	-	4
Increase in fire risk	2-4	5
Loss of biodiversity	1-3	4
Loss of jobs	2-4	-

3.1.3 Terres de l'Ebre Biosphere Reserve

A joint assessment has been made of the results obtained from the perception of agents in the territory on the different economic sectors analysed and of the results obtained through the vulnerability indicators calculated by the technical team that carried out the diagnosis of the Terres de l'Ebre's vulnerability to climate change⁴.

First of all, it is important to note that the agents' response for 16 of the 17 risks posed was that the economic sector in question had the highest possible vulnerability (4 out of 4). Only the "Changes in the distribution of crop areas" had a lower rating, at 3. By contrast, there is a wide array in the vulnerability ratings obtained through the indicators, ranging between 2 and 10.

- There was much agreement in classifying the effect of the following risks as having high vulnerability: rising sea level (agriculture and tourism), effects to livestock farming, changes in plant productivity (dry land crops), decreasing water availability in agriculture, and a risk in the increase of invasive species and/or pests (agriculture and aquaculture).
- There was a certain divergence in risks which, from the viewpoint of agents in the territory, were perceived as having maximum vulnerability: increased need of irrigation, loss of biodiversity, and health concerns due to heat waves; while the indicators gave a high rating of 7 out of 10. In the first case, the difference seems to be due to the fact that the indicator used the percentage of dry land agriculture, which is quite significant in the Terres de l'Ebre, to measure adaptation capacity. In the second and third cases, the result was due to moderate sensitivity (habitats with shared interest relative to the total surface area and the percentage of the most vulnerable population).
- There was a marked difference regarding other risks, given that the vulnerability indicators gave medium or low ratings. The most notable examples were risks associated with forest fires (6 out of 10), changes in the distribution of forest species (2 out of 10), reduction in grazing lands (3 out of 10), and changes in tourism demand patterns (4 out of 10 regarding discomfort and 5 out of 10 regarding water management). Regarding risks linked to the forestry sector, the relatively low presence of the species most sensitive to fires or drought explains these results. Regarding tourism and according to the indicators used, sensitivity is not high due to low seasonal population numbers in relation to the total population unlike other tourist destinations such as the Costa Daurada.

The summary tables below show the perception ratings and the indicator ratings for each sector, preceded by a table with the criteria followed by the vulnerability assessment.

⁴ *Estudi dels efectes del canvi climàtic a les Terres de l'Ebre: diagnosi, impactes i vulnerabilitats* (Study of climate change effects in the Terres de l'Ebre: diagnosis, impacts, and vulnerabilities). OCCC-Saladié, O., Saladié, S., Àvila, A. and Aguilar, E. Department of Geography, URV, July 2017. Life Clinomics. http://lifeclinomics.eu/wp-content/uploads/2017/07/VERSIO4_ClinomicsTEBRE.pdf

Criteria for assessing vulnerability		
Rating	Assessment	Definition
4	Very high	The economic sector and the socioeconomic environment are deemed to have very high vulnerability.
3	High	The economic sector and the socioeconomic environment are considered to have high vulnerability.
2	Low	The economic sector and the socioeconomic environment are considered to have low vulnerability.
1	Very low	The economic sector and the socioeconomic environment are deemed to have very low vulnerability.

Annex 1 presents the diagnosis tables of the impacts detected as most significant and the table of uncertainties for each sector. This assessment is based on numerical data of the identified risks and opportunities, the results of vulnerability indicators, and perceptions by economic agents.

i. Forestry sector

Vulnerability perception table

PERCEPTION OF THE FOREST SECTOR'S VULNERABILITY		
RISK	PERCEPTION RATING (1-4)	INDICATOR RATING (0-10)
Changes in the distribution of forest species	4	2
Decrease in forestry production	4	-
Increase in forest fire risk	4	6
Loss of landscape quality	4	-
Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts)	4	4
Loss of biodiversity	4	6
Risks associated with human health	3	7

ii. Tourism sector

Vulnerability perception table

PERCEPTION OF THE TOURISM SECTOR'S VULNERABILITY		
RISK	PERCEPTION RATING (1-4)	INDICATOR RATING (0-10)
Morphological changes on the coast (especially to the Ebre Delta)	4	10
Loss of landscape quality	4	6
Changes in the patterns of tourism demand	4	4
Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts)	4	5
Risk of more invasive species	4	5
Risks associated with human health	-	7

iii. Livestock farming sector

Vulnerability perception table

PERCEPTION OF THE LIVESTOCK FARMING SECTOR'S VULNERABILITY		
RISK	PERCEPTION RATING (1-4)	INDICATOR RATING (0-10)
Changes in crop types	4	7
Changes in plant productivity	4	8
Increase in irrigation needs	4	7
Changes in the distribution of crop areas	3	3
Changes in livestock farming	4	10
Morphological changes on the coast (especially to the Ebre Delta)	4	10
Loss of landscape quality	4	-
Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts)	4	7

PERCEPTION OF THE LIVESTOCK FARMING SECTOR'S VULNERABILITY		
RISK	PERCEPTION RATING (1-4)	INDICATOR RATING (0-10)
Loss of biodiversity	4	6
Risk of more invasive species	4	8
Risks associated with human health	-	7

iv. Fishing and aquaculture sector

Vulnerability perception table

PERCEPTION OF THE FISHING SECTOR'S VULNERABILITY		
RISK	PERCEPTION RATING (1-4)	INDICATOR RATING (0-10)
Morphological changes on the coast (especially to the Ebre Delta)	4	-
Disruptions to fishing and aquaculture	4	8
Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts)	4	-
Reduction in the flow of rivers and streams and a longer dry season	4	-
Loss of biodiversity	4	-
Risk of more invasive species	4	8
Risks associated with human health	-	7

3.2 - Social and institutional potential for increasing territorial resilience.

The studies on social and institutional potential for increasing territorial resilience in the three CLINOMICS territories show that there is both high social and institutional potential. However, strategies and mechanisms are required which can facilitate and regulate engagement, simultaneously ensuring continuity and usefulness. Therefore, this strategy must take into account the strengths and weaknesses that have been noted in each territory and in each sector.

3.2.1 Montseny Biosphere Reserve.

The social and institutional potential for increasing territorial resilience in the Montseny area is deemed to be outstanding. There is interest and motivation and relevant agents, both public and private, are willing to work on the issue.

The following table summarizes the results from the study carried out⁵:

Opportunities and strengths
<ul style="list-style-type: none"> • The City Councils in the 18 municipalities and the three County Councils in the area are aware of the project. • Most of the City Councils have already identified and established a working municipal representative for the project. The 3 County Councils involved have also done so. • The relevant agents, especially in the tourism sector and to a lesser extent in the agricultural sector, of the Montseny area have participated in and continue to engage in various participatory bodies and processes. The value of the territory's remarkable participatory culture towards the CLINOMICS project's objectives is noteworthy. • The authorities and primary agents involved, organised in associations, already have a great deal of experience in joint work through the Park's management and advisory bodies and, more recently, through the European Charter for Sustainable Tourism (ECST) process⁶. • There is a great deal of motivation and participation by the private tourism sector in the territory for the development of a sustainable tourism strategy (the ECST). The sector's adaptation to climate change wholeheartedly falls in line with ECST objectives. • Having the Montseny Association of Tourism Businesses, represented by 68 companies in the sector, facilitates broad representation for the sector. • As to the forest area, the Montseny Association of Landowners, with 270 members, enables dialogue and participation for representatives covering 40% of the project's scope. • Unió de Pagesos (Farmers Union), the largest agricultural union in Catalonia, is a project member; and the Young Farmers and Ranchers Association of Catalonia (JARC), including members who are part of the project, has shown interest in participating in the CLINOMICS territorial platform in the Montseny. • A total of 78 agents have been identified in this first study who have already indicated that they are willing to participate in a project participation platform (46 of whom indicated that they are interested in doing so and the remaining 32 indicated that they may be able to participate depending on availability and the platform's

⁵ *Diagnosi social i institucional de la Reserva de la Biosfera del Montseny* (Social and institutional diagnosis of the Montseny Biosphere Reserve), La Vola, March 2017. Diputació de Barcelona, Life Clinomics. http://lifeclinomics.eu/wp-content/uploads/2017/05/01_Estudi_social_agents_Montseny_CLINOMICS_2017_03_29_adaptat-per-web.pdf

⁶ <https://parcs.diba.cat/web/turisme-sostenible-als-espais-naturals/carta-europea-de-turisme-sostenible>

characteristics and organization).

- The agents interested in participating are primarily relevant agents for the project.
- The following results from the agent questionnaire are strengths in relation to existing social potential:
 - 61% of agents surveyed showed a high interest in adapting to climate change. This percentage reached 87% in the agricultural sector.
 - Despite the limited response from agents in the banking sector (5 agents), 80% showed high interest in adapting to climate change.
 - Only 14% of the agents thought of themselves as having a low level of knowledge in relation to climate change and its effects.
 - 64% of the agents thought it could be possible to adapt to climate change to reduce the negative effects on economic activities in the Montseny.
 - 54% of the agents thought they could provide valuable information and collaborate to carry out actions for adapting to climate change.

Threats and weaknesses

- None of the municipalities in the area have an Adaptation Plan although 12 of the 18 municipalities are signatories to the Covenant of Mayors for sustainable energy and have a Sustainable Energy Action Plan (SEAP). In this sense, the supramunicipal Adaptation Plan to be carried out within the CLINOMICS framework will enable significant progress in increasing the territory's resilience to climate change.
- Insurance company involvement in the project will not be straightforward. The fact that these entities are multinational companies not headquartered in Catalonia, and thus quite distant from the territory, makes identifying an agent to represent them rather difficult.
- Even though individual insurance agents working in the Montseny CLINOMICS area have been identified, some said they are not interested in being part of a project participation platform and only one said they may be interested, depending on their availability and the level of involvement required.
- Banking sector involvement is complicated for reasons similar to those of insurance companies.
- The following results from the agent questionnaire are weaknesses in relation to existing social potential:
 - Regarding city councils, 31% of the agents claimed to have a low level of knowledge in relation to climate change and its effects.
 - About 25% of the agents surveyed stated that they are not interested in taking part in a project participation platform.
 - A large number of agents indicated that time and availability was the main factor limiting participation in the project.

3.2.2 Alt Penedès

The social and institutional potential for increasing resilience in the Penedès territorial area is deemed to be outstanding and well-established. There is interest and motivation and relevant agents, both public and private, are willing to work on the issue, while a large number of companies and business associations in the wine sector, such as vineyards and wine associations, are aware of the need to act towards adapting to climate change.

The following table summarizes the results from the study carried out⁷:

TOURISM SECTOR
Strengths
<ul style="list-style-type: none"> • Year-round tourism. • Prestige of the Enoturisme Penedès Brand and the Penedès Tourism Promotion Consortium • Established wine-growing landscape. • The desire for continuity in the region by wine-making companies as shown by the important investments in recent years. • Tourist initiatives in the county that combine tourism, outdoor activities, and environmental issues. • The network of medium-to-large sized cava producers and wineries which are drivers for tourism. • Significant involvement by City Councils in the wine tourism sector, with tourism initiatives and excellent tourism websites.
Weaknesses
<ul style="list-style-type: none"> • Strong dependence on the adverse effects that climate change may have on vineyards and forests. • Rather artificial landscape due to public infrastructure and clusters of industrial activities.
FORESTRY SECTOR
Strengths
<ul style="list-style-type: none"> • Importance of the Penedès-Garraf Federation of Forest Defence Groups (ADFs) and Forest Landowners. • Forest management and preservation experience with positive results. • Significant experience in Catalonia in managing Mediterranean forests, fires, climate change effects (CREAF, GRAF Firefighters). • Important forest properties linked to the wine and cava sector, with interest and the economic capacity to carry out the relevant Forest Management Plan. • Firefighting infrastructure maintained by ADFs. • Solvent ADFs regarding investments in forestry material (machinery, wood chippers, etc.). • Good relationship between ADFs and Forest Landowners.
Weaknesses
<ul style="list-style-type: none"> • Entities involved (City Councils, ADFs, and Forest Landowners) not having their own economic resources available for adapting to climatic change or for fighting against fires. • Reliance on subsidies from the DARP, the Barcelona Provincial Council (DIBA), City Councils, the Torres Foundation • Scant capacity for carrying out projects in the forest area due to the lack of economic means. • The City Councils limit themselves to carrying out only mandatory forestry work.

⁷ *Estudi i Diagnosi de la realitat social institucional del territori del Penedès* (Study and Diagnosis of the institutional social reality of the Penedès territory). Adedma, April 2017. Diputació de Barcelona. Life Clinomics.
http://lifeclinomics.eu/wp-content/uploads/2017/06/DIAGNOSI_CLINOMICS_DEF-MAR%C3%872017Baixa.pdf

- High density and weakened forests because of the competition for water resources, requiring actions to reduce flammable material and subsequent maintenance.
- Absence of forestry companies in the county due to low profitability.

AGRICULTURAL SECTOR

Strengths

- Wine-growing is the most important and well-established agricultural activity in the county.
- The presence of large international companies which have economic and technological resources to carry out their activities and strong internal departments related to the environment and climate change impacts.
- The existence of regulatory bodies (DO Penedès, DO Cava, DO Catalunya, and CORPINAT) which are well-recognized within the sector.
- The presence of scientific and technical support structures (AVDs, INCAVI, DARP, IRTA, etc.)
- Unió de Pagesos (Farmers Union), the largest agricultural union in Catalonia, is a project member; and the Young Farmers and Ranchers Association of Catalonia (JARC), some members of which are in the project, has shown interest in participating in the CLINOMICS territorial platform in the Penedès.
- Projects associated with adapting to climate change have already been carried out in the Penedès.
- Large and very large companies are already taking measures to adapt to climate change.
- Wine Technology Platform (PTV): National business structure with involvement by the main wine sector agents in the Penedès.
- Awareness of the difficulty of the climate change adaptation issue in the world of wine.

Weaknesses

- Significant fragmentation of small vineyards, which can make the implementation of climate change adaptation actions difficult for economic and technical reasons.
- Medium and large-sized businesses are strongly competitive domestically and internationally, which can make their collaboration complicated even with CLINOMICS.
- For small vineyards, day to day affairs can hinder the long-term vision which is necessary for facing climate change issues.

3.2.3 Terres de l'Ebre Biosphere Reserve.

It may be thought that potential exists in Terres de l'Ebre, but strategies and mechanisms will be needed that allow maintaining a level of motivation and involvement throughout the project and attracting certain relevant actors that are not currently involved. Likewise, establishing strategies that promote territorial participation within a global and general interest framework will be essential.

The following table summarizes the results from the study carried out⁸:

Opportunities and strengths

- High involvement by territorial agents and citizens in the protection and defence of the territory.
- High potential for networking in the territory, especially among agents in specific areas.
- The well-established existence of a territorial identity in the Terres de l'Ebre, though more solidified in the southern counties than in the northern ones.
- Identity and connection with certain products from the territory, mainly agricultural.

⁸ *Diagnosi social i institucional de les Terres de l'Ebre* (Social and institutional diagnosis of the Terres de l'Ebre). CERES, February 2017. COPATE, Life Clinomics. <http://lifeclinomics.eu/wp-content/uploads/2017/07/Life-Clinomics-Terres-Ebre-Diagnosi-social-i-institucional-DEF.pdf>

- Important network of associations, both social and economic.
- The existence of participatory bodies and mechanisms that already have a substantial overall background in the territory and in areas closely associated with adapting to climate change, such as the Biosphere Reserve, local action groups, or the two natural parks.
- Actors with ample experience taking part in strategic planning processes that may play a major role in this project.
- Unió de Pagesos (Farmers Union), the largest agricultural union in Catalonia, is a project member. The Young Farmers and Ranchers Association of Catalonia (JARC), some members of which are in the project, has shown interest in participating in the CLINOMICS territorial platform in the Terres de l'Ebre.
- The number of actors who were reached (75) and who have expressed their willingness to participate in the project's second phase (62), as well as the broad spectrum they represent: public sector, economic sector, and environmental sector. Moreover, 79% would be willing to participate as a representative of an organization or entity in the territory.
- Well-developed relationship between all actors with the public sector.
- Major participation level by for actors regarding participatory processes in the territory, including a positive view of their usefulness.

Threats and weaknesses

- An elderly population suffering the loss and outward migration of young people, showing the need to create new economic and employment opportunities in the territory.
- Insufficient institutional coordination and agreement with a view to considering general improvements to the territory, and a lack of leadership at the territorial level.
- An entrenched culture of "no" that can be damaging in the development of comprehensive strategies. In this sense, the territory has a tendency towards being reactive. At present, a shift towards being proactive should be encouraged to maintain the territorial identity once achieved through being reactive.
- The agricultural sector represents many of the territory's identity features but is suffering from significant decline and gradual abandonment.
- The lack of an overall territorial vision and of meaningful socioeconomic projects, showing poor economic collaboration.
- The development of Sustainable Energy Action Plans (SEAP) is still relatively new in the territory. Many of them are still being drafted. In the future, special care must be taken in their implementation and in ensuring they do not become an empty promise.
- A lack of established local participatory bodies, essential structures in helping to work towards a culture of social participation.
- Poor networking by actors in the economic and environmental sector, and lack of diverse interconnection within the same sectors. Likewise, a general relationship is lacking with the Ebre Observatory (OE), a very important body in strategic terms for the territory.
- In spite of the level of participation by actors and their good assessment, it is necessary to take into account aspects that can undermine their involvement, such as transparency in the processes and effectiveness in the methodologies.

4.- Managing adaptation to climate change

LIFE-CLINOMICS arose from evidence showing that, in order to respond to the challenge of adapting to climate change, social organization at present, despite its potential, is still insufficient. LIFE-CLINOMICS proposes a governance model that must be participatory and inclusive, capable of giving voice and vote to the relevant territorial actors in the definition and application of ACC measures.

This governance model can be considered one of the project's main contributions and, therefore, ensuring its continuity over time and the replicability of the model across Catalonia and other Mediterranean territories has become a fundamental objective.

4.1 – MeTACC

Governance will revolve around Territorial Platforms for Adapting to Climate Change (MeTACC) in which both business and sector associations, as well as the local authorities and social agents involved, will participate. MeTACCs must become the leading entities for advancing towards territorial resilience, not just from a theoretical level, but from an operational and executive level.

MeTACCs should not merely assess actions - they must propose them in a cross-cutting manner. This proactivity must turn them into the arena for a paradigmatic bottom-up process. The role of MeTACCs must be complemented by Sector Platforms for Adapting to Climate Change (MeSACC) or by more specialized working groups to discuss concrete actions and more specific and individualized ways forward for each economic sector.

In this sense, the role of the MeTACCs and the MeSACCs in the post-project phase - when the Action Plan for Adapting to Climate Change (PAACC) has been approved and is progressively executed, especially pilot actions - must be specifically redefined. It would then seem appropriate for the MeTACCs to go beyond their role as a participatory body. This can only be done if the MeTACCs, or the entity into which they evolve, give continuity to their functions (see point 6.1), appointing a supra-municipal (or even supra-county) local authority that would become their managerial entity. Depending on the territorial area of intervention, this managerial entity may be different.

To summarize, the entity into which the MeTACCs evolve must be a stable management space giving capacity for action and continuity to the LIFE-CLINOMICS project, and a body for participation and socialization of knowledge. Notable areas of responsibility this space must include are:

- A space for the territorial agents involved with climate issues to come together, boosting participation and proactivity by the actors, and anticipating and resolving possible conflicts of interests between them.
- A management office for adaptation at the local level, promoting participation and proactivity by territorial actors.
- A technical management and administrative support office to centralize information, organize meetings, logistics, communications, etc.
- A territorial adaptation and resilience observatory, tracking the implementation of the measures and evaluating results.
- A space for climate change adaptation plans tracking, discussion, and regular updating, serving as a backbone for generating resilience.
- A capacity-building tool for local agents, developing training and knowledge transfer tasks.

- A recognized capacity for dialogue with local authorities, other supra-municipal authorities, and economic and social agents on whom the availability of resources must be counted on.

4.2 - Managing entity for adaptation at the local level

For the purposes of the foregoing, and to ensure the applicability and effectiveness of MeTACC decisions, it will be essential to endow them with sufficient institutional capacity for becoming the authoritative spokesperson with local authorities, with relevant higher-level authorities concerning the issue, or with those that have the resources to implement measures and actions. Advocacy by the MeTACCs will increase with their ability to influence regulations.

For this reason, as noted before, post-project MeTACCs must be associated with (or assigned to) authorities present in the territorial area in question, all while avoiding overlapping and improving coordination, especially in the implementation of the measures. This authority must become the managing and driving entity for the MeTACC or the entity which takes on its functions. Each managing entity's function as a technical and managing office of the MeTACC— or the entity into which it evolves—, must be recognized and equipped with resources as part of its organizational chart. Therefore, the managing entity will be the core of the participatory structure or the driving force of the MeTACC from which the platform must be coordinated, with maximum participation by agents in the territory.

The role of the driving force in steering the MeTACC includes functions such as the following:

- The promotion of initiatives regarding climate change, both public and private, giving institutional support, and encouraging participation by actors in the territory.
- Maintaining and updating the database of agents to be invited.
- Managing calls and registration for platform sessions.
- Preparing and delivering work materials for the sessions.
- Session logistics: materials, premises, equipment, etc.
- Offering facilitators for the sessions, if appropriate depending on the platform's topic and/or objective.
- Drafting the corresponding reports for the participatory process and feedback reports to participants.
- Managing and monitoring online participation, if this type of mechanism is implemented.

Finally, the managing entity must strengthen the MeTACC's ties to municipal action to ensure the best possible success of the measures taken. In this sense, it would be helpful to tie the MeTACCs and their working groups to the reinforcement of the Covenant of Mayors for Energy and Climate initiative, which would provide a suitable European context for their work. The replicability of MeTACCs could be an engine for balancing the burden of mitigation, nowadays much higher, and adaptation in the Covenant's work. The

local development agent (ADL) role, already existing at present, offers the possibility of expanding ACC actions, all while taking advantage of currently available resources, with administrative efficiency.

4.3 - Citizens and territorial agent participation

The governance model proposed by the project must be participatory and inclusive, with the proposal of territorial and sector platforms (MeTACC and MeSACC) resulting as the best instruments for this inclusive approach.

In this sense, participation has also been the basis for the LIFE-CLINOMICS project. Therefore, the CLINOMICS post-project Strategy aims to give special visibility to participation, which constitutes a strategic focus that is closely associated with governance. Thus, social participation will continue to be the cornerstone of the adaptation strategy.

Therefore, MeTACCs with a mixed structure and a stable core, or driving force, are suggested, along with an open and flexible structure. There will be a formal group of members, which have expressly expressed their commitment to belonging to the MeTACC, either on behalf of the various social or territorial agents or individually. At the same time, other participants representing profiles and sectors of interest will be invited to the project at given times during its implementation.

The number of sessions and workshops will be largely based upon the schedule for implementing the respective measures and actions and their monitoring and evaluation. It is deemed appropriate to make use of a predetermined annual schedule with two or three plenary sessions.

Regarding the MeSACCs, they will remain dependent on the MeTACCs. In this regard, MeSACC forums and working groups should regularly include topics related to adapting to climate change and transfer their conclusions to the MeTACC. In the opposite direction, the MeTACCs may bring certain discussion or analysis items to the MeSACCs.

4.4 - Local network for adapting to climate change

The impetus given by the project for adapting to climate change in the territories will lead to the creation of local networks made up of representatives from the sectors involved in the process that have the desire to continue and promote the implementation of the actions derived from the PAACC through its activities. The network will facilitate collaboration between social and economic sectors (businesspeople, workers, and entities) and take advantage of synergies between sectors of economic activity (tourism, agriculture, forestry, and fishing).

5.- Planning and implementation

Each MeTACC will establish the priorities that will give coherence and structure to the actions that must be carried out in their respective territorial areas, which will be articulated in an action plan.

The Action Plan will compile the measures and actions identified during the participatory processes promoted by the MeTACCs, informed accordingly and, where appropriate, proposed by the designated experts, as well as contextualizing and incorporating the existing initiatives and actions.

5.1 - Criteria for defining territorial areas

The CLINOMICS Strategy is an ACC Strategy designed to be implemented through local management, not necessarily municipal but through relatively small territorial areas enabling the conciliation of the intentions of the majority of the actors involved, thus allowing the establishment of priorities through the identification of the synergies and positions present among the main socioeconomic sectors. The characteristics of the three territories chosen by LIFE-CLINOMICS are a suitable starting point for the subsequent identification of the ideal territorial framework in each geographical area.

As noted, local resilience to climate change is insufficient and unsatisfactory as shown by the difficulties in the operational implementation and deployment of the Covenant of Mayors for Energy and Climate. This is due to the fact that ACC policies often exceed local responsibilities and have a longer implementation time than other environmental policies.

Therefore, considering the replicability of the CLINOMICS model, properly defining the territorial scale for intervention is very important. In this sense, the multicriteria analysis methodology used to evaluate vulnerabilities and risks has proved to be very responsive to the scale adopted in quantifying the various parameters and indicators. The reliability of the risk and vulnerability diagnoses, the applicability of the actions, and their monitoring will depend on the territorial scope.

Finally, the choice of the scope must also allow for an appropriate governance of the strategy and may require pre-existing administrative or institutional structures, easily approachable and well-established in the territory. In this sense, the scope of intervention will seek balance between the geographical area (even if diverse or complex) and the availability of adequate institutional frameworks for implementing the strategy. In other words, it is necessary to seek and find balance between the territory as the natural space for intervention and the territorial scope of the administrative body or entity that will have to enable the intervention. The diagnosis of institutional capacity and the map of main actors in each territory is useful for this.

5.2 - Territorial and sector action plans: structure, challenges, and opportunities

The drafting of the Action Plans for Adapting to Climate Change (PAACCs) for each territorial area concerned, and to the extent possible for each sector, in accordance with their socioeconomic realities, and the subsequent implementation of the actions based on the priorities assigned by the agents is the core of the work for MeTACCs and MESACCs.

Therefore, the PAACCs must compile the measures and actions identified and prioritized by the participatory processes driven within the framework of the MeTACCs, fine-tuned and redeveloped accordingly by the designated experts. Furthermore, the PAACCs must also take advantage of, incorporate, and contextualize pre-existing initiatives and actions related to climate adaptation and territorial resilience.

The action plans can be adjusted to the outline of operational objectives and measures proposed by the ESCACC, in the context of the main vectors or environmental parameters and of the large sector-based activity groups (Water, Biodiversity, Energy, Forestry Management, Fisheries and marine ecosystems, Agriculture and Livestock, Tourism, Industry and services, Urban development, Mobility, and Health). However, in order to give continuity to the initial purpose of LIFE-CLINOMICS, and given the intended focus on socioeconomic resilience, the following groups of action areas have been suggested: Agroforestry, Tourism, and Fishing, always with a cross-cutting perspective determined by the presence of socioeconomic agents.

All actions must satisfy social, economic, and environmental viability and sustainability criteria. Having the agreement and commitment of the main actors in the economic and/or territorial areas in which an action is to be implemented will also be an essential condition. However, the actions will be prioritized based on their cross-cutting nature, replicability, implementation time, and innovation, both in technical terms such as governance or impacts on business models and the labour market.

In this sense, one of the main criteria must be the cross-cutting nature of the actions. This means measures that affect various areas and that, for this reason, can become a priority due to their ability to create synergies. This is the case regarding issues associated with irrigation (water and agriculture) or agroforestry integration and patchwork spaces with territorial planning and the conservation of biodiversity or, even, the promotion of ecosystem services unlikely to value in terms of money (forestry management, biodiversity, and landscape).

Thus, the Action Plan is structured based on previously defined areas and in accordance with the priorities that have been established by the MeTACCs with the help of technical experts. Each action must be fully defined and specified and contain at least the following information:

- A justification of its implementation regarding the climate challenges and risks it aims to avoid or reduce.
- The identification of the implementation coordinator and the actors involved.
- A calculation of economic profitability.
- An estimate of the potential for quality employment and, wherever possible, specification by groups: young people, women, level of qualification, or contract type.
- An approximate schedule and implementation timeline.
- Funding.

Finally, the PAACC will also have to provide concrete measures for the development of new business models based on the circular economy, bioeconomics, and ecodesign which aid in shifting towards a new production and consumption paradigm that is aligned and consistent with climate adaptation. In addition to being

desirable, the aim is to show that this strategic framework is viable and results in a positive cost-benefit ratio over the medium and long term. Therefore, Action Plans, actions, and projects must also have, as an essential condition, a positive cost-benefit ratio.

It is appropriate for the PAACCs to also consider measures for strengthening the development of scientific studies that provide data on climate change impacts at a local scale and in the sector-based areas with which the project works. Actions aimed at increasing knowledge, supporting research, promoting innovation, strengthening impact monitoring systems to keep track of the measures that are being implemented, and defining indicators to learn about the effectiveness of the actions must be proposed.

The studies carried out within the CLINOMICS framework make it possible to have initial knowledge of the challenges and opportunities that each territory and sector deem most important and relevant in shaping the PAACCs' body of priorities. The challenges and opportunities are compiled in the following tables:

5.2.1 Montseny Biosphere Reserve

Sector	Challenges	Opportunities
Livestock farming	Avoiding the abandonment of agricultural and livestock activities	Boosting livestock practices that improve adaptation
	Avoiding increased damage due to the greater occurrence of diseases and pests and their effects	The MBR-NP's role in regulating minor activities
	Avoiding the loss of summer grazing land	The integrated vision of the agricultural-forestry-livestock system and the production-distribution-consumption cycle
	Managing fire risk	Promoting agricultural and livestock practices that reduce the risk of forest fires
Forestry	Avoiding the abandonment of forestry management - valuing products and services	Enhancing drought resistance for certain species - forestry management
	Managing fire risk	The LIFE Tritó (Montseny brook newt) project to improve riparian habitats
	Preventing and reducing the effect of pests	Secondary forestry products for maintaining rural income
		The world of forestry's engagement with associations
Tourism	Maintaining landscape quality and richness	Boosting livestock farming activity
	Improving water cycle management - ensuring water resources	The LIFE Tritó project
	Managing fire risk	Loss of climate comfort in coastal areas, year-round visitors to the Montseny
	Avoiding a reduction in biodiversity	The European Charter for Sustainable Tourism, for promoting tourism activity adaptation
		The tourism sector's engagement with associations

5.2.2 Alt Penedès

Sector	Challenges	Opportunities
Livestock farming	Managing changes in the distribution of arable areas	Changes in crop types
	Improving water cycle management - ensuring quality water resources	Changes in wine productivity (and in other crops)
	Avoiding the loss of biodiversity	Changes in crop management and techniques due to climate change
	Avoiding the disappearance of extensive livestock farming	Traditional agricultural and livestock farming practices
Forestry	Lowering the risk of reduced river and stream flow	The potential for forestry to take advantage of biomass and vine shoots
	Longer dry season	
	Managing forest areas - fire risks	
	Avoiding the loss of biodiversity	
Tourism	Maintaining landscape quality and richness	The loss of climate comfort in coastal areas, year-round visitors in the county
	Managing changes in tourism demand	Tourism products: wine tourism, culture, sport, animal migration, seasonal variation
	Managing fire risk	
	Avoiding the loss of biodiversity	
	Underestimating risks, which could pose a risk in itself	

5.2.3 Terres de l'Ebre

Sector	Challenges	Opportunities
Livestock farming	Avoiding effects to crops and other activities due to morphological changes in the Ebre Delta	Implementing more efficient irrigation techniques
	Improving water cycle management - ensuring quality water resources	Changes in crop types/varieties
	Managing and improving intensive livestock farming conditions - more efficient farms	
Forestry	Managing fire risk - forestry management	The potential for forestry to take advantage of biomass
	Avoiding the loss of biodiversity	
Fishing and aquaculture	Avoiding effects on fishing due to morphological changes in the Ebre Delta, increased water temperature, and other impacts derived from climate change	
Tourism	Minimizing impacts due to an increase in sea level: the loss of coastline, morphological changes to the coast...	Possible seasonal changes
	Controlling invasive and/or disruptive species	The sector is responsive to environmental certifications
	Improving water cycle management - ensuring quality water resources	Redefining tourism products
	Maintaining landscape quality and richness	
	Minimizing impacts on people's health	

5.3 - Pilot actions

The uncertainties associated with climate change and adaptation processes require the PAACCs to be equipped with mechanisms having a demonstration effect, with the capacity to promote proactive commitment by territorial and sector agents and giving certainty to the utility and necessity of all actions.

The MeTACC in each territory will have the opportunity to choose two pilot actions, which must be dual in nature: they must tackle two important issues in the territory and give confidence and structure to the entire PAACC.

The resources for implementing these actions are provided by the LIFE-CLINOMICS project and, from the beginning, are distributed among local authorities and the European Union in accordance with the project's joint funding ratio.

As the starting point for the investment process in adapting to climate change, it is desirable for the relevant local authorities in each territory to be responsible for the pilot actions. This requires a special effort towards consensus within the MeTACC itself. The actions must be chosen by this body but their implementation must also be realistic for local authorities in terms of the reach of their powers. The opinion of local authorities is key for this point.

Territorial, social, and economic agents must be made aware of the significance of climate change, so it can be incorporated into their respective planning agendas, both individually and in the organizations, associations, and entities to which they belong. It is important to be aware of the need to adapt equipment, infrastructure, as well as productive processes and surroundings to the effects of global change and to promote needed measures and investments. In this sense, climatic risks pose a challenge to socioeconomic activity but may generate opportunities for new activities and boost competitiveness.

6.- Assessment and Monitoring

The inherent characteristics of global change mean the strategy is based on adaptive management of the problem. Therefore, it is necessary to have stable management frameworks that give continuity to instruments that are enabled to assess the evolution of the impacts, the efficiency of the measures taken, and, where appropriate, reviewing the Strategy and the Action Plans.

In a changing situation, it is necessary to have up-to-date information and sufficient flexibility in the analysis to make proper decisions at all times. The adaptation measures implemented, and the evolution of the degree of vulnerability and the risks for the different social and economic areas of each MeTACC must be constantly monitored and assessed using appropriate indicators.

In this sense, the MeTACCs must become local climate adaptation and resilience observatories, developing the local monitoring role regarding adaptation to global change.

6.1 - Local observatories for adapting to climate change

The best opportunity for the continuity of the MeTACCs is their conversion into local observatories for climate adaptation and resilience, which will only be possible if they receive dedicated support from territorial managers.

Local observatories will develop a continuous, *on site* monitoring function in the field of climate change and climate change adaptation in particular. At the same time, they must be participatory spaces that bring together all territorial agents (social, economic, and public officials) and assume and/or coordinate, based on the realities in each territory, MeTACC and MeSACC tasks once the project has officially concluded. They must compile training needs and bring local knowledge to the most relevant current climate change projects in the territory.

Local observatories should be understood more as a function than an entity. Management, support, and continuity responsibilities can take the form of an administrative unit within a wider area of the territorial entities, incorporating ACC functions, or as a responsibility that is assigned to an already existing unit in the territorial entity.

This entity will have to organize and manage the observatory's activities and, in particular, call for meetings, safeguard documents, and share information about the activities.

It will be formed by all economic, social, and political agents in the territory who take on the responsibility of promoting ACC processes and will rely on advice from experts who will contribute their knowledge to the smooth running of the discussions. Some ACC promotion actions may include: compiling training needs and raising awareness of the most relevant climate change projects in the territory; raising people's awareness about the benefits of economic activities as landscape and biodiversity shapers; raising awareness among professionals from the economic sectors about the needs and benefits of implementing climate change adaptation measures; and transferring all information generated to promote the local replicability of the adaptation actions.

In short, the observatory is envisaged as a complex and heterogeneous body with various levels of power and responsibility in which the management unit, agents that participate in the discussions, promote and carry out investments, and experts come together.

Each observatory will have the capacity for self-organization, though it would be desirable for them to become entities that meet at the initiative of the management unit's or a significant number of their members. The observatories have three fundamental tasks: updating and implementing the PAACC, taking stock of the work done, and sharing information about the activities carried out and the ACC progress in the territory.

6.2 - Expert Group

The Expert Group (formed by three experts in ACC in the territories and three experts in ACC in the economic activities) created by LIFE-CLINOMICS is a powerful tool for the continuity of ACC processes. The possibility of maintaining the continuity of the Expert Group, as collaborators with the observatories or the local ACC network, can be considered to provide specialized and specific knowledge when necessary, but above all to encourage the capabilities generated through CLINOMICS. They would have regular communication activities with the local ACC network, through annual meetings, and through other analysis and orientation activities requested by the observatories or for specific topics of interest to the local ACC network. In addition, the option for advice to be given through experts specialized in a specific subject can be considered.

6.3 - Adaptation indicator system

As a reference, the PAACCs will use the system of indicators developed within the framework of the CLINOMICS project. This system of indicators will be characterized by easily identifiable and measurable items, shared by the various Action Plans, which will enable assessing progress in the territories' adaptation to climate change and the activities entailed in the project. These indicators will be characterized by the ease of their implementation in the operational and functional context of local authorities, which often lack sufficient technical resources. Despite their relevance, indicators with more complex or exhaustive formulations for use in academic and research fields are not being considered by LIFE-CLINOMICS at this time.

The review of this system of indicators shared by MeTACCs and local observatories will be carried out jointly, strengthening and sustaining the current CLINOMICS project's network system. It should be noted that the actions that are developed within the framework of this strategy, and the PAACCs derived therefrom, have a clear intent to transform the territories and the activities that are carried out in them to increase adaptation and to advance towards their transformation in becoming more resilient. These actions also have an important effect on people and, therefore, it will be necessary to assess effects while actions are implemented.

7.- Territorial and sector capacity building

Another strategic axis of the CLINOMICS Strategy must be contributing to the generation and compilation of climate knowledge with data collection on a local scale to widen the base of existing information.

In addition, the strategy must ensure the transfer of knowledge acquired to potential user sectors. In this sense, not only scientific and technical knowledge is necessary, but significant capacity building in labour, economics, and funding areas is also needed.

Capacity building and knowledge transfer will enable us to apply existing knowledge regarding climate change and adaptation measures at the local level and to better understand and assess the expected risks and impacts on the territory, its activities, and the labour market.

The MeTACC is the main governance and institutional tool, but it is also the tool that provides sufficient technical content for its actions to guarantee their effectiveness, both in terms of funding availability and in the identification of the agent or entity that implements the actions. In this manner, proposals that are unlikely to be carried out can be avoided.

In this context, as stated above, MeTACCs must transcend their role as a participatory body and, through their managing entity, must provide sufficient technical content to their actions in order to ensure their success. Thus, MeTACCs and MeSACCs must develop an intense training and capacity-building program for the territorial agents and endow the territory with knowledge on climate adaptation and resilience from national and supranational experts and governmental institutions.

An important transfer tool will be promoting awareness of actual success stories, carefully selected for their demonstrative nature - once again showing the importance of networking.

To achieve this objective, it will be useful to consolidate the Expert Group (point 6.2) created for the LIFE-CLINOMICS project which, among other duties, must regularly assess:

- a) The degree of resilience reached in the territories and in economic activities.
- b) The level of resilience integration in the planning agendas of local authorities, economic entities, and social entities.

8.- Communication and raising awareness

There is sufficient knowledge at present about climate change and the construction of the "vulnerability-impact-adaptive response" triangle, but this knowledge has neither contributed to raised awareness for the population as a whole nor for the main agents thus far.

Therefore, planning and implementing actions and measures aimed at raising awareness about climate change and the need to introduce, in personal behaviours and corporate and/or institutional agendas, adaptive response actions against vulnerability and the risks associated with climate change is of the utmost urgency.

However, such awareness should not only emphasize that climate change poses a risk and a threat to socioeconomic activity. Rather, it is essential to explain that proactively addressing this issue is an opportunity that must be exploited for creating new activities and raising competitiveness.

In this sense, there is no clear and distinct perception that the challenge can become an opportunity for modernizing local economies, improving competitiveness, market positioning for companies, and boosting

quality employment and that it is an opportunity for the renovation, modernization, and environmental transformation of public policy and infrastructure.

The CLINOMICS Strategy must merge this awareness requirements and apply this knowledge to a specific territorial context, with fully defined biophysical and socioeconomic characteristics.

In order for communication and dissemination to be effective, it will be necessary to find the right channels for each audience: farmers, fishermen, forest landowners, tourism businesses, employees in any of these sectors, local authority employees, ACC experts, and permanent and seasonal residents. The use of new technologies, internet (websites, local information portals, etc.) and social networks (Facebook, Twitter, YouTube, etc.) must play a vital role. However, traditional resources such as local media (radio and TV networks, local press, and even multi-sector fairs) cannot be forgotten.

The regular programming of lecture series regarding the climate issue must also form part of the awareness strategy. In addition to presenting contextual information, actual success stories must be highly visible in all communications due to their demonstrative nature.

Moreover, for the population in general, it will be necessary to design communication campaigns focused on the power and the potential impact of responsible consumption in a general manner. Citizens must become informed consumers and labelling must be promoted in which visibility is given to products that are committed to climate and environmental sustainability.

Most awareness campaigns will likely adjust to specific territorial and issue-related contexts. However, networking and collaborative work in general are possible with the continuity of LIFE-CLINOMICS, both for reasons of economic efficiency and for the technical enrichment implied by sharing strategies and results regarding changing and diverse environments and topics.

9.- Administrative and regulatory tools

Local authorities can create administrative and normative tools in the form of municipal ordinances. Tax ordinances - incorporating measurable environmental criteria in taxation - and regulations must reinforce adaptation strategies and place them in a favourable context for their development. The tax classification of activities supporting ACC and the establishment of tax rebates is advisable where possible.

Within this context, municipal tools and competencies in urban regulation and planning, in administrative authorization and intervention of the economic activities, in the incorporation of climate adaptation criteria in works and services projects, or in mobility management will also be useful. Urban planning in general, specific land-use plans, and suitable infrastructure planning must incorporate criteria for adapting to climate change in their environmental assessment reports.

Another tool involves introducing climate criteria into public procurement procedures. In this way, the green purchasing taking into account the carbon footprint of the supplies or the innovative purchase must be present in all contract specifications.

The Catalan Law on climate change and the framework created by the strategies and programs related to climate change promoted by the Government of Catalonia, and the Catalan Office for Climate Change (OCCC) in particular, must be legal tools of reference. In the medium term, this policy and regulatory context should compile, develop, and consolidate the MeTACCs and the MeSACCs and consider them the top tools for the governance of climate adaptation at a local scale.

Moreover, the Strategy and the PAACCs must create synergies with the current regulatory framework, in particular the European framework. Thus, they must integrate and internalize the objectives of the Common Agricultural Policy (CAP) and the EAFRD and Rural Development Program of Catalonia (PDR) funds, fisheries policy and the Spanish Federation of Municipalities and Provinces (FEMP), forestry and the European Fund for Strategic Investments (EFIS), tourism, SME competitiveness, infrastructure policy and the European Regional Development Fund (ERDF), and policy frameworks of an environmental nature.

10.- Public-private cooperation

Facing a world of uncertainty, unpredictability, and reality in the long-term, ACC actions are unlikely to be undertaken as a result of current thinking by political, economic, and social decision-makers. Mitigation strategies and actions already have a place in business and institutional agendas as they often respond to questions of savings and are tied to an economic return of short-term investments. In the case of climate adaptation actions, however, the return is usually long term thus resulting in lower immediate business interest.

The private sector will hardly generate supply for a demand that will take time (years) to occur. The challenge is to overcome the barrier of the perception of uncertain risks faced with the actual costs of ACC measures in an economic framework that tends to underestimate the future.

Therefore, the market itself does not generate necessary adaptation actions. A conscious and proactive thrust by all local actors is necessary, especially by those with investment capacity, namely business and government.

In this context, local authorities can be a driving and steering force, building a framework for action that generates new investments, promotes economic development, and enables an increase in employment jointly with economic and social agents, thus triggering a long-term investment process that ensures economic and social sector resilience.

The MeTACCs and/or the observatories can take on the role of being the driving and steering force by enabling themselves to:

- support investments,
- share information on the investments envisaged by each agent,
- coordinate them whenever possible, and
- arrange them when consortium action is appropriate.

Public authorities must deem the promotion of agreements for developing financial instruments that are expressly aimed at climate adaptation as strategic: from specific lines of insurance for the different economic areas to foresee or reduce the economic impact of risks, to funding methods for private activities aimed at implementing investments and actions to reduce vulnerability.

The CLINOMICS Strategy implementation must include knowledge on how to incorporate the banking and insurance sectors to ensure the development of the plans and the investments and build a climate of confidence between these sectors and the promoters of adaptation actions, be they public or private. In this sense, the principles that inspire Ethical Banking largely coincide with the CLINOMICS approach and, in general, the conceptual framework of adapting to climate change.

The insurance sector has begun to incorporate the climate change factor, but it must be given a more structural approach rather than one dealing focused on the short-term or the risk to be covered. This is absolutely essential in the agricultural sector, in which climate risks, far from being a one-off event, will become the regular course of events where activities take place. Currently, insurers do not have insurance premiums that take into account ACC as such.

In this short-term scenario, the future must be approached and built through new market and company models of economic returns including a detailed cost-benefit, risk-benefit, or similar analysis. Therefore, it is essential to identify the benefits that ACC actions provide — which are currently considered intangible at best—, taking into account aspects such as integrated economies, industrial symbiosis, ecosystem services, biodiversity conservation, or the creation of quality, skilled employment. Awareness must be raised regarding the possibilities and opportunities derived from ACC and a sense of collaboration between all actors must be fostered.

Return on investment calculations by government and business must incorporate the economic concept of externalities, along with resources and tools that contribute to the green economy.

Finally, in this context of public-private collaboration, sustainability and ACC must be firmly incorporated into company strategies and their CSR agendas and, in particular, into community outreach by financial entities. In this regard, establishing a relationship with the Respon.Cat initiative would be valuable.

11.- Financial resources

In order to deploy the Strategy and the implementation of the PAACCs, the availability of human and financial resources enabling the execution of the planned actions must be ensured.

Regarding financial resources, it is important to differentiate those that will be necessary for the maintenance, strictly administrative and structural, of the management and participatory bodies that are established. Moreover, fund raising or facilitating the contribution of financial resources for implementing the actions will be needed.

11.1- Operation of the managing, administration, and governance bodies

Financial resources must be envisaged for helping to maintain the structure of the MeTACC, which will act according to the observatory model, and the "managing office for adapting to climate change". These include the financial needs for MeTACC operations, or, in other words, standard funding for expenses associated with technical office staff, administrative support staff, current expenditure, dissemination, websites, social networks, and so forth. With this budget, the MeTACC's triple role would be ensured: a space for dialogue, a technical management office, and a territorial resilience observatory.

The basic human resources required for maintaining the envisaged structures will be provided by the directly involved territorial authorities, which may create a new unit within their organizational chart or incorporate the adapting to climate change process role into an already existing unit.

The maintenance of a collaborative mechanism between LIFE-CLINOMICS partners for participating in applications for subsidies from European funds has been suggested, which could allow a more ambitious operation of the observatories and other participatory bodies, as well as greater coordination of the agents involved in the investment processes.

11.2- Implementation of the Action Plan for Adapting to Climate Change

Likewise, funding for specific projects and actions from the Plan must be envisaged, for which resorting to *ad hoc* funding will be necessary from relevant authorities and companies regarding anything that could be coordinated and arranged in the MeTACCs and the observatories. Standardized subsidy program funds from various authorities or European funds from the range of funding programs available in the European Union may also be relied upon. In this case, public-private collaboration and private funding will also be relied upon, through agreements and accords with companies in the context of CSR policies and various crowdfunding formulas.

Regardless, the existence of a managing entity that underpins MeTACC continuity must ensure sufficient capacity to generate the technical proposals that will allow access to such funds.

The implementation of the action plan is a central pillar for LIFE-CLINOMICS. To do so, political engagement by all agents, economic willingness by public authorities and private companies, and social determination by all other agents in the territory is necessary. The maintenance and coordination of all these efforts is one of the roles of the ACC observatory and ACC managing entity.

Economic and financial provisions may be territorial or external. In the territorial area, investments made through governmental resources and private companies using their own resources or loans in carrying out actions from the plan are accounted for. Externally, the submission of projects eligible for funding by the

European Union, particularly the regional share of FEDER funds, fundraising campaigns by the Biodiversity Foundation, and other fundraising activities that may be appropriate are also accounted for.

Two conditions must be guaranteed for territorial observatories and/or MeTACC activities: participation by financial entities and insurers, to facilitate access to internal funds, and maintaining collaboration between LIFE-CLINOMICS beneficiaries regarding the submission of projects competing for European funds.

12. Governance of adaptation to climate change

ACC forms part of climate policy, thus requiring its incorporation into future projects for all territorial, social, and economic agents. Its interweaving in the area of economic processes is weaker than in the case of mitigation and this requires for conscious action by public and private investors and the organization of a voluntary action process.

Within the LIFE-CLINOMICS framework, actions by agents will be coordinated through the METACCs and the MESACCs. In addition, it is necessary that these participatory, promotion, and decision-making bodies have a solid existence after LIFE-CLINOMICS, whether with the same name or with an enhanced evolution and conversion into other entities such as ACC observatories. Local authorities will act as guarantors of the continuity of shared decisions and responsibilities for all agents represented through these entities.

Sections 4.2 and 6.1 in this strategy set the criteria for giving functional and organic continuity to MeTACCs and MESACCs.

The extension of ACC processes to other territories is also a LIFE-CLINOMICS goal. Dissemination and replicability actions can accomplish this objective during the project's existence.

LIFE-CLINOMICS will develop a Covenant for adaptation to climate change. By signing this Covenant, representatives from the activity sectors or territories will commit to increasing resilience.

Once the project's administrative course has ended, the creation of an ACC advisory body is suggested, which could be located at the OCCC and have members such as business agents, trade union agents, local authorities, or climate entities from around Catalonia. To that end, and to avoid duplicating efforts and entities, the provisions in the Catalan Climate Change Law (16/2017) on the creation of the Social Panel on Climate must be taken into account, which could accommodate this specific component in responding to the issue.

13.- Strategy indicators

This section takes into account the indicators of the medium and long-term potential of the territories and the economic sectors to adapt to climate change. Reference will be made to monitoring indicators for

strategy and intervention capacity, which will be crafted in accordance with the program, the four strategic areas, and the priority work lines defined in the introduction of this document.

They differ from the system of indicators introduced in section 6.2 of this strategy, for they are aimed at knowledge, information, and sharing results.

The following are understood as references of the continuity potential of the strategy:

- The incorporation of adaptation and resilience planning in authorities' mandates and in the range of good practices by economic and social agents.
- ACC integration into the duties of local authorities and their managing and governance entities.
- The synthetic assessment of impacts on the sectors.

The following are understood as intervention capacity references:

- The capacity-building and training of public and private agents in the territories.
- Maintaining participatory engagement by agents.
- The availability of stable logistic and financial support structures for bringing investments to fruition.

Glossary

ADF - Forest Defence Group.

ADL - Local Development Agent.

CAP - Common Agricultural Policy

CLINOMICS - A LIFE Project entitled "Increasing resilience. Opportunities and challenges of local economies and society in adapting to climate change".

EAFRD - European Agricultural Fund for Rural Development⁹.

ECST - European Charter for Sustainable Tourism - A management tool that helps protected areas continually improve the development of tourism activities, taking into account the needs of the environment, the local population, and local tourism companies.

EFSI - European Fund for Strategic Investments (Juncker Plan).

ERDF - European Regional Development Fund.

ESCACC - Catalan Strategy for Adapting to Climate Change. Horizon 2013-2020¹⁰.

FEMP - Spanish Federation of Municipalities and Provinces.

MeSACC - Sector Platforms for adapting to climate change. MeSACCs are meeting spaces for agents from a participating sector in CLINOMICS, to discuss and propose actions for adapting their sector's activities to the effects of climate change.

MeTACC - Territorial Platform for Adapting to Climate Change. MeTACCs are meeting spaces for sector-based socioeconomic agents participating in CLINOMICS to discuss and propose actions for adapting activities carried out in CLINOMICS territories to the effects of climate change.

OCCC - Catalan Office for Climate Change¹¹.

PAACC - Action Plan for Adapting to Climate Change.

PDR - Rural Development Program of Catalonia for 2014 - 2020, approved by the European Commission on 28 July 2015.¹²

⁹ http://exteriors.gencat.cat/ca/ambits-dactuacio/afers_exteriors/ue/fons_europeus/quins_fons/feader/

¹⁰ Catalan Strategy for Adapting to Climate Change. (ESCACC, Horitzó 2013-2020). November 2012.

<http://canviclimatic.gencat.cat/web/.content/home/actualitat/docs/escacc.pdf>

¹¹ <http://canviclimatic.gencat.cat/ca/>

PEIN - Areas of Natural Interest Plan.

Resilience - the ability of an ecological or social system to absorb alterations and retain their functions and the ability to adapt to stress generated by changes.

RSC - Corporate Social Responsibility.

SEAP - Sustainable Energy Action Plans, and SECAP - Sustainable Energy and Climate Action Plans. SEAPs and SECAPs are documents in which signatories to the Covenant of Mayors define how they intend to achieve the objectives. Mitigation and adaptation actions, a schedule, and the assignment of responsibilities are established.

Vulnerability - In accordance with the Catalan Strategy for Adapting to Climate Change, Horizon 2013-2020 (ESCACC), each sector's vulnerability to a given risk is based upon three variables:

Exposure - the presence of people, means of subsistence, environmental goods and services, infrastructure, and economic, social, or cultural assets in places that could be negatively affected by the impacts of climate change.

Sensitivity - the degree to which a system or sector is affected, whether positively or negatively, due to climate-related stimuli.

Adaptive capacity – the inherent capacity of socioeconomic system or sector to adapt to the impacts of climate change, moderate potential damage, take advantage of opportunities, and face the consequences. The crafting of institutional capacity in effectively responding to climate change.

¹² <http://agricultura.gencat.cat/ca/ambits/desenvolupament-rural/programa-desenvolupament-rural/document-pdr/>

Annex 1

Montseny Biosphere Reserve

Forestry sector

Impact perception table

Impacts	●: negative ●: positive ●/●: ambivalent
●	Low economic profitability from forestry leads to the abandonment of forest management. Recognizing that the value of forestry products and services largely depends on the social context.
●	<p>Changes in temperature and water availability will imply a reduction in the climate suitability for the three most important species in terms of forest use: holm oak, cork oak, and beech. Such changes could lead to lower productivity, growth (as already detected in Montseny beech trees), and regeneration capacity, with a different impact depending on the species and forest structure conditions.</p> <p>Species that could end up having more suitable conditions, such as white pine, seem unlikely to benefit forestry use.</p>
●	The fact that holm oak and cork oak can reach higher altitudes in the mountains (to the same extents as beech trees are moving higher) opens the possibility for these two species to maintain significant coverage despite decreasingly suitable climate conditions.
●	In the past, beech trees were favoured in forestry use, partly at the expense of oak groves. With the regression of the beech trees, oak trees could occupy more space, especially dry oak trees, which are less affected by climate change.
●	The greater recurrence of droughts may negatively affect the regrowth capacity of some species (such as holm oak), as well as the production of other forest products. In spite of this, trees such as holm oak and cork oak are highly adaptive to the Mediterranean climate in their handling of water loss. It will be necessary to see the extent to which they are affected.
●	Forestry management can benefit the resistance of certain species to drought. Thus, large-sized trees are generally more resistant to the effects of drought on growth. Cork oak specimens with thicker bark and larger trunk diameters are more likely to survive and regrow. Clear forests appear to be better able to respond to drought.
●	Forestry managers perceive that, based on how forests are managed, water cycle management and availability can be improved.
●	The LIFE Tritó Montseny project opens up the possibility for improving riparian habitats and managing headwaters, thus influencing water availability.
●	<p>An increase in fire risk is expected which may negatively affect the growth of certain species such as holm oak and cork oak. However, these species do have a high capacity for subsequent regrowth.</p> <p>It should be noted that all municipalities in the MBR-NP, except for one, have an approved firefighting and prevention plan, that certain city councils have approved specific ordinances regarding this risk, and that nearly all municipalities in the MBR-NP have ADF participation. Regarding participants in forestry sector meetings, the work done by authorities and landowners is appreciated, but more work is deemed necessary in facing a clearly-growing risk.</p>

Impacts ●: negative ●: positive ●/●: ambivalent	
●	Certain secondary forest products (such as cork, grazing use, and pine nuts) could continue to have an important contribution to income in a rural world wherever the species remain in spite of climate change. However, non-timber forest products and ecosystem services have not yet translated into significant economic value. In spite of this, it is starting to be perceived by forestry managers that the way to manage the forest must be changed, seeking greater profitability and value from secondary products, and society must also change in considering that services provided by forests need to be compensated.
●	The increase in temperature and the reduction of precipitation aggravate the effect of pests, which leads to greater tree mortality. This phenomenon has already been detected at present. Some of the pests result from species that were not previously found in our latitudes, thus hindering their control and eradication. In spite of this, it is thought by some participants in the sector meetings, that - both forestry administration and forestry managers - have accumulated experience and tools to control and fight against pests, which would facilitate the adoption of measures.
●	A limited perception of the importance of biodiversity for the sector's activity is still detected.
●	The consolidated existence of engagement in associations in the forestry world could favour the adoption of measures for adapting to climate change.

Table of uncertainties

Uncertainties
<ul style="list-style-type: none"> The effects of climate change on biodiversity can lead to changes in the forest ecosystem and produce new balances that cannot be predicted precisely in the case of the Montseny.
<ul style="list-style-type: none"> The fact that the Montseny has a marked altitude gradient, slopes in various directions, and a somewhat abrupt topography offers a variety of climate situations and it is difficult to predict the impacts of the effects of climate change on a micro-scale.

Tourism Sector

Impact perception table

Impacts ●: negative ●: positive ●/●: ambivalent	
●	The reduction of high quality forest areas for visitors (beech, oak, fir, and riverside woods), as well as the loss of colourful changes throughout the year, will have negative effects on the influx of visitors. Similarly, the reduction of varied landscapes, also aesthetically valued, and those giving landscape richness (scrubs, meadows, waterways, etc.) will have similar effects. Forest growth could lead to the disappearance of panoramic views on certain routes.
●/●	Livestock farming activity is essential to maintaining interest in the MBR-NP for tourism since the mountain landscape, as well as many of the products grown or resulting from first transformations that a tourist or visitor may purchase, relies on the preservation of these activities. In this sense, livestock farming activities, which may evolve through consolidation or sticking through a more uncertain future, condition a good deal of tourism's future in the massif.

Impacts ●: negative ●: positive ●/●: ambivalent	
●	The decrease in the quantity and quality of water resources can negatively affect the optimal development of tourism activities. It is clearly important to point out the existence of good practice manuals and that water saving measures are already being applied to facilities in the sector. It remains to be seen whether the adoption of this measures spreads.
●	The LIFE Tritó Montseny project opens up the possibility for improving riparian habitats and managing headwaters, thus influencing water availability.
●	The increased risk of fires can affect natural values and the landscape. Although all municipalities in the MBR-NP, except for one, have an approved firefighting and prevention plan, that certain city councils have approved specific ordinances regarding this risk, and that nearly all municipalities in the MBR-NP have ADF participation, the sector deems it is not prepared to prevent and fight fires.
●	There is a risk of reduced interest in the Montseny for carrying out certain activities, such as mushroom or chestnut gathering. This could be harmful for the sector if no alternatives are found, but it has a positive side because it will reduce the impacts of overuse in the natural environment, especially in the forest. The sector viewed this quite positively at the meetings.
●	The increase in temperature and the reduction of precipitation could lead to a reduction in biodiversity and could lead to the loss of flora and fauna species or habitats of conservation interest, causing lower attraction in the Montseny for visitors and lower interest for scientific tourism.
●	The reduced duration and extent of snow covered areas will reduce the occasional influx of many visitors in the winter. This effect is considered positive for the sector since it is an influx that does not result in economic benefits and creates significant distortions, for example on the roadways.
●	The loss of climate comfort in summer due to rising temperatures in coastal areas may be an opportunity to make the influx of visitors to the Montseny more year-round as it is very concentrated in the spring and fall at present.
●	The European Charter for Sustainable Tourism (ECST) in the Montseny is an ideal framework to promote various actions for adapting to climate change. The sector views it as a great tool.
●	The consolidated existence of engagement in associations in the tourism sector could favour the adoption of measures for adapting to climate change.

Table of uncertainties

Uncertainties
<ul style="list-style-type: none"> The tourism sector is affected by supra-local dynamics, often international in scope, which act in a very short term. They introduce notable unpredictability. The type of tourism and visitors that the Montseny has suffers less from these dynamics than sun and beach tourism, but if the Montseny expands its offer and welcomes some of the activities from this type of tourism, it could become more dependent on these fluctuations than at present.
<ul style="list-style-type: none"> The fact that tourism activity is closely linked to the survival of agricultural activities, considering the uncertainty they face, also leads to questions about how the tourism sector can evolve.

Agricultural Sector

Impact perception table

Impacts ●: negative ●: positive ●/●: ambivalent	
●	There is a risk of increasing water demand for crops to compensate for the increase in evapotranspiration.
●	Water stress can reduce the production of certain species. The change from dry land crops to irrigated crops to maintain production through irrigation does not seem to be a notable risk as the trend is now moving towards crop varieties that are more resistant to water stress. Above all, the 17% of cultivated land for cereals may be affected as greater demand for water due to higher evapotranspiration would come on top of lower water availability (specially in summer).
●	Less snow cover will reduce water availability as runoff from accumulated snowmelt is an important source of crop irrigation.
●	The LIFE Tritó Montseny project opens up the possibility for improving riparian habitats and managing headwaters, thus influencing water availability.
●/●	The expected increase in temperatures could prolong the growth cycles of certain crops and increase yields in some places, though it may be reduced in others. Despite the possibility of increased yields, they may become limited due to the lack of water or nutrient availability.
●	<p>The increase in temperatures in the coldest areas of the Montseny and the reduction of the risk of frost and the number of days with frost could favour crops that are not viable at present. Likewise, a change towards the use of species and varieties that are better adapted to the new conditions may be carried out by the sector.</p> <p>Wine growing, which is now quite small-scale and located on the periphery of the Montseny, could take advantage of better climate conditions which may lead to expansion. The global economic context, which shows a growing interest in wine growing, would help.</p>
●/●	The acceleration of the crop cycle (the earlier beginning of a plant's growth and maintenance period and the reduction of the time needed to complete the life cycle) could have negative consequences on production and grain quality for cereals, especially dry land cereals such as oats, wheat, and barley. In this regard, it is important to note that 88.6% of cultivated land is used for cereals. Nevertheless, crops could be preserved and even extended in dry land areas with more moisture, as it is the case in the Montseny.
●	The abandonment of agricultural and livestock activities, as a consequence of the loss of economic profitability for farms, is a process that has been taking place in recent decades due to socioeconomic reasons found within the sector. The effects of climate change add greater difficulty to this reality. It is envisaged that, progressively, agricultural and livestock land will be replaced by forests as activities are abandoned, as has been the case since the middle of the last century. One resulting consequence is that greater forest area would increase the risk of fire.
●	<p>The increased risk of forest fires that is expected due to the increase in temperature, lower precipitation, and the growth of forested areas would also affect agricultural production.</p> <p>It should be noted that all municipalities in the MBR-NP, except for one, have an approved firefighting and prevention plan, that certain city councils have approved specific ordinances regarding this risk, and that nearly all municipalities in the MBR-NP have ADF participation. Nevertheless, several participants at the meetings held with the economic sectors are aware of the existence of fire prevention and fighting measures, but think they are not developed as required (leading to the result that adaptation capacity is not perceived as sufficient).</p>

Impacts ●: negative ●: positive ●/●: ambivalent	
●	Greater damage may occur due to higher rates of diseases and pests which would affect agricultural production.
●	Agricultural cooperativism, hardly present in the Montseny's past, is perceived as an instrument for promoting certain products (wine, olives, organic farming, etc.), reducing production costs, improving distribution networks, and so forth.
●	Good transportation networks, especially around the entire periphery of the MBR-NP, accessibility to the interior of the Natural Park, and its proximity to important urban areas could facilitate the commercialization of new products.

Table of uncertainties

Uncertainties
<ul style="list-style-type: none"> The difficulty in assessing the behaviour of the various crops in the Montseny leads to uncertainties regarding which crops may have more favourable production and which ones may be harmed. This difficulty is magnified by the variability of the mountain's microclimates, slopes, and altitude.
<ul style="list-style-type: none"> The socioeconomic context of the sector makes it difficult to preserve activities due to a lack of attractiveness and generational renewal, and it is subject to fluctuations in the market and the expected reduction in CAP aid (in the case of cereals and fodder). These are variables that can significantly determine the direction of the changes that eventually end up occurring.

Livestock Sector

Impact perception table

Impacts ●: negative ●: positive ●/●: ambivalent	
●	The risk of a loss in productivity and the quality of livestock-derived products (meat, milk, and eggs, especially) is noted as a consequence of extreme environmental conditions that could affect livestock welfare and productivity. Loss of activity may also affect the risk of an increase in diseases and pests that could affect livestock production. The effect would be different depending on the species.
●	Ruminants (cows, goats, and sheep) have greater tolerance to an increase in temperature than pigs and birds, which may be advantageous in promoting livestock farming based more on the former, which would be more environmentally sustainable. Extensive livestock farming in undergrowth helps in managing fire risk.
●	The increased cost of feeding animals may affect the economic profitability of farming. Likewise, the abandonment of traditional activities along with lower future precipitation may lead to the loss of summer grazing lands for livestock. It should be taken into account that extensive (more resistant) livestock farming, which could form part of the sector's adaptive capacity, will suffer much more from the reduction of meadows and grazing lands.
●	The abandonment of agricultural and livestock activities, as a consequence of the loss of economic profitability for farms, is a process that has been taking place in recent decades due to socioeconomic reasons found within the sector. The effects of climate change add greater difficulty to this reality. It is envisaged that, progressively, agricultural and livestock land will be replaced by forests as activities are abandoned, as has been the case since the middle of the last century.

Impacts ●: negative ●: positive ●/●: ambivalent	
●	Water stress can lead to water availability and quality problems regarding consumption by animals.
●	The LIFE Tritó Montseny project opens up the possibility for improving riparian habitats and managing headwaters, thus influencing water availability.
●	In the Montseny and its surroundings, it could be possible to promote certain livestock practices that may contribute to mitigating the effects of climate change favouring adaptation at the same time. In particular, a more integrated vision of the agricultural-forestry-livestock system and the production-distribution-consumption cycle can be brought forward. In an economic context in which the viability of livestock production depends on external factors such as economic aid, market prices, and so forth, a more integrated approach as indicated would potentially allow less dependence on these factors.
●	In a global economic context, an increasing tendency in the consumption of certain livestock-derived products (organic products, and especially cheeses) has been noted.
●	The MBR-NP can serve as the framework for regulating small-scale activities (initial artisanal transformations, homemade production) to favour its economic viability, and work has already begun in this direction. This can also be encouraged through other tools (legislation, planning, etc.) that proactively regulate such uses and activities.
●	Agricultural cooperativism, hardly present in the Montseny's past, is perceived as an instrument for promoting certain products and initial artisanal transformation processes (cheeses, meat processing, etc.), reducing production costs, improving distribution networks, and so forth.
●	Good transportation networks, especially around the entire periphery of the MBR-NP, accessibility to the interior of the Natural Park, and its proximity to important urban areas could facilitate the commercialization of new products.

Table of uncertainties

Uncertainties
<ul style="list-style-type: none"> The socioeconomic context of the sector makes it difficult to preserve the activity due to a lack of attractiveness and generational renewal, and it is subject to fluctuations in the market and the expected reduction in CAP aid (in the case of fodder). These are variables that can significantly determine the direction of the changes that eventually end up occurring.
<ul style="list-style-type: none"> The profitability of the agricultural-forestry-livestock system is an uncertain variable as the tendency towards reducing the size of grazing areas or greater dryness in such areas can reduce the economic profitability of their use as grazing lands for livestock, thus affecting the entire system.

Alt Penedès

Forestry sector

Impact perception table

Impacts ●: negative ●: positive ●/●: ambivalent	
●/●	<p>Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts).</p> <p>Compared to other counties in Catalonia with forest species that are different from those in the Alt Penedès, this risk is not thought to have a very negative effect due to the lack or low presence of forest species with high or medium sensitivity to drought in the county, which are more affected by the decrease in water availability than species with low sensitivity, such as white pine.</p> <p>However, despite this conclusion, the decrease in water availability negatively affects the growth of tree species most present in the region, such as white pine.</p>
●	<p>Risk of a reduction in the flow of rivers and streams and a longer dry season</p> <p>Reduced precipitation, increased evapotranspiration, and lower infiltration have led to a reduction in the total volume of water passing through the Alt Penedès gauging stations in recent years, with a downward trend.</p> <p>Of all the vulnerability indicators analysed, the indicator associated with this risk is the one that obtained the highest rating, 5.96 on a scale of 0 to 10. This risk is deemed to have negative effects on the sector, especially for riverside woods which, despite having low presence in the county, will have a tendency towards decreasing.</p>
●	<p>Increased fire risks in forest systems</p> <p>The rise in temperature and the longer duration, frequency, and intensity of droughts, as well as the increased topo-climatic suitability of the white pine (a species that accumulates substantial biomass at its base), will lead to an increase in potential fire risk which will have negative effects on the forestry sector.</p> <p>Moreover, even though increased temperatures will lead to an increase in the coverage of Mediterranean forests better adapted to fires (natural regeneration of white pine), with a high capacity for natural regeneration after fires, these species that require less water and are better resistant to heat are less economically valuable at present.</p> <p>However, the need to recover traditional agricultural and forestry practices, the use of extensive livestock, old forestry-livestock practices of clearing undergrowth, and taking advantage of forest biomass combined with vine shoots to obtain energy, has been confirmed, which can be a management tool for avoiding major risks.</p>
●/●	<p>Loss of biodiversity</p> <p>Regarding the loss of biodiversity in the forestry sector, the effects are not deemed to be very negative due to the low variety of forest species in the county, with a large predominance of white pine, holm oak, and shrubland. However, due to increased temperatures and the frequency of drought, the confluence of ecological environments occurring in certain areas could indeed be negatively affected, for example in the Garraf massif, in which areas of wet vegetation of a Central European nature is found alongside the dominant Mediterranean vegetation. There could also be negative effects on wildlife in areas where thermophilic species are found alongside others of a Central European nature.</p>

Table of uncertainties

Uncertainties
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Tourism sector

Impact perception table

Impacts	●: negative ●: positive ●/●: ambivalent
●/●	<p>Loss of landscape quality</p> <p>The reduction in size of habitats that give landscape richness to the Alt Penedès (such as the patchwork of vineyards, forests, and shrubland) due to increased temperatures and the frequency of drought, as well as the loss of environmental and landscape value following a fire, have negative effects on tourism, regarding the influx of visitors for example.</p> <p>Furthermore, the reduction in the flow of waterways and the proliferation of warehouses and facilities associated with agricultural or other activities which are located on rural land can also have a negative visual impact and reduce the county's attractiveness.</p> <p>Moreover, the territory's rolling landscape is an element that gives it continuity and appeal, a constant that will continue being a landscape value in the Alt Penedès. In addition, the value of the agroforestry patchwork as a way to manage forested areas and fires (using crops as natural firebreaks, agricultural-forestry-livestock practices) can also be deemed an opportunity that reduces the negative effects of this risk.</p>
●/●	<p>Variation in tourism demand</p> <p>The reduction of rainfall in summer and the resulting decrease in the quantity and quality of water resources can negatively affect the optimal development of tourism activities. Should wine production diminish considerably, due to the effects of pests for example, this could also indirectly affect the tourism sector which is specialized in wine-growing activities (wine tourism), for example in the reduction of wine tourism staff, the reduction of visiting hours, or the reduction of visitors, resulting in a negative effect on earnings for the sector.</p> <p>Nevertheless, changes in tourism demand could be a source of potential for the county, such as year-round visits would be. The tourism sector is promoting sustainability projects in the territory with tourism products such as the Penedès 360 (three circular routes for walking, slow cycling, and mountain biking), as well as the launching of Enoturisme Penedès, companies with the BIOSPHERE label. This tourism certification, "Biosphere Destination", which can be acquired by wine tourism companies, will bring new tourism and production and consumption models to the county that promote the respectful use of heritage and sustainable development.</p> <p>Furthermore, the proximity of the Alt Penedès to Barcelona and Tarragona, as well as the social appreciation of wine tourism and sustainable tourism, can become opportunities that increase the annual number of visits to Enoturisme Penedès wineries and museums.</p>

Table of uncertainties

Uncertainties
<ul style="list-style-type: none"> The possible loss of climate comfort or extreme overcrowding in Catalan coastal areas could lead to a diversification of tourist destinations, especially in summer. This could lead to a seasonal change in the influx of visitors to the county, concentrated in the spring and fall at present.
<ul style="list-style-type: none"> It is currently one of the counties in the province of Barcelona with the lowest level of overnight stays. Overnight stays could increase with attractive deals, for example, the promotion of diverse tourist packages with stays of one or more nights, including additional activities such as visits to wineries, museums, or trips around the county. However, the proximity to Barcelona and Tarragona will continue in contributing to stays of only one day without overnight stays.

Agricultural sector

Impact perception table

Impacts	●: negative ●: positive ●/●: ambivalent
●	<p>Changes in crop types</p> <p>Although occasional water inputs are made in vineyards due to increased temperatures and to compensate for heat waves, and it is expected that this will continue to rise, the fact that most crops in the region are dry crops (99%) makes the risk of changing crop types (from dry to irrigated land) not have much of a negative effect on the Alt Penedès due to greater water demand for crops, as may be the case in other areas of Catalonia.</p>
●/●	<p>Changes in vine productivity</p> <p>The risk of decreased vine productivity due to increased temperatures and periods of drought is not deemed to have much of a negative effect on the county. This is due to the strong presence of varieties that are better adapted to drought (Xarel·lo and Macabeu) and to the existence of climate change adaptation initiatives for wine (the recovery of adapted local varieties not depending on foreign varieties of vines, among others)¹³.</p> <p>Adaptive capacity is considered quite good since agronomic and oenological solutions are available for reducing impacts to grapes wherever they may occur, thus helping to reduce impacts to wine production and quality.¹⁴</p>
●	<p>Changes in the distribution of arable areas</p> <p>The abandonment of vineyards in the event of decreased production, or due to the frequency of extreme drought periods, and the resulting increase in shrubland could lead to negative impacts related to more fires as the vineyard firebreak effect would be lost.</p> <p>The replacement of vineyards with shrubland would lead to a reduction in economic returns from</p>

¹³ See Cenit-DEMETER Project.

¹⁴ See article *La vinya, clau en la fixació del carboni i la regulació del cicle de l'aigua (The vineyard, key for carbon fixing and water cycle regulation)*. Source: http://medacc-LIFE.eu/sites/medacc-LIFE.eu/files/documents/vinya_save.pdf

Impacts	
	<p>●: negative ●: positive ●/●: ambivalent</p> <p>rainwater, as such land use is not profitable.</p>
●/●	<p>Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts)</p> <p>The increase in irrigation needs for crops due to an increase in evapotranspiration and a greater frequency of drought is deemed to have a negative effect on the agricultural sector. At present, water inputs are needed for vineyards in the event of drought periods and this is expected to increase in the future.</p> <p>Nevertheless, precision farming practices, rainwater collection systems (such as the 25,000m³ Bodegues Torres water irrigation pond¹⁵), crop rotation, groundwater conservation strategies, and other projects underway for encouraging water efficiency actions in the agricultural sector are improving this sector's adaptive capacity.</p>
●	<p>Decrease in water quality</p> <p>The decrease in water quality, due to the acceleration of salt dissolution as a result of increased water temperatures and a lower dilution flow, is deemed to have negative effects on the agricultural sector in the county.</p> <p>The <i>Environmental Diagnosis of river basins in the province of Barcelona</i> (2012) observed that the biological quality of the water at the bottom of the Foix river was "terrible" and that it had very high rates of chemical pollution.</p>
●	<p>Increase in fire risk</p> <p>In assessing the increase of fire risk in terms of the impact it may have on crops, it is deemed that it will not have considerably negative effects on the agricultural sector since, on one hand, the basic forest fire hazard map indicates that this risk is low in the county's flat areas, which are mainly covered by vineyards and, on the other hand, because vineyards act as firebreaks in the event of fires in forest areas.</p>
●/●	<p>Loss of biodiversity</p> <p>Regarding the loss of biodiversity, due to wine-growing specialization in the county, the agricultural sector may become affected by the loss of grape varieties, especially those most sensitive to drought.</p> <p>The effect of this risk is not deemed negative if the reintroduction of old varieties and the promotion of new varieties that are better adapted to warm climates continues to be promoted.</p>

Table of uncertainties

Uncertainties
<ul style="list-style-type: none"> The study of the relationship between increased temperatures, the advance of the grape harvest, and the resulting effects on wine quality due to a faster ripening of the grapes should be deepened¹⁶. Faster ripening results in the production of wines that are more acidic, have a higher alcohol content, and age more quickly. It will be necessary to adapt oenological practices to the possible new grape characteristics and to tendencies in consumption, or to influence this consumption to adapt it to the new grape characteristics and, therefore, to the wine that may be produced.

¹⁵ See <http://www.torreearth.com>

¹⁶ See the Report number 4, December 2016 by the Vineyard, wine and cava Observatory, http://agricultura.gencat.cat/web/.content/de_departament/de02_estadistiques_observatoris/08_observatoris_sector_ials/02_observatori_vinya_vi_cava/fixers_estatics/informes/Informe-4_2016_V4_final.pdf

Livestock Sector

Impact perception table

Impacts ●: negative ●: positive ●/●: ambivalent	
●	<p>Reduction of grazing areas</p> <p>The risk of reduced grazing areas is not deemed to have negative effects for the sector, on one hand, because the livestock sector, compared to the agricultural sector, has a considerably reduced presence in the region (95% of the Utilized Agricultural Area (UAA) is occupied by cultivated land and 5% by grazing land), and on the other hand, none of the participants deemed this risk to be relevant. A different question is whether an increase in current land area used for grazing is desirable as a measure to raise livestock farming profitability.</p>

Table of uncertainties

Uncertainties
<ul style="list-style-type: none"> A significant number of the 232 livestock farms in the region form part of the poultry sector. Birds may become more affected by climate change than ruminants as they have greater intolerance to increased temperatures. This is why possible changes in the type of livestock farming is deemed uncertain.

Terres de l'Ebre Biosphere Reserve

Forestry sector

Impact perception table

Impacts ●: negative ●: positive ●/●: ambivalent	
●	<p>Changes in the distribution of forest species</p> <p>The decrease in rainfall and, above all, the increase in temperatures could change the coverage of plant species, increase the coverage of white pine, which will replace, and therefore imply a decrease in, other tree species located in higher altitudes, such as black pine, red pine, or beech. Holm oak will also undergo changes in altitude.</p> <p>As the forestry sector has little importance in the Terres de l'Ebre, the impacts of climate change on this sector will be relative. However, the most exploited forest species is black pine, which is one of the forest species most affected by climate change. Nevertheless, using energy resources such as biomass can contribute to better management of forested areas.</p>
●	<p>Increase in forest fire risk</p> <p>The increase in the risk of fire in forested areas is one of the most significant effects regarding the impacts of climate change on the Terres de l'Ebre forests, which is only mitigated by the fact that farmland is still significant in this area.</p> <p>A greater frequency of forest fires may negatively affect the normal growth of various plant species and communities.</p> <p>The abandonment of crops as well as a tendency towards reducing forest management and exploitation further increases vulnerability to forest fires.</p> <p>An increase in forestry management, not only from the point of view of fire prevention, or the intensification of studies on the risk of fires, could contribute to reducing vulnerability.</p>

	The fact that the forestry sector has little importance in the Terres de l'Ebre mitigates the impacts on this sector.
●/●	Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts) Although drought and increased temperatures will have a negative impact on forest species and communities, increasing water stress and the risk of forest fires, the vulnerability of the forestry sector is low as there is very little such activity in the Terres de l'Ebre.
●	Loss of biodiversity The risk of biodiversity loss due to increased temperatures and reduced and irregular precipitation patterns has a high impact on forest systems and will imply a reduction in the coverage of the most sensitive communities and plant species, such as black and red pine, holm oaks, beech, or riverside woods. Thus, flora species of interest for conservation will be affected by this situation. Acting to improve habitats with sensitive species or increasing the number of areas with a technical forest management or improvement plan could contribute to reducing the sector's vulnerability. Continuity in treatments or the cultivation of less sensitive varieties could help reduce the sector's vulnerability.

Table of uncertainties

Uncertainties	
●	The main uncertainty for the forestry sector is determined by aspects not directly related to climate change, but by intrinsic factors in the sector that are closely related to economic viability matters related to forestry operations. It may turn out that climate change ends up promoting forestry management to obtain biomass as an energy resource that, even if modest on a global scale, could help reduce the use of fossil fuels and, consequently, negative impacts on climate.

Tourism sector

Impact perception table

Impacts ●: negative ●: positive ●/●: ambivalent	
●	Morphological changes on the coast (especially at the Ebre Delta) Rising sea level due to climate change has already been observed in the Terres de l'Ebre, especially in the Ebre Delta. The effects on the rest of the Terres de l'Ebre coastline are noticeable mainly when sea storms occur, which are increasing in frequency and impacts. The main effects are the retreat of the Ebre Delta due to the 1-3 mm/year rise in sea level and a subsidence of 1-5 mm/year, the alteration and reduction of the width of the beaches, and the effect of infrastructure, such as ports and seafront promenades. From a tourism point of view, vulnerability is mainly due to the loss of tourist appeal on the coast, especially the loss of top tourism draws such as the beaches. Also, the loss of biodiversity in the Delta associated with the morphological changes to the coastline increases the tourism sector's vulnerability against this risk. The measures undertaken to date are palliative in nature for the impacts and do not reduce the sector's vulnerability.
●/●	Loss of landscape quality This risk is related to the reduction of high-quality forested landscape areas that could be disturbed by the effects of climate change (increased temperatures and changes in precipitation) and forest fires. It is also related to changes in the distribution and structure of cultivated areas and the decrease in the attractiveness of rivers due to lower water flow. Changes that climate change could lead to the coast also pose a risk in terms of losing landscape quality.

	However, the vulnerability indicators for this risk to the tourism sector are medium as the sector can adapt by redefining tourism products.
●/●	Changes in the patterns of tourism demand
	The greater frequency of heat waves and the loss of climate comfort due to excess heat at the height of summer, or the decline and degradation of beaches due to rising sea levels and the greater frequency and intensity of storms, along with the risks of water restrictions for drinking and/or recreational uses, do not currently represent a high vulnerability for the sector if palliative measures for restoring tourist resources (beaches) or proper water use, among others, are maintained. The high adaptability of the tourism sector in redefining tourism products or adapting the promotion strategy and target audiences makes the impact of climate change moderate for the sector.
●	Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts)
	The decrease in the quantity and quality of water resources can negatively affect the optimum development of tourism activities, with losses in the quality of services offered due to water restrictions or the loss of tourist appeal for certain resources. In spite of everything, the sector's adaptability through the promotion of environmental certifications for tourist companies and territories (CETS, EMAS, ISO 14001, etc.), or the redefinition of tourism products and changes in promotion strategies and target audiences, means the sector has medium vulnerability.
●	Loss of biodiversity
	This risk could lead to a negative effect for tourism, especially for tourism associated with rural and/or nature tourism. This risk could affect landscapes that are tourist resources, such as the Ebre Delta, and, indirectly, could affect local cuisine. The tourism sector's involvement in the conservation and management of habitats and landscapes could contribute to reducing the sector's vulnerability.
●	Risk of more invasive and/or disruptive species
	This risk could result in greater tourist discomfort during their tourism experience, especially regarding mosquitoes and the black flies, causing a loss in the destination's attractiveness for tourists. Indirectly, it could also affect culinary offerings due to changes in local products. Continued treatments against black flies or mosquitoes could help reduce the sector's vulnerability.
●	Impacts on people's health
	Increasing temperatures, hot nights, and heat waves have impacts on people's health, especially the most vulnerable populations, which could lead to heat stroke, dehydration, low blood pressure, and insomnia. All of the foregoing has a high impact on the tourism sector, which must deal with limits to outdoor activities and invest in insulation and cooling for tourist establishments.

Table of uncertainties

Uncertainties
<ul style="list-style-type: none"> Increases in heat waves, hot nights, or disturbances by nuisance species such as black flies or mosquitoes could lead to changes in seasonal tourism, to the detriment of coastal areas and the benefit of inland areas. The main uncertainty is the evolution of the Ebre Delta as the combination of the impacts provoked by climate change (rising sea level) along with the absence of sediments that accelerate subsidence may affect a large area of the Delta in just a few years' time. Solutions for mitigating the vulnerability of these impacts on this tourist destination have not yet been determined.

Livestock farming sector

Impact perception table

Impacts ●: negative ●: positive ●/●: ambivalent	
●/●	<p>Changes in crop types</p> <p>The diversity of existing crops in the Terres de l'Ebre makes it difficult to establish a single effect from changes in crop types as each crop could be affected in various ways. Dry land crops present a greater risk of changes than irrigated crops, since they are more exposed to the impacts of climate change, especially the reduction and irregularity of precipitation.</p> <p>Presently, the main adaptation actions are related to the implementation of new irrigation systems, the majority of which are auxiliary.</p> <p>Despite these measures, irrigated crops are not exempt from suffering the effects of climate change due to decreased water availability, both surface water and groundwater, due to decreased precipitation and increased evapotranspiration.</p>
●	<p>Changes in plant productivity</p> <p>This is a risk that affects all crops in general due to the impact of climate change on the acceleration of the crop cycle, which could result in negative consequences to the production and quality of agricultural products. Above all, it affects the range of dry land fruit-bearing crops (primarily olive trees, grapevines, and almond trees) due the tendency towards reduced and irregular precipitation. Dry land crops located in the Terra Alta (grapevines and almonds) are crops which may be most negatively affected by climate change.</p> <p>The introduction of new varieties and/or species that are more suitable for the new climate situation could reduce the sector's vulnerability.</p>
●	<p>Increase in irrigation needs</p> <p>The increase in irrigation needs for crops due to an increase in evapotranspiration and a greater frequency of drought is deemed to have a negative effect on the entire agricultural sector. Irrigated crops require more water to maintain production. Likewise, dry land crops tend to implement water input through auxiliary irrigation to ensure production. These two tendencies lead to an increase in water demand for irrigation that will not always be available due to decreased groundwater and surface water availability.</p> <p>Improvements to irrigation efficiency, education in the use of irrigation, and new growing techniques, such as dry direct-seed rice, could reduce the sector's vulnerability.</p>
●/●	<p>Changes in the distribution of crop areas</p> <p>This risk may result in the altitudinal displacement of some dry land crops such as grapevines or olive trees, though this does not constitute significant changes at present. Nevertheless, the continued abandonment of dry land crops located in fringe areas has been observed, due to increased water needs and a lack of auxiliary irrigation. This implies a transformation towards forest covers.</p> <p>In the case of the Ebre Delta, an abandonment of crops located on the seafront has been observed due to the increase in salinity resulting from the subsidence of the Delta and rising sea level.</p>
●	<p>Changes in livestock farming</p> <p>It is thought that there will be an impact on extensive livestock farming associated with the availability of grazing lands, which are very sensitive to water regime. An increase in mortality, miscarriages, and stress due to increased temperatures has been observed in extensive livestock farms, which implies increased investments and expenditure for cooling systems and water needs.</p> <p>The construction or adaptation of farms towards more efficient energy and water use could contribute towards reducing vulnerability.</p>
●	<p>Decrease in water availability (due to an increase in evapotranspiration and greater frequency of droughts)</p> <p>An increase in irrigation needs for irrigated crops has been observed in addition to new demands for auxiliary irrigation for dry land crops due to an increase in evapotranspiration and the greater frequency of droughts. Failure to adapt may lead to a loss of competitiveness compared to other areas.</p> <p>The vulnerability of the livestock farming sector could increase as a result of the reduced availability of</p>

	surface water and groundwater and the low means for investing in new irrigation and technology due to the sector's ageing.
●	<p>Morphological changes on the coast (especially at the Ebre Delta)</p> <p>The disappearance of rice crops on the seafront indicates the impact of rising sea levels and the subsidence of the Ebre Delta. This is largely due to a lack of water and sediments input from the river which historically contributed to maintaining a water level at the Delta that was suitable for agricultural activities and the stability thereof. This situation also has an effect on irrigation and drainage infrastructure and facilities. There is, therefore, a serious effect to the physical integrity of the Delta that calls for immediate measures, especially related to the mobilization of sediments retained in the basins. Despite the existence of numerous studies, there is no defined action plan at present, but a series of specific actions for counteracting the short-term impacts of storms and rising sea levels.</p>
●	<p>Increase in invasive and/or disruptive species</p> <p>Crops and the production and quality of agricultural products are affected by various species. Most of these species already existed in the territory and others have been introduced by humans. Increased temperatures could lead to more intense and more frequent impacts. The possible arrival of new species in the area, the presence of which is directly related to climate change, must also be taken into account.</p>

Table of uncertainties

Uncertainties	
●	<p>The main uncertainty of the livestock farming sector is directly related to whether it will be possible to face the serious risks of the physical disappearance of the Delta in social terms, if urgent measures are not quickly implemented towards the contribution of sediments that reduce its subsidence.</p> <p>The evolution of the ever-changing agricultural market introduces elements of great uncertainty when implementing measures to improve the sector's adaptive capacity.</p>

Fishing sector

Impact perception table

Impacts ●: negative ●: positive ●/●: ambivalent	
●	<p>Disruptions to fishing and aquaculture</p> <p>The aquaculture sector is directly impacted by climate change, especially by warming waters in the Fangar Bay and the Alfacs Bay. This warming causes a reduction in production and a decrease in marketable sizes. It also causes an increase in water eutrophication which aggravates the problem. The lower input of freshwater and nutrients from the Ebre river also increase this sector's vulnerability.</p> <p>Aquaculture activity is also affected by the proliferation of species that affect production and by the closure of the bays, especially the Fangar Bay.</p> <p>Improving the management of green filters for water input to the bays, installing solar pumps to transfer water from drains to lagoons and bays, incorporating more resistant varieties into the new situation, or offshore aquaculture facilities could help reduce the sector's vulnerability.</p>

Table of uncertainties

Uncertainties	
●	<p>Climate change impacts on fishing are most clear in the increased sea water temperatures which can alter catches in terms of quantity and quality, though it is difficult to predict which changes are directly related to climate change and which ones are related to other factors such as pollution or overfishing, among others.</p>