



Pyrenean Climate Change Strategy:

A climate action cooperation strategy

European Regional Development Fund (ERDF)



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SUMMARY

The Pyrenees is a mountain bioregion that is particularly vulnerable to the effects of climate change. In general, mountainous regions are places with great ecosystem diversity in which, sadly, the average annual temperature is increasing faster than the global average. Climate change has a tremendous impact on biophysical and socio-economic systems like flora, fauna, water resources, energy, and tourism, as well as farming and grazing.

They urgently need climate policies for this reason, and the seven Pyrenean territories of France, Spain, and Andorra have specific directives to this end. However, the majority do not take into account two differentiating factors: a cross-border focus, and the specific nature of the mountains. The Pyrenean Climate Change Strategy (PCCS) provides a framework that complements existing strategies that take into account these two specific elements.

The PCCS has been built and developed with the collaboration and contribution of hundreds of individuals from the scientific, political, and socio-economic spheres. The strategy aims to take all relevant contributions from the seven border territories into account. This document was produced between June 2020 and September 2021 thanks to an inclusive and participatory process that has enriched the PCCS with suggestions and opinions that represent most Pyrenean players.

The following provides a summary of the baselines of this new cross-border climate change strategy for the Pyrenees region.

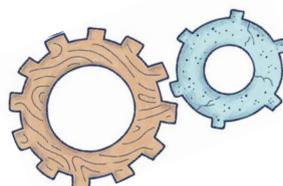
ONE VISION for 2050:

In 2050, the Pyrenees region will be resistant to the effects of climate change.



5 FUNDAMENTAL PRINCIPLES referring to cross-border cooperation; knowledge creation and transfer, innovative actions, actions in synergy with other strategies, and Pyrenees region visibility in Europe and around the world.

5 STRATEGIC GOALS relating to knowledge development, sustainable natural resource and biodiversity management, fair and ecological transition contributions, coherent territorial management to face climate change related risks, and contributions to governance that favour knowledge exchange, cooperation, and coordination.



The strategy is organised around **5 SYSTEMS and 15 CHALLENGES**, and will be implemented through action plans for two periods, 2030 and 2050.

The PCCS is based on a new system of governance, that is particularly important for achieving the proposed advances and goals, with a dynamic system capable of promoting horizontal coordination with other sectoral policies (related to climate change), vertical coordination (with strategies and policies defined on a State and European level, and with international agreements) and territorial (with local and regional strategies). At the same time, the PCCS's governance must integrate the great diversity of the Pyrenees region's policies and social, economic, and scientific entities and players, allowing for the creation of relationships that constantly adapt to the needs and changes that an uncertain future demands.

INTRODUCTION

The Pyrenean Climate Change Strategy falls within a global climate action framework, supported by multiple initiatives and actions on an international, national, regional, and local level.

In fact, climate change is a global phenomenon that affects all regions of the world, with many consequences beyond just the environment. Among them, the climate system's warming is causing an increase in extreme weather events, reduced ice and snow cover, and rising sea levels, threatening the territorial integrity of many States, as well as the human rights of our most vulnerable populations. International cooperation is necessary for efficient action, including the participation of all States according to their ability to do so. This is the aim of the Paris Agreement, the first binding and universally-adopted climate change agreement.

The Pyrenees is a mountainous bioregion that is particularly vulnerable to the effects of climate change. Seven climate change policies in three countries converge in this territory: two EU member States, France [Aquitaine and Occitanie], and Spain [Aragon, Catalonia, the Basque Country, and Navarre], and a third country, Andorra. Most of these policies do not sufficiently take into account two different facts: the mountainous nature of the territory, and the cross-border focus. This was the motivation to define a cross-border strategy on climate change for the entire Pyrenees mountain region.

In 2010, the Working Community of the Pyrenees [CTP] Consortium launched the Pyrenean Climate Change Observatory [OPCC] to study climate evolution and the impacts of climate change in the Pyrenees region. This CTP work unit has been active for a decade, and its work and publications have had a major impact on the territory. In order to provide some examples of this work, the OPCC manages an updated information portal and geoportal that can be accessed through the OPCC's website: www.opcc-ctp.org. In 2018, the OPCC also coordinated the publication "Climate change in the Pyrenees: impacts, vulnerability, and adaptation", which constitutes the most recent and complete knowledge base on climate change in the Pyrenees region, involving the contributions of more than 80 individuals from the scientific community and Pyrenees territory.

On the other hand, in late 2019, the CTP's Pyrenean strategy was approved as the result of more than two years of reflection and consultation. This strategy clearly includes climate change as one of the leading threats affecting all Pyrenean territories.

The process of producing this document was organised into two phases. Phase I was developed between October 2020 and March 2021 with five virtual working meetings open to technical, scientific, and social entities from the Pyrenean massif specialised in climate

change that are part of the POCTEFA OPCC ADAPYR project; the OPCC's advisory committee; the climate change referents from the CTP territory that make up the OPCC's technical committee, as well as all the other referents who typically collaborate with the CTP on topics that may be related to climate change (health, youth, circular economy, heritage, etc.). Following these five working meetings, a first draft of the document was produced.

During the first quarter of 2021, a system of consultation with the technical committee of the OPCC referents allowed for a first version of the strategy to be written.

Phase II of the strategy's development was based on implementing a participation and consultation plan with different players from the Pyrenean territory. These players from the public and private sector came from associations, local authorities, private players, municipal networks, universities, and research centres. Five thematic workshops and seven territorial workshops were held that, in addition to consolidating the new strategy, helped propose actions that fostered the development of the PCCS's 2030 Operational Plan. Online consultation was opened up in parallel with this process to collect proposals, thereby complementing the work being carried out in the various workshops.

Between 1 and 3 October 2021, the Trans-Pyrenean Youth Forum was held in El Pueyo de Jaca [Huesca, Aragon] within the framework of the Pyrenean Youth project, with co-funding from the Erasmus+ programme. This event was attended by 60 young people from the seven territories of the Pyrenees region. During the forum, the concern of Pyrenean youth in terms of climate change was centre stage. As a supplement to this document, suggested ideas from the participatory workshop carried out during this forum were collected.

The process concluded with one last feedback workshop on 6 October 2021. With the contributions received during the 12 participatory workshops, and following approval from the technical committee of OPCC referents, the final version of the document was submitted for public consultation from 21 October to 5 November 2021.

A meeting was held with the Directorates General for the Environment and Climate Change from Aragon, Catalonia, Navarre, the Basque Country, Nouvelle-Aquitaine, Occitanie, and Andorra to secure commitment from the seven Pyrenean territories. During the meeting, the consolidated and definitive version of the PCCS was presented.

This strategy was approved by the CTP's Executive Committee in November 2021 following its technical validation by the Technical Committee of referents of the OPCC, and ratified by the seven CTP territory presidencies in December 2021, with its presentation at the annual Plenary Council of the CTP's Presidencies.

CLIMATE CHANGE CONTEXT

International Context

On an international level, [the Agenda 2030 for Sustainable Development](#) was adopted during the General Assembly Summit of the United Nations in New York on 26, 27, and 28 September 2015. It is the action plan to eradicate poverty, protect the planet, and ensure prosperity.

It establishes 17 Sustainable Development Goals (SDGs), with targets for each goal that must be met by 2030. Some of these goals are directly related to climate change, such as SDG 13, which aims to "Take urgent action to combat climate change and its impacts". The aim is to strengthen the resistance of countries and their ability to adapt to climate disasters and hazards, focusing on fostering the abilities of the least developed countries and small island developing states. This ambition is reflected at all levels: through the strengthening of international cooperation, in particular through the implementation of the Green Fund; in the development of national planning and policies, through public awareness-raising, and the creation of early warning systems¹. In addition, there are other SDGs relating to the impacts of climate change, such as SDG 14 to "conserve and sustainably use the oceans, seas, and marine resources for sustainable development", SDG 15 to "protect terrestrial ecosystems", and SDG 6 to "ensure availability and sustainable management of water and sanitation for all".

Climate change has also been the subject of an international agreement, the [Paris Agreement](#), which was adopted on 12 December 2015 during COP21. This is the first binding and universally-adopted climate change agreement. Article 2 of the agreement establishes specific targets: limiting global temperature increase to 1.5 °C above pre-industrial levels, strengthening the ability to adapt to the adverse effects of climate change, promoting climate change resilience and encouraging development with low greenhouse gas emissions.

Lastly, it is important to remember that the evolution of climate change is supervised on a global level by the IPCC (Intergovernmental Panel on Climate Change), an organisation created in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP). The IPCC's main task is to evaluate the state of knowledge on climate change, its causes, and its effects. The IPCC publishes periodic reports, the last of which is "Climate Change 2021: The Science Basis", published on 9 August 2021 as the first of three parts that make up the IPCC's sixth assessment report, whose other two parts on impacts and solutions will be completed in 2022.

These international commitments are reflected in the application of policies on a regional and national level.

European Context

This is the case on a European Union level with the [European Green Deal](#) presented by the European Commission on 11 December 2019. The European Green Deal consists of a collection of policy initiatives mainly aimed at achieving carbon neutrality by 2050. To do this, the European Green Deal must mobilise all sectors of the economy (energy, industry, buildings, etc.), with financing of up to 1 billion Euros over 10 years. In this sense, the European Commission also presented the European Climate Pact on 9 December 2020, which is meant to involve citizens and society at large in climate action. Likewise, the EU's 2050 climate neutrality target has been binding for all member states since 9 July 2021.

The European Commission has taken the lead in this area with the publication of the ["European Climate Law"](#) (EU Regulation 2021/1119). This regulation² requires net emissions to be reduced by at least 55% by 2030 when compared with 1990 levels, as detailed in the ["Climate Target Plan"](#) of September 2020. In order to achieve this target, the European Commission presented its ["climate package"](#) ("Fit for 55") on 14 July 2021. Among the unprecedented measures proposed by the EU's executive arm are the introduction of a carbon tax at the European Union's borders, the expansion and strengthening of the European carbon market, and putting an end to the sale of internal combustion vehicles by 2035².

1. www.agenda-2030.fr/17-objectifs-de-developpement-durable/article/odd13-prendre-d-urgence-des-mesures-pour-lutter-contre-les-changements
2. <https://www.touteurope.eu/environnement/urgence-climatique-l-essentiel-sur-l-action-internationale-et-europeenne/>
3. https://ec.europa.eu/clima/policies/adaptation/what_en#tab-0-1

Lastly, in order to put into practice the Green Deal's ambition to improve the European territory's resilience against the effects of climate change, the European Commission adopted its new [European climate change adaptation strategy](#)³, on 24 February 2021. In order to prepare itself for the inevitable consequences of climate change, four key goals can be highlighted: making adaptation smarter, faster, and more systematic, and intensifying international action on climate change adaptation.

It is also important to note that **here are already cross-border and transnational climate change strategies in Europe**, such as the ones covering the Danube River and Baltic Sea, as well as mountain areas such as the Alps and the Carpathian mountains.

These strategies are initiatives that have inspired the development of the Pyrenean Climate Change Strategy.

	ALPS	CARPATHIAN MOUNTAINS	BALTIC SEA	DANUBE RIVER
Level	Alpine Convention EUSALP macro-region	Carpathian Convention	Council of the Baltic Sea States EUSBR macro-region	Danube River Protection Convention EUSDR macro-region
Timescale	Alpine climate target system 2050	Long-term vision 2030 for the fight against CC + Action Plan 2023	Baltic 2030 Action Plan (CBSS) EU Strategy for the Baltic Sea Region 2019-2024	Climate Change Adaptation Strategy 2020 - 2027
Contents	Mitigation - Adaptation by sectors	Mitigation - Adaptation for sectors of the Convention	Mitigation - Adaptation by thematic areas of the EUSBR	Adaptation to water issues
Governance	Alpine Conference CC Regions and States and Local Alpine City Player Thematic Group	COP - CC Group States Thematic groups of the Convention	States and regions Thematic groups of the Convention EUSBSR stakeholders	States of the Danube EUSDR stakeholders

Figure 1: Table summarising the characteristic features of other European climate change strategies. Source: the author.

National Contexts

IN FRANCE

On a national level, France adopted its first [National Climate Change Adaptation Plan \(PNACC\)](#) in 2011, followed by a second for the 2018-2022 period. The overall goal is to implement actions necessary to adapt France's metropolitan and overseas territories to the regional climate change forecast for 2050, in line with the targets of the previously described international conventions. This national adaptation policy is an essential complement to the climate change mitigation policy, whose aim is to achieve carbon neutrality. It also intends to avoid contradictions between the different adaptation actions and the environmental protection actions. In addition, it recognises the value of biodiversity and the services ecosystems provide in adaptation, seeking out synergies wherever possible and focusing on nature-based solutions.

This PNACC is comprised of 6 "areas of action".

At first, the "governance" area of action intends to strengthen the adaptation process's strategic management in a co-construction logic with different territorial levels of governance, including local players and civil society. The "prevention and resilience" policy is based on preventing climate-related catastrophic risks. The goal is to reduce the impact of natural catastrophes on health and safety, and the environmental, cultural, social, physical, and economic assets of individuals, companies, and communities in the climate change context. This includes the transition to robust forest management that can reduce the risk of forest fires.

The "Nature and environment" area of action has the aim of strengthening ecosystem resilience so that they can adapt to climate change and take advantage of ecosystems' abilities to help our society adapt to climate change, anticipating future transformation. The measures that must be applied refer to diverse resources and environments, such as aquatic ecosystems and water, soils, seas and coastlines, forests, and biodiversity.

The fourth area of action, "Economic sectors", refers to strengthening economic activity's resilience to climate change. It affects tourism, fishing, agriculture, agri-foods, forestry, and the financial sector.

The fifth area, "Knowledge and information", has the aim of developing knowledge on climate change, while spreading and providing access to information. This target is achieved through research, education, training, and awareness-raising.

Finally, the last area refers to strengthening international climate change adaptation action by France, meaning its role as a leader in international, EU, and regional cooperation organisations. In particular, this involves strengthening cross-border observation and leveraging mechanisms to identify common vulnerabilities and possible vulnerability transfers, as well as strengthening the adaptation abilities of cross-border players and territories.

This is the PCCS's ambition, which helps strengthen collaboration and joint action between France, Spain, and Andorra in a region that is particularly vulnerable to the effects of climate change: the Pyrenees.

IN SPAIN

The second [Spanish National Climate Change Adaptation Plan \(PNACC\)](#), covers the 2021-2030 period, and was adopted by the Council of Ministers on 21 January 2020. This PNACC is meant to respond to the growing need for climate change adaptation in Spain, as well as its international commitments in this area. It lays out the basis for promoting more climate-resilient development over the next decade, as well as coordinated and coherent action to avoid and reduce current and future damage derived from climate change, and build a more robust economy and society.

The PNACC 2021-2030 expands upon the themes addressed, players involved, and the ambition of its targets. For the first time, the PNACC framework establishes strategic goals and defines a climate change adaptation and impact indicator system. Nine specific goals are identified, contributing as a complement to the overall target. The first goal is to strengthen climate change knowledge, meaning systematic climate observation, producing knowledge on impacts, risks, and adaptation in Spain, and transferring this to society. This will allow for the corresponding adaptation measures to be defined and applied. Strengthening the country's adaptation abilities is a guiding

principle of this strategy, as well as its integration into public policy, monitoring, and evaluation. Administrative coordination and reinforced governance in the area of adaptation are also the subject of a specific goal. Lastly, it also involves promoting the participation of all players, including different levels of administration, the private sector, social organisations, and the public at large, which actively contributes to the construction of climate change-derived risk responses. Achieving these goals will allow Spain to fulfil and develop the commitments acquired in the European and international context.

Next, the lines of action are divided into 18 areas of action in the annex included with the PNACC. These are: climate; human health; water resources; natural heritage, biodiversity, and protected areas; agriculture, livestock, fishing, aquaculture and food; coastlines, marine environments, forests, desertification, inland fishing and hunting; cities, urban planning and construction; cultural heritage; energy; mobility and transportation; industry and services; tourism; insurance activities and the financial system; reducing the risk of catastrophes; research and innovation; education and society; and peace, security, and social cohesion. In addition, there is a work area on the interaction between the various areas. Lastly, an important aspect of this National Plan is that it laid out the application and development of territorial adaptation plans, where necessary, in which the PCCS will be involved.⁴

This Spanish PNACC, whose areas of action are quite similar to those of France, spans a wide variety of fields of action, many of which are necessary in order to face the challenges posed to the Pyrenean mountain range, for which reason they are reflected in the PCCS's contents.

IN ANDORRA

In recent years, Andorra has adopted a series of measures and instruments that demonstrate its appetite to support the international commitments acquired in 2015 with the Paris Agreement. This governmental commitment is also being driven by the declaration of a state of climate and ecological emergency, approved by the Andorran Parliament on 23 January 2020, which was written with active youth participation, asking that the Government drive the transition towards carbon neutrality as per Sustainable Development Goal 13 [Climate Action]. In line with the international commitment to reduce emissions and address climate change, Andorra was one of the first countries to update their national determined contribution (NDC) in 2020. This NDC represents the first update to this report, and includes the commitment to reach carbon neutrality by 2050, as was already announced at PreCOP 25 [October 2019], standing as its most noteworthy change.

In terms of climate change adaptation measures, these were identified and prioritised by the Participatory Andorran Climate Change Adaptation Process in 2015 (PAACC).

Reaching these targets involved the implementation of goals and actions defined in Law 21/2018 on energy transition and climate change [Litecc] and the [National Energy and Climate Change Strategy \(ENECC\)](#), approved in February 2021, which should lead to a reduction in greenhouse gas emissions to guarantee carbon neutrality by 2050. More recently, the National Mobility Strategy, approved in September 2021, focuses on reducing the internal mobility sector's emissions by 50% in 2030 compared to 2017, and achieving decarbonisation in this sector by 2050.

The strategy defines the tools that will be used to reach the targets established in the Law on Energy Transition and Climate Change [Litecc], and is framed by the Government's roadmap, known as H23, and by the Sustainable Development Goals (SDGs). The targets and actions defined in the strategy are binding for the public administration, and are integrated into their planning.

The document is structured into five programmes: the decarbonisation programme; the climate change adaptation and resilience creation programme; the programme for a national carbon credit market and other fiscal tools; the social transition programme; and the innovation, research, and systemic observation programme. The programmes are also itemised into 17 specific activities.

Given that 95% of greenhouse gas emissions come from the energy sector, the strategy's first programme is focused

4. Considering the possibility that this Pyrenean Climate Change Strategy is recognised as one of these territorial interest plans

on decarbonising this sector, as well as other sectors that pollute less but are equally strategic [Programme I]. In parallel, and given that the effects of climate change in Andorra have already begun to be observed, plans have been made to work to adapt to this phenomenon in order to reduce risks and improve the country's resilience [Programme II].

In order to achieve the mitigation and adaptation goals, the programme for a national carbon market and other fiscal instruments was created to help cover the cost of applying and operating the strategy's activities [Programme III].

However, the paradigm shift in the energy sector and the fight against climate change will not be possible without a social transition aimed at educating, training, awareness-raising, and empowering all of society as to the importance of these strategic goals and the habit changes necessary to achieve them [Programme IV].

Lastly, mechanisms to encourage innovation and research to put the most advanced technologies into practice and continue with the systemic monitoring of developments to adapt the planned activities will be reinforced [Programme V].

In contrast with France and Spain, Andorra has adopted a joint climate change adaptation and mitigation strategy.

Although the PCCS is essentially a strategy focused on adaptation, which is an important topic in the Pyrenees region, its intention is also to integrate mitigation measures that have positive synergies with adaptation. These measures are coherent with the Andorran strategy, however they are of course also aligned with the climate change mitigation policies implemented in France and Spain.

Regional and Cross-Border Contexts

All of the CTP member Pyrenean territory Autonomous Communities and Regions have produced their regional climate change policies, as well as some legislation such as Catalonia's Law 16/2017, which is in line with the directives of State and European strategies, although the terminology and denomination change from one territory to another (strategy, roadmap, SRADDET, etc.).

These strategies have various common characteristics. They have targets for 2030-2050, the majority dealing with mitigation as well as climate change adaptation, and address various common themes. They are led by the Autonomous Communities and Regions in consultation and coordination with inter-sectoral groups. Some strategies, such as those of Occitanie, Aragon, and Catalonia, include specific measures for the Pyrenees region. The following is a table summarising these strategies.

	NOUVELLE-AQUITAINE	ARAGON	CATALONIA	OCCITANIE
Timescale	SRADDET 2030 Néo Terra roadmap 2030	The Aragon Climate Change Strategy horizon 2030 [EACC 2030]	The Catalonia Climate Change Adaptation Strategy 2021 2030 [ESCACC30]	SRADDET - Occitanie 2040 Mountain Plan 2025
Common Themes	Territorial Planning; Energy; Transportation and Mobility; Ecosystems and Biodiversity; Water; Forestry; Agriculture; Tourism; Natural Hazards; Soil (Agriculture); Waste; Health; Circular Economy; Municipal Action (towards Towns and EPCI);			
Mountain	Information - Outreach - Education; Innovation - Research; Monitoring - Evaluation			
Governance	Region State SCOT - EPCI representatives COPTec Scientific Council [AcclimaTerra] Citizens [part of the budget]	Government of Aragon - DCCEA Inter-Ministerial Committee on Climate Change Aragon Climate Committee Citizens: "Participation	Catalan Climate Change Office [OCCC] Inter-Ministerial Commission on Climate Change [CICC] Catalonia Climate Change Experts Group [GECCC] Social Climate Change Round Table Public participation in production	SCOT - EPCI State Region Assembly of Territories' Mountain Parliament Citizens [part of the budget]
	ANDORRA	BASQUE COUNTRY	NAVARRÉ	
Timescale	National energy strategy and the fight against climate change [EENCC] 2020-2050 National mobility plan 2021-2050	Basque Country Climate Change Strategy 2050 LIFE URBAN KLIMA 2050 project [2019-2025]	HCCN-KLINA 2030-2050 roadmap for the fight against climate change LIFE-IP NADAPTA-CC project 2018-2025	
Common Themes	Territorial Planning; Energy; Transportation and Mobility; Ecosystems and Biodiversity; Water; Forestry; Agriculture; Tourism; Natural Hazards; Soil (Agriculture); Waste; Health; Circular Economy (Andorra); Municipal Action (the Basque Country, Navarre);			
Mountain	Information - Outreach - Education; Innovation - Research; Monitoring - Evaluation			
Governance	Ministry of the Environment, Agriculture, and Sustainability Affairs The Office on Energy and Climate Change The National Commission on Energy and Climate Change Permanent technical work sub-commission within the framework of mobility	The Basque Country Government - DMA The Basque Country Commission on the Environment, climate change section Technical Group on CC Coordination	DG of Territorial Planning and Environment Inter-Ministerial Commission on Climate Change [CICC] AGORA KLINA multi-agent platform	

Table 1: Brief presentation of the strategies of the seven Pyrenean territories.

The CTP's seven member territories have a long history of cooperation, particularly in terms of climate change with the Pyrenean Climate Change Observatory. Today, the CTP-OPCC wants to go further and increase the resilience of the Pyrenean cross-border space by developing a Pyrenean Climate Change Strategy looking towards 2050. This strategy is focused on the cooperation of the seven territories in order to strengthen, complement, and coordinate the mosaic of regional strategies.



Since its creation in 1983, the CTP has promoted cross-border cooperation between its members: the two French regions of Nouvelle-Aquitaine and Occitanie; the four Spanish autonomous regions of Catalonia, Aragon, Navarre, and the Basque Country; and the Principality of Andorra.

Since 2005, the CTP has been the Managing Authority of the Cross-Border Cooperation Operating Programme between Spain, France, and Andorra (POCTEFA) for the 2007-2013, 2014-2020, and 2021-2027 periods.

The CTP aims to respond to the territory's challenges with its [Pyrenean Strategy \[2018-2024\]](#), which should make the CTP a benchmark for Pyrenean territorial, social, and economic cohesion, and for representation to defend Pyrenean interests among European Union institutions. The 24 million residents of the territories to which the Pyrenean Strategy applies are facing a series of common challenges, the first of which is climate change:

- Adaptation to climate change, mitigation of its effects, and natural hazard prevention.
- The lack of a long-term strategy to improve the quality of life and attractiveness of the territory (in priority areas as varied as tourism, agri-food, culture, and linguistic diversity), and guaranteeing local services. In this sense, innovation and research are also addressed in unequal measure.
- Difficulties with mobility (transportation, infrastructure) and digital connectivity, which affect the economic fabric and cause a decline in local industry

In order to respond to these risks, the Pyrenean strategy is organised into thematic pillars, and defines a series of operational objectives: three major strategic pillars with a thematic dimension and a cross-cutting pillar. For each of these, an application tool has been defined to facilitate management between the CTP bodies.

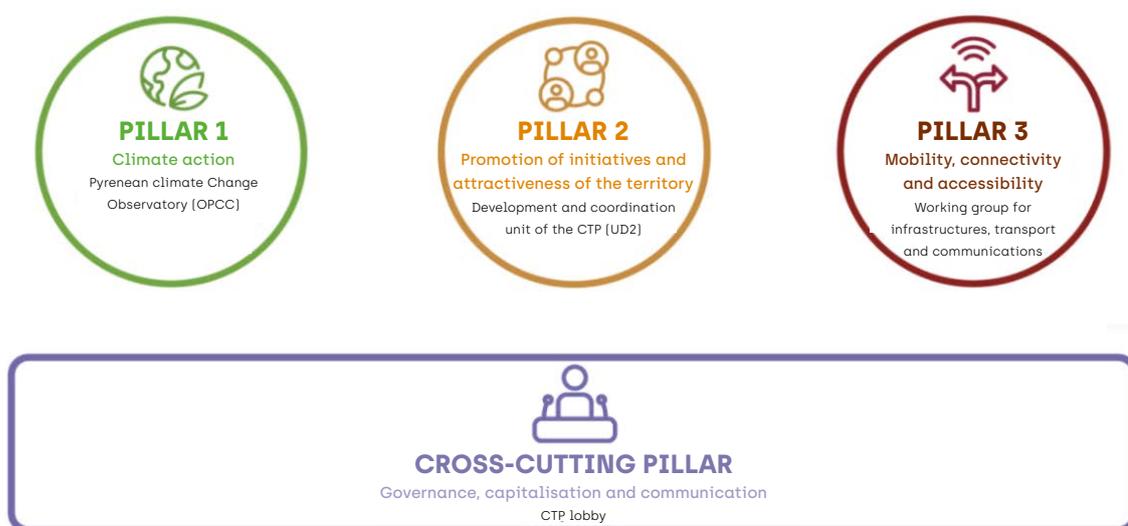


Figure 2: Strategic pillars of the Pyrenean Strategy

The Pyrenean Climate Change Observatory (OPCC) is the CTP's implementation tool for climate change, and has worked since 2010 to analyse and understand climate change in the Pyrenees region to help the territory adapt to its impacts. The goal of **pillar 1 "Climate Action"** is to transform the Pyrenean Climate Change Observatory into a benchmark climate change platform to influence decision-making, connecting the scientific world to public administrations and socio-economic sectors. This pillar also intends to achieve the following goals:

GOAL 1:

Improving knowledge on climate change: in the Pyrenees: climate foundations, vulnerabilities, impacts and risks on natural and human systems (sensitive ecosystems, forests, biodiversity, water resources, natural risks, infrastructure risks, tourism, agro-pastoralism, energy, population, and health).

GOAL 2:

Promoting innovation through specific actions in the area of climate change based on capitalising positive results.

GOAL 3:

Ensuring the transference of recommendations and results from OPCC work to related sector players so as to allow for better adaptation and resilience for the Pyrenean territory.

GOAL 4:

Increasing the visibility of the Pyrenees in terms of climate change and to participate in European and international networks.

GOAL 5:

Ensuring the continuity of the work of the Observatory, consolidating the existing governance structures, such as the OPCC Technical Committee, and the central activities of the Observatory, such as the OPCC web platform and the geoportal, the communication activities and institutional representation activities.

As such, the PCCS is a strategy that should reinforce the climate action carried out by the Working Community of the Pyrenees and favour the application of a common, overall strategy for the Pyrenean territory.

STRATEGIC POSITIONING AGAINST CLIMATE CHANGE IN THE PYRENEES REGION

Produced in consultation with Pyrenean territory players, the Pyrenean Climate Change Strategy (PCCS) proposes a sustainable vision of the territory for the year 2050; a future scenario that is at once rational and intuitive, cohesive and prospective. It must allow for the region's drivers to be involved, and propose a convergent and coherent intervention framework in the creation of a common Pyrenees region ambition. This vision translates into strategic goals that describe the results that must be achieved.

The PCCS is the result of a systemic focus that considers climate change as a "background factor". It aims to provide answers, jointly considering the effects of climate change, and possible transformations to the territory and the territorial strategies applied. These strategies influence the territory's ability to adapt through multiple factors [geographic, socio-economic, institutional, etc.].

The interaction between the various components or systems of the Pyrenean territory have allowed the challenges that must be faced and the lines of action to follow in response to be identified.



Figure 3: Diagram of the PCCS's systems Source: the authors

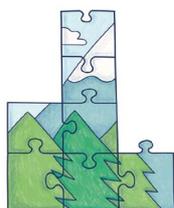
Lastly, the Pyrenean Climate Change Strategy is based on certain founding principles that distinguish and characterise the Pyrenean bioregion and the governance of its territory, as the fifth important component to take into account.

Vision for 2050

The 2050 time horizon for the PCCS's vision is based on European goals connected to the [European Green Deal](#), as well as the notion of climate neutrality. This vision is aligned with European goals, and should facilitate European recognition of the strategy. An intermediate horizon of 2030 also completes this vision, supported with the proposal of an operating action plan for its application.

In 2050, the Pyrenees region will be resistant to the effects of climate change.

THIS VISION WILL MEAN THAT WE WILL HAVE:



A Pyrenees region that is rich in environmental resource diversity, shared and managed sustainably to guarantee its conservation and protection.

A Pyrenees region that acts as a carbon sink, thereby contributing to the climate neutrality of its dependant regions.



A Pyrenees region whose economy has made a successful ecological, energy, and climate transition.

A Pyrenees region whose land planning and prevention systems protect the population and their health from risks and phenomena.



Founding Principles

In order to implement a strategy that can respond to the ambitions set with this vision, we must establish the fundamental principles that will guide our actions and the collection of players that must contribute collectively to this strategy.

1. CROSS-BORDER COOPERATION

Promoting interaction between the Pyrenean regions through the identification of common adaptation priorities and their alignment with regional and national efforts.

2. KNOWLEDGE GENERATION AND TRANSFER

Promoting interdisciplinary and inter-territorial knowledge, the identification of best practices and experiences, assessing them and transferring them to all the territories and sectors of the Pyrenees region.

3. INNOVATIVE ACTIONS

Exploring, promoting, and participating in innovative focuses, both technological as well as in management/governance, that encourage the connection between science, policy, practice, and society.

4. ACTION SYNERGIES WITH THE CTP'S PYRENEES STRATEGY

Promoting synergies with the sectors, and with mitigation actions and the integration of climate change into the actions of other areas of the Pyrenean Strategy (PS).

5. EUROPEAN AND INTERNATIONAL VISIBILITY

Contributing to the visibility of the specificity of mountain area climates and the cross-border nature of the Pyrenees region on a European and international level.

Strategic Goals

Defining an ambition that complements the vision. Its goal is to describe the results the Pyrenean Climate Change Strategy intends to obtain.

SG 1: Developing knowledge on the Pyrenean climate and its variability.

SG 2: Sustainably managing biodiversity and natural resources when faced with the impacts of climate change and improving the associated ecosystem services.

SG 3: Contributing to a fair climate and ecological transition, assisting the Pyrenean economy and population through this process.

SG 4: Promoting territorial management that is compatible with the risks associated with climate change, ensuring territorial balance.

SG 5: Contributing to knowledge-based coordination, cooperation, and governance, reinforcing awareness-raising, communication, and environmental education.

Systemic Pyrenean territory focus

The inclusive and systemic focus helps centralise efforts on key components that are specific to the Pyrenean bioregion. As such, two "cross-cutting" systems are defined that characterise the Pyrenean strategy: climate and governance. In turn, these two systems are directly related to the three other "central" systems: Resilient Natural Spaces, Adapted Mountain Economy, and Population and Territory.

The PCCS's challenges and lines of action are proposed around these systems.

PYRENEAN TERRITORY CHARACTERISTICS

The publication "Climate change in the Pyrenees region: impacts, vulnerabilities, and adaptation" (OPCC, 2018) constitutes the most complete and recent knowledge base on climate change in the Pyrenees region. From this publication's elements of knowledge, a synthesis of each system's problems is presented, complemented with data from the OPCC2 project and projects associated with the OPCC (PIRAGUA, CLIMPY, REPLIM, FLORAPYR, CANOPEE, and ADN-Pirineos, for example)⁵.

This preliminary analysis of the Pyrenean territory's main climate change impacts and vulnerabilities is necessary in order to contextualise the challenges and lines of action identified in the PCCS.

We shouldn't forget that the Pyrenees region also immersed in a context of global change. Throughout the last century, the bio-physical components (atmosphere, water resources, soils, biodiversity, among others) have been altered as a result of the intensification of anthropic activities and different types of territory management with rural and mountain area abandonment. The proof of these effects on the planet itself have led it to be considered the Anthropocene Era.

In the Pyrenees, climate change is occurring in a context of social change characterised by the progressive abandonment of the territory's traditional uses. This dynamic has generated major changes to soil use during the last 50 years, with notable implications in vegetation succession, and subsequent changes to the landscape. Therefore, Pyrenean ecosystems must be understood to

5. All of these projects have been financed by ERDF funds through the INTERREG POCTEFA 2014-2020 project

be cultural landscapes in the middle of a process of change due to traditional uses that have been modelled for centuries being abandoned (agriculture, livestock, logging, and hunting), as well as recent human-caused climate change.

Within the scope of the PCCS, this interaction between factors affects many of the challenges that define it. In this sense, most of the lines of action defined to address the 15 challenges intend to fulfil the need to study and better understand the effects of climate change within a context of global change.

Climate

RISE IN TEMPERATURE:

Between 1949 and 2015, the average temperature in the Pyrenees rose quite clearly, with an increase of 0.2 °C per decade. This increase has been generalised across the entire mountain range, with small differences between the north and south sides, and more pronounced during the summer period (June, July, and August).

Despite the uncertainties associated with future socio-economic scenarios and the limitations of the numerical models used to obtain climate projections, the main climate models agree that there will be intensified global warming in the coming decades, especially in mountain areas. According to projections made by the CLIMPY project, a significant increase in daily maximum and minimum temperatures is expected throughout the 21st century, during all seasons of the year, and throughout the Pyrenean region. Between now and 2030, the variation to the average maximum temperature value compared with the reference period [1961-1990] could stand at between 1 °C and 2.7 °C on average for the entire Pyrenean region. These values will most likely increase by 2050, with values oscillating between 2.0 °C and 4.0 °C.

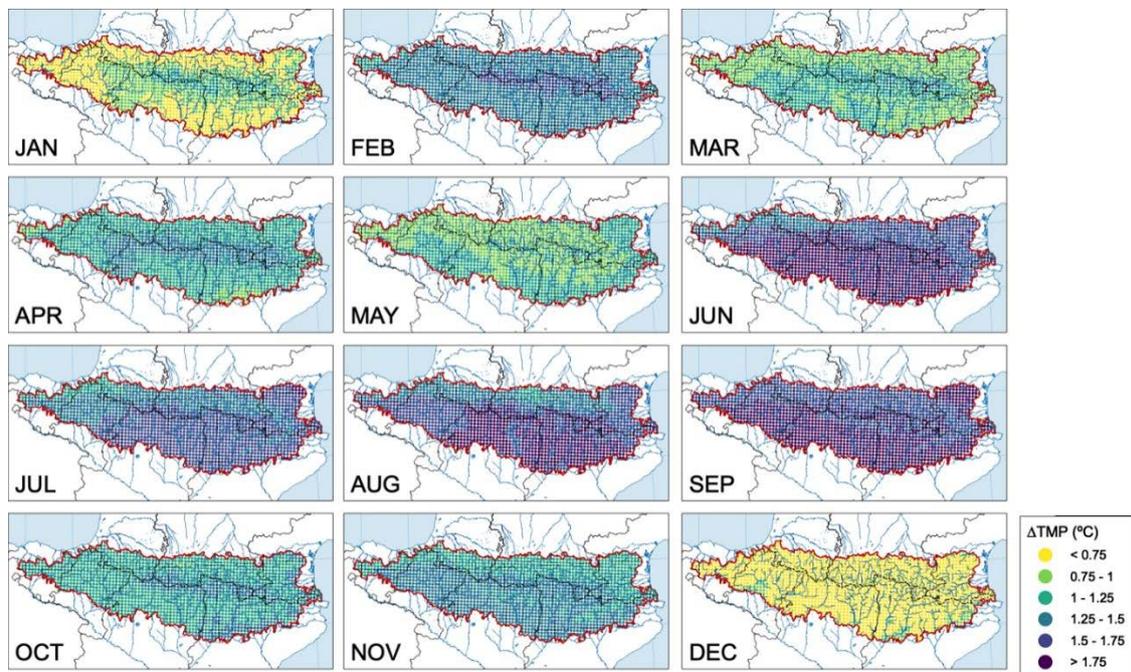


Figure 4: rojected change for average monthly temperatures (Δ TMP, in °C) for the time horizon 2011-2040 compared with the 1981-2010 period: average values in a total of six Regional Climate Models (RMC) under emissions scenario RCP 4.5. [Source: CLIMPY, 2020].

REDUCED PRECIPITATION:

In terms of precipitation, the downward trend in annual volumes has been confirmed, mainly due to the reduction in summer and winter precipitation. The precipitation climate indicator shows its downward trend of approximately 2.5% per decade over the last 60 years (according to data observed during the 1949-2015 period). This trend's value shows great variability from one year to the next, with dry years being predominant in recent decades, with some very wet years with precipitation higher than the period's average. In terms of territorial differences, the downward trend in annual precipitation is greater on the southern slope than the northern slope of the Pyrenees, although there is not a major contrast.

According to future projections from a collection of models, no significant changes are expected to average annual precipitation values in the coming decades. Nevertheless, uncertainties increase as we approach the end of the century. Particularly important are possible changes to seasonal precipitation behaviour, which could affect water availability both in the environment, as well as socio-economically during periods of the year with greater demand. Therefore, providing stakeholders with updated information on the climate will be a major challenge to effectively address the consequences of climate change.

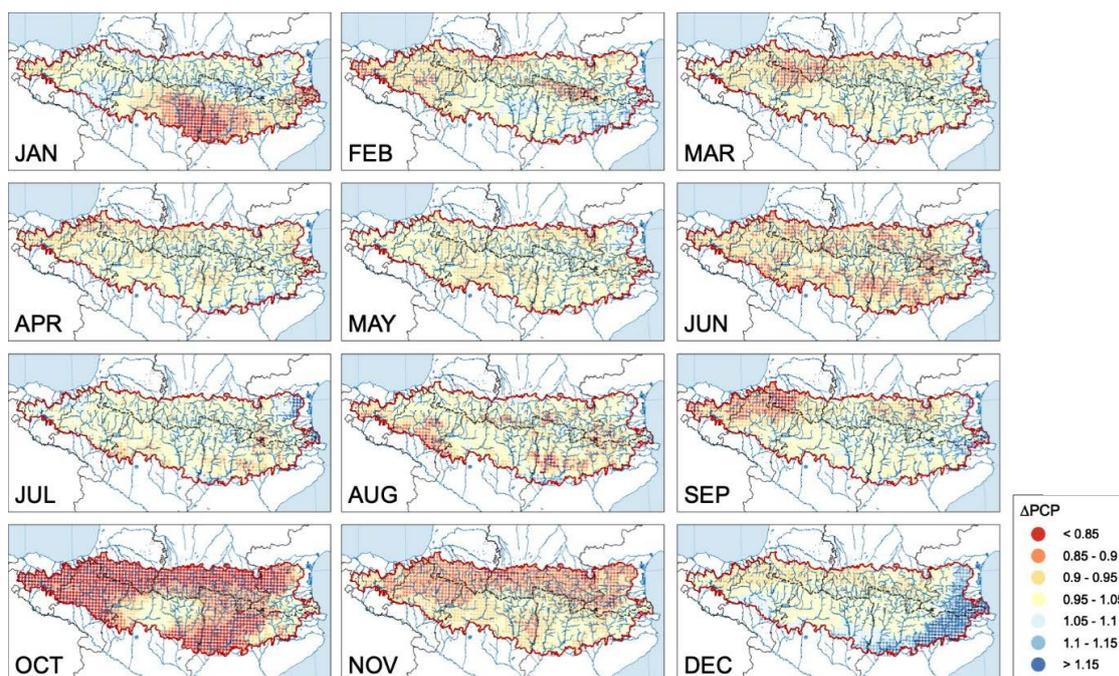


Figure 5. Projected monthly change for average precipitation (ΔPCP , relative values) for the time horizon 2011-2040 compared with the 1981-2010 period: average values in a total of six RMCs under emissions scenario RCP 4.5. [Source: the CLIMPY project, 2020].

OTHER COMING CHANGES: SNOW COVER

If global warming continues at its current rate, this could result in the intensification of climate variability and the trends already identified regarding the evolution of the key climate variables. Significant effects have been observed in the characteristics of the Pyrenean bioregion's climate, water, environment, and landscape. In particular, the CLIMPY project's results forecast a significant decline in the average thickness of Pyrenees snow, despite major year-to-year variability. Analysing the evolution of snow cover over the last half century is complex, as there is not enough continuous and robust historical data in series over time. This is due to measurement instrumentation installation and maintenance being more complex at higher altitudes. However, based on the southern side's beacon network, a statistically significant decrease in snow coverage has been identified in this area between 1950 and today. It is forecast that this trend will continue in the central Pyrenees, where the average snow depth at an altitude of 1,800 m could be reduced by half in 2050 according to the current reference data, while the amount of time snow remains on the ground would be reduced by more than a month. In this context, greater international network participation would help raise awareness as to the mountain range's vulnerability to climate change.

Therefore, we must ensure that observation data monitoring and updating continue, along with climate modelling through future scenarios.

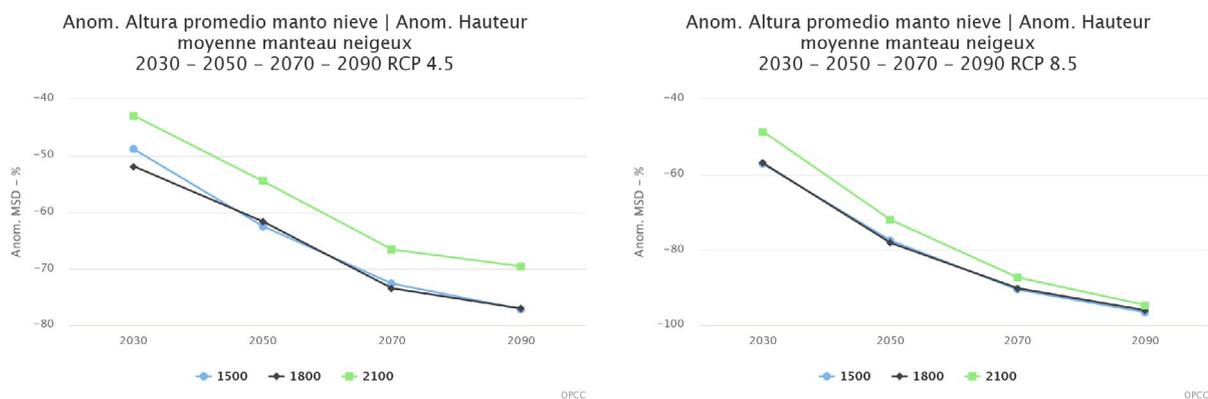


Figure 6: Average projected change in Pyrenees snow cover thickness, expressed as a % of reduction compared with the average value for the 1986-2005 reference period and depending on the altitude. [Source: see analysis section, geoportal OPCC 2021 (<https://www.opcc-ctp.org/fr/geoportal>)].

Resilient natural spaces

WATER RESOURCES

The Pyrenees region water resources are extremely important, and play a fundamental role not only in the Pyrenees, but also in their area of influence, which includes the Ebro, Adour-Garonne, and Rhône Méditerranée Corse Mediterranean basins, as well as the Basque Country and Catalonia. In the Ebro basin, for example, Pyrenees rivers represent nearly 70% of the basin's total water resources⁶.

Climate change has caused changes to the average annual flow of many Pyrenees region rivers in recent decades. However, these changes are attributed to both climate causes and the evolution of plant cover and changes to soil uses, with the influence of each factor not always being easy to quantify separately. Significant decreases in average annual flow of more than 50% have been detected at gauging stations in the Ebro basin studied during the 1950-2010 period.

The decrease in winter snow accumulation due to a rise in temperatures and the decrease in snowfall is currently causing an increase in winter flows. The increased frequency and intensity of droughts is causing a decrease in river flows during summer and autumn months. It is clear that these changes affect the recharging and discharging of underground water, both surface and shallow, which are particularly sensitive to changes in climate conditions. Key studies indicate that subterranean water recharge could be reduced by up to 20% in some massif areas by the mid-century. This could cause reduced flows from many springs.

Lastly, these changes could have a major impact on water resource quality. Droughts and longer periods of water scarcity will increase the concentration of contaminants, while an increase in flooding frequency and intensity could cause an increase in nutrients and contaminants brought into rivers.

The combination of low flows and toxic substances that affect aquatic biological communities is already causing structural and functional problems for river ecosystems.

Therefore, acting to guarantee resilient Pyrenean river management and the good quality of the resulting water will be essential.

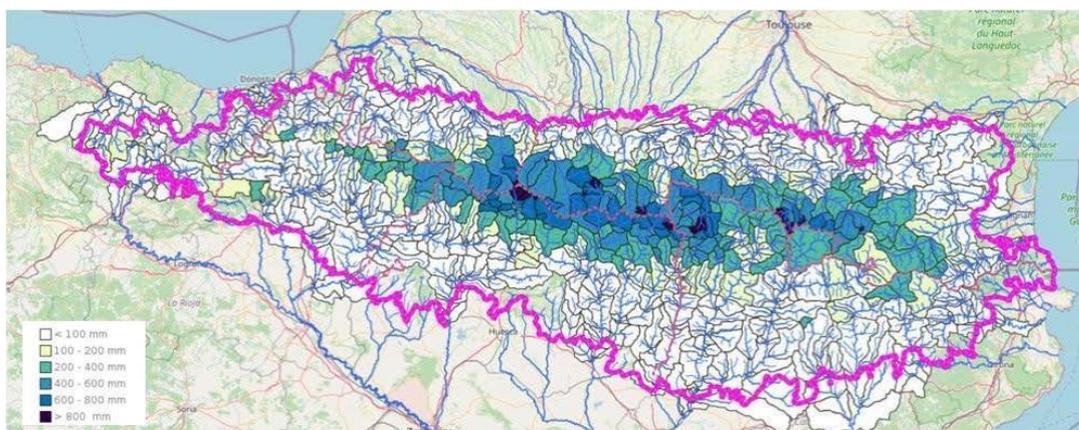


Figure 7: Hydrological network and Pyrenees annual snowfall estimation (in mm) for the 1960-2010 period, according to the SWAT model. [Source: PIRAGUA project 2018-2020, see geoportal OPCC 2021].

BIODIVERSITY IN THE MOUNTAINS

The Pyrenees region is a biodiversity-rich natural environment characterised by the presence of numerous endemic species; for example, nearly 200 plants on the French side of the Pyrenees are endemic. The Pyrenean massif also offers refuge to numerous animal species such as vultures, royal eagles, saxicolas, western capercaillies, Egyptian vultures, grebes, among the birds; roe deer, deer, chamois, brown bears, marmots, stoats, desmans, among mammals; but also many amphibians and reptiles, including *Atelopus longirostris*, Pyrenees mountain lizards, Pyrenean newts, etc.

High-altitude mountain ecosystems that are characterised by a great richness of endemic species with small distribution areas and limited dispersal capacities are particularly vulnerable to climate condition variations. The reduced extension and persistence of snowfall recorded in the Pyrenees in recent decades has consequences for the various species that live in snowy environments. This is the case for large mountain mammals, such as the Pyrenean chamois (*Rupicapra pyrenaica*) or certain plant species associated with snowy peaks such as the dwarf willow (*Salix herbacea*).

The sum of climate and man-made factors could cause changes to Pyrenean flora distribution and composition, to the point of putting ecosystem function and its ability to provide important goods and services at risk. Climate change could increase the propagation risk of certain alien species and other harmful ones already present. Forest fauna tend to respond to global warming by changing their distribution. Animal and plant displacement in search of adequate climate conditions could influence the connectivity of the Pyrenees region's natural spaces.

As such, implementing actions to fight against the progressive loss of biodiversity is essential, particularly when it comes to fighting emerging infestations and diseases, but also in order to face the impacts of extreme climate events on biodiversity, and strengthen the ecosystem services that depend on it.

FORESTS

Forests cover 59% of the Pyrenean range's surface area and represent a renewable natural resource, ecosystems rich in biodiversity, in-demand tourism and public spaces, protection against natural events (avalanches, rockfalls, floods, etc.), and an important natural CO₂ sink.

Global warming and changes in soil use are altering the diversity and distribution of many plant and forest species' communities in the Pyrenees region. Climate change may affect forest productivity and its ability to trap CO₂ from the atmosphere through photosynthesis. Climate change may alter forest health conditions, and lead to imbalances with pathogen communities.

Beyond the potential impacts of climate change on trees and forests themselves, it is important to consider the predictable consequences on the numerous ecosystem services and functions that mountain forests provide. In fact, climate change may significantly impede Pyrenean forest multi-functionality, causing death in protection and production forests, notable habitat and species destruction, and forest landscape deterioration. In addition, climate change may influence forests' ability to protect us against certain natural hazards typical of mountain areas.

Therefore, improving this renewable resource's sustainable management is essential, reinforcing the protective role of forests and their biodiversity, coordinating this with extractive uses at the same time.

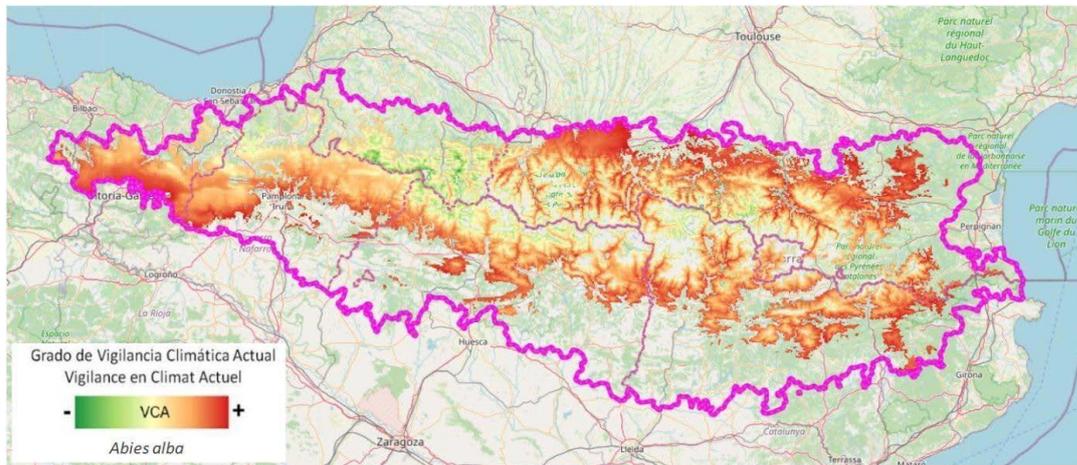


Figure 8. Current climate monitoring map (SCA) of *Abies alba*, obtained by correlating the current distribution of forest cover where the species is in the majority with average values of the different climate variables of interest to this species during the 1981-2010 period. [Source: CANOPEE project 2016-2019, see [geoportal OPCC 2021](#)].

SENSITIVE HIGH-ALTITUDE MOUNTAIN ECOSYSTEMS

Glaciers, high-altitude mountain lakes, frozen caves, and bogs of the Pyrenees are emblematic elements of the Pyrenean landscape that are vulnerable to recent climate change and growing pressure from humans. More than one thousand high-altitude mountain lakes have been inventoried in the Pyrenees.

Bogs are ecosystems characterised by an accumulation of organic material due to anoxic conditions caused by the medium's water saturation. In the Pyrenees, bogs are generally minerotrophic bogs fed by subterranean and surface water. Their formation depends on the topography and hydroclimatic conditions.

For thousands of years, these lakes and bogs have played an essential role when it comes to maintaining biodiversity, contributing to the storage of carbon and supplying water resources. These wet areas have been necessary spaces for shepherding activities, and have become a tourism resource more recently.

The predicted impacts on lakes and bogs in the Pyrenees region due to human-caused climate variability overlap with those caused by anthropogenic activities (heavy metal deposits, fish stocking, increased supply of nutrients and sediments, hydroelectric uses, and shepherding).

Droughts and changes in precipitation could alter the water cycle, changing the amount of water available in high-altitude mountain lakes. These changes, combined with an increase in temperatures, could alter the physical and chemical conditions of lakes, with the negative consequences that entails for plant and animal communities. The effects of climate change may also accelerate the Pyrenean bog degradation process, and reduce their flooded surface area. Their current role as carbon sinks could be inverted, transforming them into CO₂ emitters instead of capturers, with a considerable loss of biodiversity and iconic landscapes.

The accelerated retreat of the Pyrenean glaciers not only implies a series of indirect ecological impacts but represents an irreversible loss of cultural and environmental heritage. From 1984 to 2016 an estimated 20 of the 39 glaciers recorded in 1984

disappeared, which equates to a glacier surface area loss of 516 ha. In other words, more than half of the Pyrenees' glaciers have disappeared in just 32 years. Glacial retreat since the 1980s has doubled the 20th century's rhythm and rate of change, moving from 9.33 ha lost annually between 1850 and 1984 to 17.76 ha lost annually for the 1984-2016 period. Studies on mass balance and surface hypsometry changes confirm Pyrenean glacier imbalance in terms of environmental conditions, with several metres of thickness lost annually. If forecasts by the main climate models are correct, it is likely that many European glaciers will disappear by the mid-21st century, which would mean the disappearance of almost all glaciers in the Pyrenees given their more southern location.

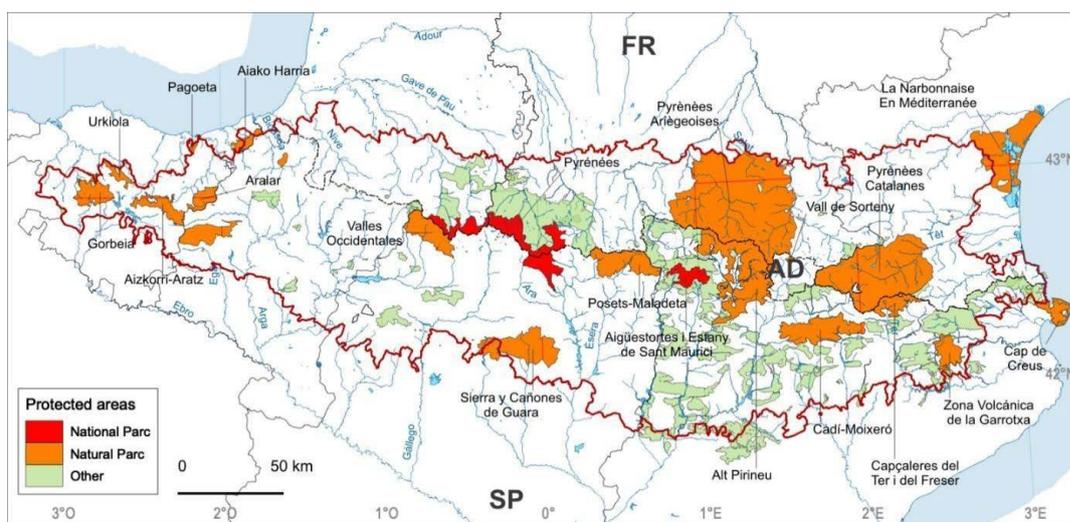


Figure 9. Environmental protection areas [Source: EIONET, 2021; Government of Andorra, 2020].

Adapted mountain economy

TOURISM

The Pyrenean massif's tourism sector is one of its territories' economic drivers, with winter tourism being the main source of income and the engine behind local development in various Pyrenees regions, such as Aragon and Andorra, where it represents 7% and 15% of their GDP, respectively.

However, in recent years this sector of the tourism industry has been identified as being highly vulnerable to the effects of climate change.

The effects of climate change on snow cover duration could affect the 2,163 km of ski slopes in the Pyrenees, which would reduce the winter tourism appeal of some of the 38 downhill ski resorts currently operating throughout the mountain range. Delayed ski resort openings of between 5 and 55 days have already been observed at low and medium altitude resorts. Another typical impact is related to changes in the landscape and, in particular, with acceleration in the deterioration process of certain iconic elements of the high-altitude mountain landscape, such as bogs, glaciers, and lakes.

In addition, the influence of climate change on the main natural hazards may particularly affect the integrity of tourism infrastructure and tourist safety.

Nevertheless, climate change could also have positive effects on mountain tourism. Gradual warming, particularly more mild temperatures in autumn and spring, could prolong the Pyrenees region's mountain tourism season.

In this context, the current tourism offer's deseasonalisation, and the promotion of more sustainable tourism offerings, are challenges that are important in terms of maintaining Pyrenean tourism.

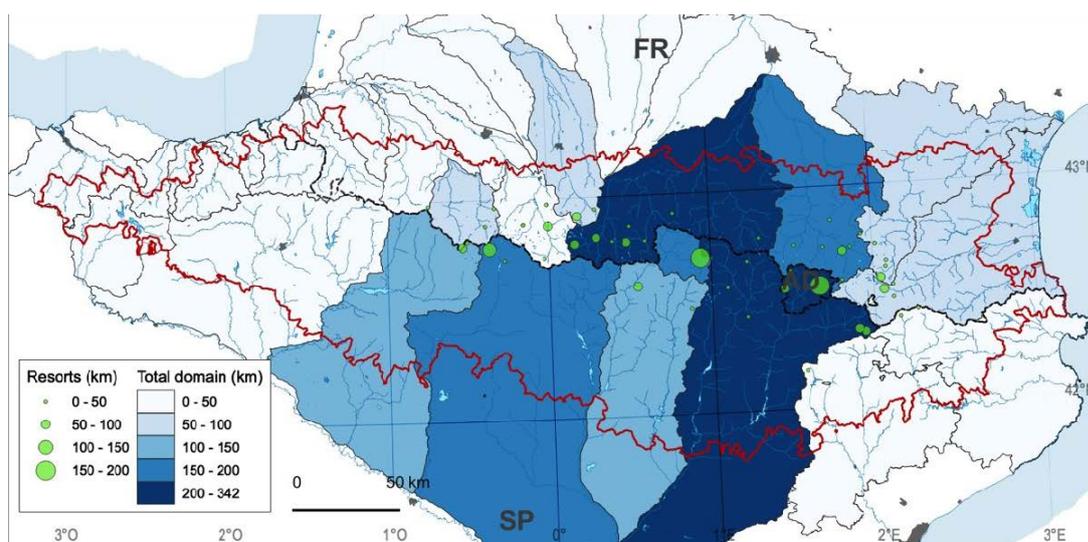


Figure 10. Location of ski resorts and total skiable surface area by the operations council (km).
(Source: PIRAGUA project 2018-2020, see [geoportal OPCC 2021](#)).

AGRICULTURE AND MOUNTAIN PASTORALISM

Agriculture and livestock are key socio-economic sectors owing to their high strategic, economic, and territorial value on both sides of the Pyrenees. Although their presence is unequal across the range, agriculture employs 8.4% of the French side's working population, for example, while this sector represents only 2.6% of companies in Andorra, and 0.4% of total salaried workers in the country.

Mountain pastures are an essential resource for the sector, and offer numerous eco-systemic services to society, services such as production, maintaining biodiversity, landscape resources, water quality, and carbon sinks, reducing the risk of fire, and keeping populations in mountain areas. Climate change may have both positive and negative effects on the Pyrenees region's agricultural sector.

The increase in the concentration of atmospheric CO₂, the consequent increase in average air temperature, as well as changes in seasonal precipitation patterns and the greater frequency and intensity of extreme weather events could affect agriculture, pastures, and livestock in the Pyrenees, and even the population employed in the area directly. This will have different impacts in different areas.

It is quite likely that reduced water availability, crop calendar changes, and increased farmland damage and loss due to extreme weather events will come together to reduce crop productivity. Likewise, climate change could favour the propagation of certain crop diseases and infestations, or cause natural reforestation (an expansion of forests at the expense of shepherding areas), and certain typically Mediterranean crops not traditionally farmed in the Pyrenees region.

Contrarily, the gradual increase in temperatures predicted for the coming decades could lengthen the growing season of many crops, particularly in mid-mountain valleys. The elevated concentration of CO₂ in the atmosphere could have a fertilising effect on crops to a greater or lesser degree depending on the type of crop and the evolution of other limiting factors such as water or certain nutrients. This could lead to an increase in mountain grazing productivity, as long as spring and summer droughts are not too intense. On the other hand, it could also cause changes to pasture composition and distribution, leading to changes in forage quality with negative effects for the sector.

In addition, increased average temperatures and heatwaves directly affect animal health and well-being. These new climate conditions could increase the propagation and prevalence of livestock diseases.

While there are uncertainties as to the exact magnitude of these impacts, it is very likely that climate change will pose risks in the coming decades in addition to the sector's current socio-economic problems, such as a lack of generational replacement, price fluctuations, and an abandonment of the activity. Therefore, the viability of the agricultural and extensive livestock sectors that are most exposed to the negative consequences of climate change must be guaranteed, as they provide important benefits to the agro-ecosystem.

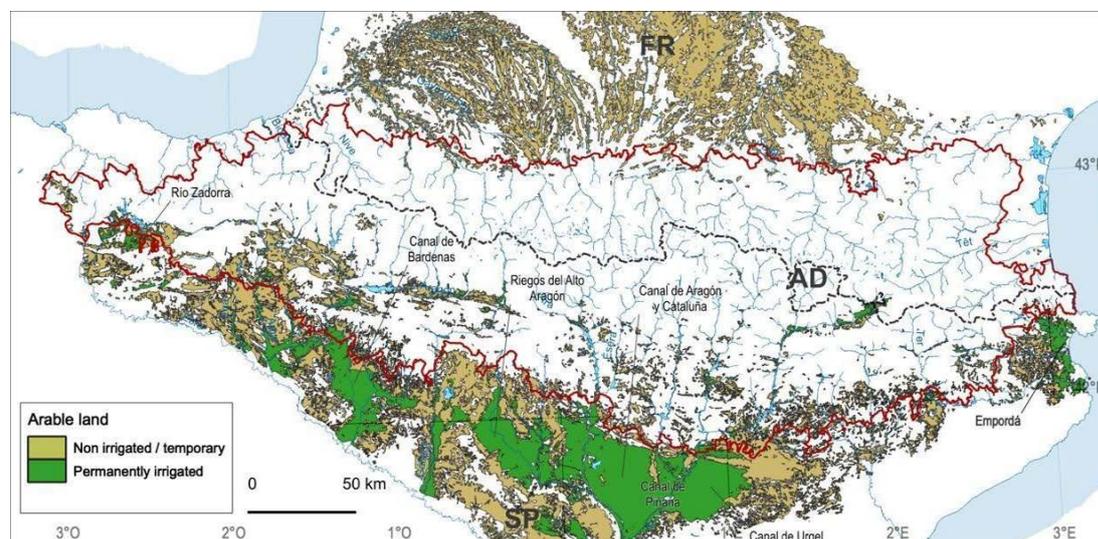


Figure 11. Water use in agriculture: non-irrigated or seasonally irrigated areas, and permanently irrigated areas. [Source: HEC, 2020; Corine Land Cover, 2018.]

ENERGY

The energy sector is responsible for a large portion of the greenhouse gas emissions produced by man. At the same time, the sector is vulnerable to the effects of climate change, both in terms of energy supply (effects on energy production) and demand. In terms of renewable energy production, climate change may have negative effects on hydroelectric, thermoelectric, and wind energy production in the Pyrenees, while the effects on solar thermal and photovoltaic energy production could be positive in some areas.

In the Pyrenees region, the energy sector is characterised by the importance of the hydroelectric sector on both sides of the massif. The Ebro and Garrone basins, and the inland basins of Catalonia are highly important from an energy perspective, both on a regional and national scale. In the Pyrenees-Ebro basin, the potential installed hydroelectric energy represents more than 50% of the entire Pyrenees region's installed potential energy. In terms of the French side, 49% of the potential regional installed energy in Occitanie is hydroelectric energy, while Nouvelle-Aquitaine makes up 15%. It is highly likely that the greater climate variability expected in the coming decades will have negative effects on the massif's hydroelectric production and maintenance of its energy infrastructure.

The impact of climate change on the water cycle may affect hydroelectric plants' capacity to produce energy during certain periods of the year. Likewise, wind energy production could be negatively affected in the coming decades due to climate change. Energy production and transportation infrastructure could also be affected by the expected increase in natural hazards. This decline in energy efficiency could be problematic, especially as it is expected that seasonal energy demand will vary considerably in the coming years due to increased average temperatures and heatwaves.

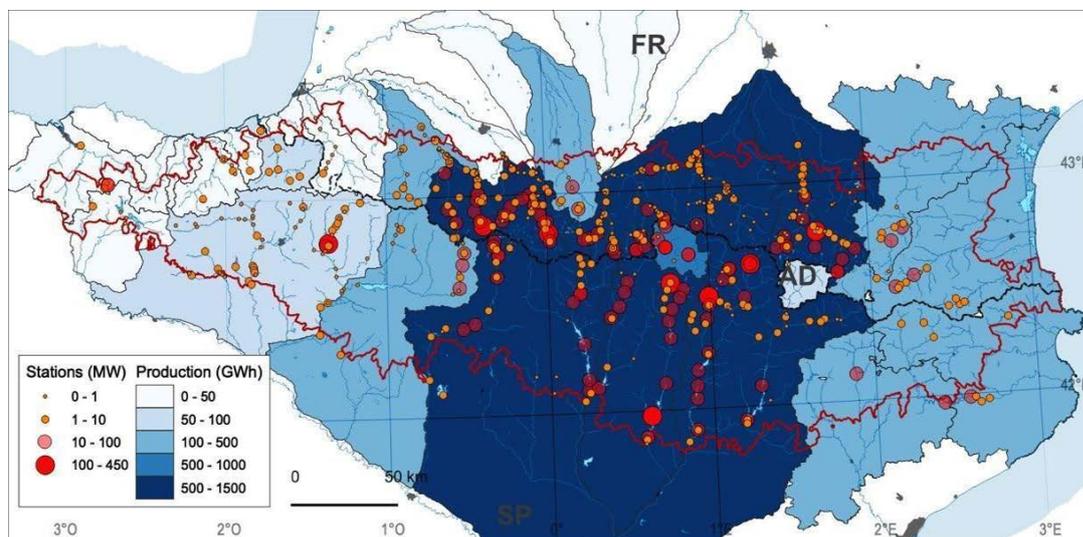


Figure 12. Location of hydroelectric plants according to their installed capacity [MW] [a], and average annual production by the operations council [Gwh] [b]. [Source: CCH, CHE, the Spanish Ministry of Industry, the Government of Andorra, and the authors].

Therefore, it will be important to take advantage of the opportunities that arise out of the energy sector in order to adapt to this evolution. For example, producing electricity through solar energy could be favoured in the future due to an increase in solar radiation across the mountain range, which is estimated to see a 10% increase over current capacities by mid-century. Other renewable energies such as thermal solar, wind, geothermal, and biomass (PIXIL, ENERGREEN) should also be evaluated and considered. The Pyrenees is a region with great potential for capturing energy from renewable energy sources that could make up a generation network distributed throughout the territory, and make the territory resilient from an energy perspective. Nevertheless, when it comes to planning energy facilities, certain landscape and ecological sustainability criteria must be integrated into the climate change focus.

Population and territory

NATURAL HAZARDS

The idea of natural hazards covers all threats that certain natural dangers and events pose to the public, structures, and equipment. While these natural events can be more or less violent, they are always capable of being dangerous in environmental, economic, and human terms. Natural hazard prevention consists of adapting to these events in order to reduce their foreseeable consequences and potential damage insomuch as possible⁷.

In terms of extreme hydro-meteorological events in the Pyrenees region, both in terms of floods and droughts, an analysis of the recurrence of these phenomena in recent decades shows an upward trend⁸.

Various episodes of floods have caused major damage in the Pyrenees region. One just has to think back on the events of October 1940, which mainly affected Catalonia and France, and caused dozens of deaths, or the floods of November 1982, that devastated much of Andorra and caused catastrophic damage in Catalonia, not to mention the impacts in Aragon and Languedoc-Roussillon. In June 2013, there was major damage to the old Midi-Pyrénées region, Catalonia, and Aragon. The Bidasoa basin (mainly the Baztan river) was affected by deadly floods in 1913, and again nearly one hundred years later in July 2014.

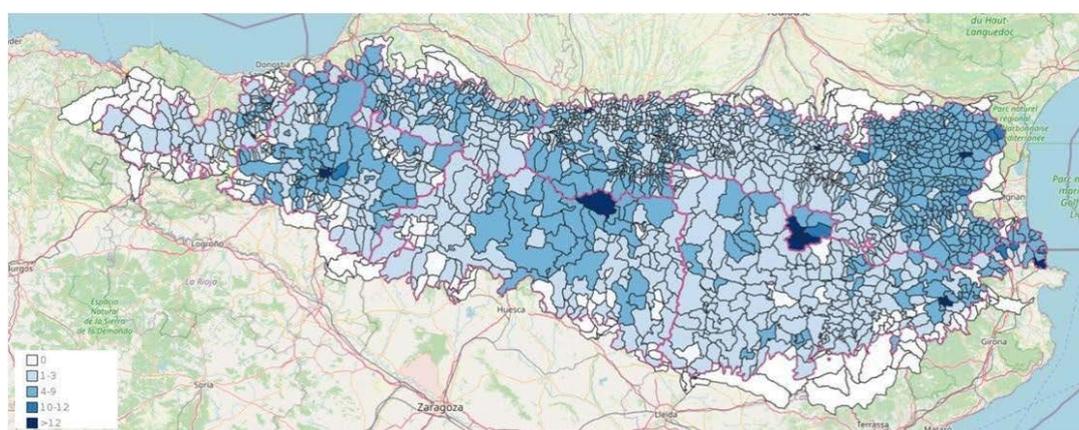


Figure 13: Flooding events in the Pyrenees region during the 1981-2015 period. [Source: PIRAGUA project 2017-2021].

7. <https://www.gouvernement.fr/risques/risques-naturels>

8. PIRAGUA project

Under the influence of climate change, the Pyrenean territory could face an increase in the frequency and intensity of many natural events: an increase in maximum and minimum temperatures, heatwaves, and droughts; an increase in the frequency of intense rainfall and the intensity of hail storms; an increase in flood-associated risk; and the weakening of rock and slope stability. This last case would occur to a degree not yet known, but could be the result of a combination of more frequent intense rainfall events, high temperature events in synergy with periods of droughts (fires), and the acceleration of permafrost deterioration and melting processes.

The Pyrenees region is a mountain territory where a multi-risk perspective that integrates new climate scenarios and possible cascading effects that could occur in mountain areas is essential. In addition to promoting the territory's multi-risk management, creating a culture of risk among the population is fundamental, as are spaces for exchange that allow a basis to be established for better cross-border coordination on the range's natural hazard prevention and management.

HEALTH

The World Health Organisation (WHO) reports that climate change is responsible for at least 150,000 premature deaths each year, a figure that could double by 2030⁹. Climate change acts as a risk aggravating or multiplying factor, amplifying many of the problems that the public is already facing.

Among the direct impacts, we can point to an increase in air temperature, which has a direct impact on public health, with an increase in hyperthermia and heart or respiratory diseases that can cause spikes in mortality. In terms of indirect impacts, climate condition changes cause a series of cascading reactions, which run from pathogenic species or disease vectors establishing themselves, to changes in their behaviour, and even changes to air quality. Specifically, climate change can lead to the appearance and proliferation of animal, plant, and microbial species that can cause allergies, poisonings, and infectious diseases.

Infectious diseases are transmitted through so called "vector animals", which are the subject of particular attention in the environmental health field. Until now, the worsening and propagation of certain diseases has been attributed to faster and more frequent global transport. However, scientists have recently pointed to climate change's influence on these disease vectors, as increased temperatures favour their development, expanding their areas of distribution and accelerating the development of pathogens. For example, this is the case with tiger mosquitoes, which are responsible for transmitting Chikungunya, Dengue, and Zika.

Therefore, guaranteeing optimal levels of preparation, prevention, and training against climate extremes, emerging diseases, and natural hazards is also an important challenge.

LAND PLANNING AND URBAN DEVELOPMENT

Land and urban planning are fundamental tools, and key planning instruments to guarantee the rational use of mountain territories, as well as the necessary prevention and preparation for climate challenges.

In a climate change scenario characterised by more frequent and intense extreme events, encouraging the adaptation of land planning is necessary so that urban centres and infrastructure can be more resilient, and essential services and land in urbanised areas can be reinforced.

To do this, acting on all elements that determine vulnerability to climate change and its associated risks is essential. First, minimising exposure to climate and natural hazards is necessary, taking into account their greater frequency and intensity, and possible changes to return periods. This involves a review of land use in light of a changing climate and limiting land sealing, for example. On the other hand, reducing the sensitivity of these systems is also fundamental, acting on construction types, materials used, and applying certain design criteria such as green building. Lastly, action will need to be taken to improve response capabilities so that human systems are better prepared to address their exposure and sensitivity to change in the new climate context.

The test will be accompanying Pyrenean territories in this new challenge, taking into account the new demographic dynamics caused by COVID-19, as well as seizing on emerging opportunities to keep populations in the territory.

RAISING CITIZEN AWARENESS

In large part, climate change adaptation measure success depends on public climate change knowledge and levels of awareness regarding this major global crisis. For this reason, it is first necessary to inform all citizens on and off the range as to the effects of climate change, and its implications for the various human and natural systems throughout the region.

Secondly, raising awareness among all sectors of the population as to the particular vulnerability of the Pyrenean bioregion to the effects of climate change is fundamental, as it is the most efficient way of truly raising awareness on the challenges of global and climate change. These steps are essential in order to encourage individual behavioural change towards a more sustainable lifestyle model that lets people enjoy the Pyrenees region's current natural resources, without forgetting about future generations.

In addition, a third fundamental level must be advanced for climate action, promoting and supporting public involvement. To do this, it is necessary to organise groups of individuals that want to collaborate by observing climate events and adopting responsible measures.

In this sense, there are multiple tools to raise awareness on climate change. The Pyrenees region's challenge is producing the most appropriate tools to reach the public, coordinating current participatory science networks, and maintaining their vitality over time and throughout the territory, while at the same time meeting public expectations in terms of participation in the various initiatives.

CLIMATE CHANGE CHALLENGES AND LINES OF ACTION IN THE PYRENEES REGION

In order to achieve the Pyrenees region's strategic goals on climate change, 15 challenges are proposed that concern different sectors of the Pyrenean reality, yet together allow for overall action to be taken in terms of the climate change issue.

Thirty-eight lines of action have been developed to specify the way the various challenges will be faced. Each line of action specifies concrete actions geared towards orienting the PCCS's first implementation operations plan, which are meant to achieve the first climate goals in the Pyrenees region during the initial period of 2030.

After each challenge's description and the associated lines of action, a table is presented to summarise how each line of action contributes to the PCCS's strategic goals, and on which fundamental principles they are based.

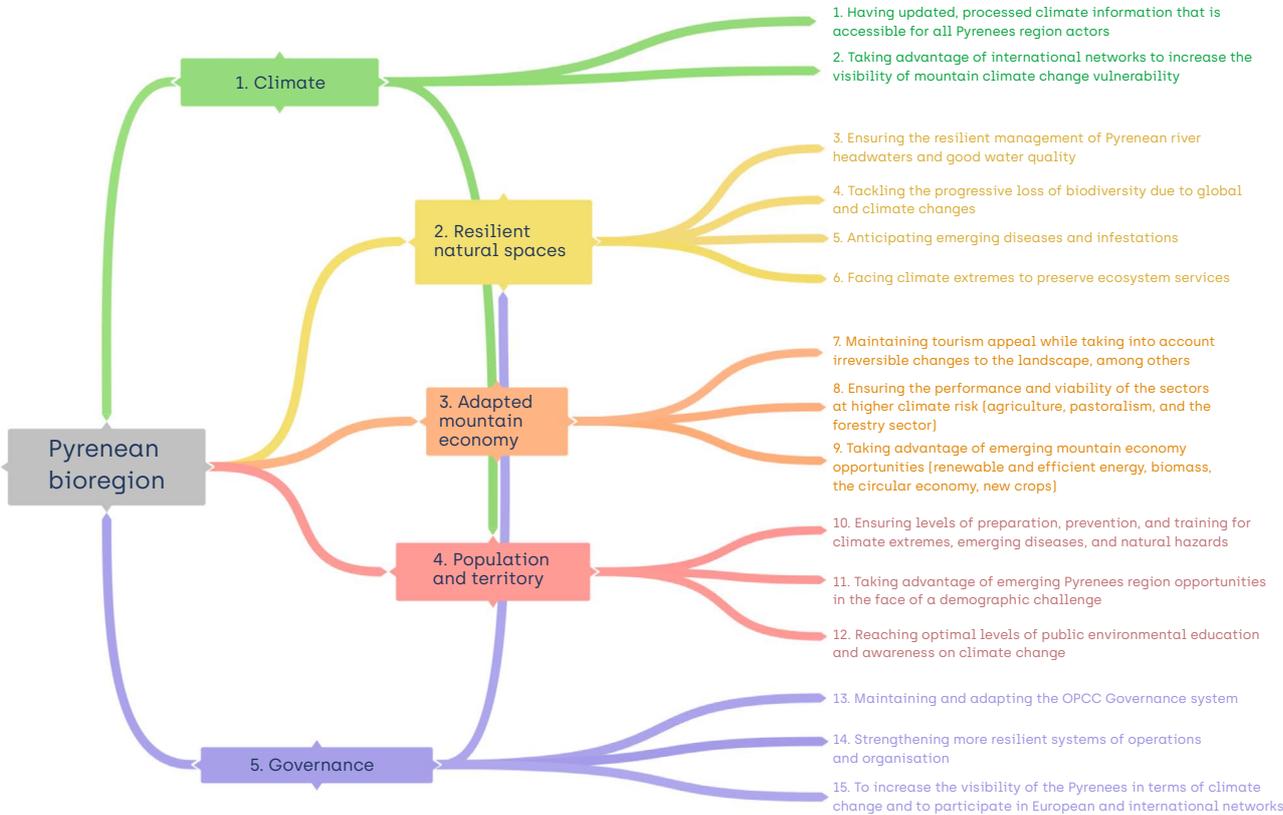


Figure 14: Owards a Pyrenees Climate Change Strategy systemic focus.

CHALLENGE 1:

Having updated, analysed climate information that is accessible for all Pyrenees region stakeholders

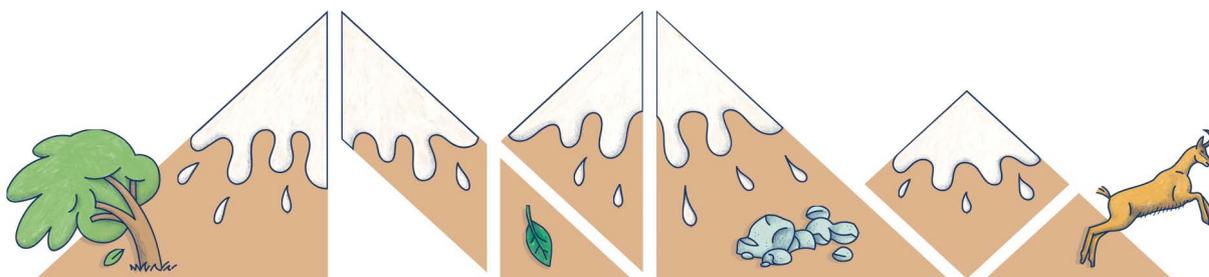
Despite the uncertainties associated with future socio-economic scenarios and the limitations of the numerical models used to obtain climate projections, the main models agree that there will be intensified global warming in the coming decades, especially in mountain areas.

In the Pyrenees region, the progressive global warming trend and regional changes in soil use produce a complex scenario in which socio-economic and natural systems are highly sensitive to variations that may be caused by future climate conditions when compared to the current ones.

In this complex context, understanding Pyrenean climate trends and evolution is fundamental. This can be achieved by unifying and standardising existing information, developing climate indicators, and making future projections. Sharing and transferring this knowledge to the territories through geographic information systems, among others, must allow vulnerability to climate change impacts to be reduced, with better adaptation to its effects.

LINES OF ACTION

- 1.1. Promoting innovation and scientific climate knowledge transfer.
- 1.2. Updating Pyrenean-scale climate databases and making them available to the territories.
- 1.3. Updating the calculation of key sectoral climate change indicators on a mountain-range level.
- 1.4. Providing continuity to cross-border climate variability mediation and monitoring systems, introducing innovative technologies.



CHALLENGE 2.

Taking advantage of international networks to highlight mountain climate change vulnerability

Mountain areas do not tend to be large greenhouse gas emitters, however they receive regional impacts that are often irreversible. According to the European Commission, the European Union, Norway, and Switzerland have towns located in mountain areas that cover approximately 1,900,000 km² [nearly 40.6 % of the total landmass]. These mountain areas are home to 94.3 million people, which represents 19.1% of the total population of the countries analysed.

The EU's efforts to finance adaptation strategies and measures has been concentrated largely on European Economic Area cities. Nevertheless, mountain areas are important ecosystem service providers that society needs in order to guarantee the quality of life of local populations and those of major cities located downstream.

In this sense, the most effective way of raising awareness on the particular vulnerability of the Pyrenees region is to actively participate in European and international research networks on mountain areas and climate change, as well as cross-border organisation networks such as the Carpathian Convention and the Alpine Convention.

LINES OF ACTION

- 2.1. Taking part in national and international mountain area climate change networks.
- 2.2. Promoting synergies and collaborations with European and cross-border organisations from other mountain areas.

CHALLENGE 3:

Ensuring the resilient management of Pyrenean rivers and good water quality, particularly at river headwaters

The Pyrenees play a fundamental role in the provision of water resources to territories located on both sides of the range. The Pyrenees are the source of major rivers such as the Ebro, the Adour, and the Garonne, where a large part of their subterranean and surface flows used downstream.

An analysis of the instrumental series of flows shows an overall trend toward decreased average annual flows in recent decades. This drop can only be due in part to climate change, although the effect of changes in the use of land and plants is also important, particularly on the southern side of the range.

Regardless of the origin, the models appear to indicate that this trend will bring with it a change in future water resource availability. These water cycle changes could affect many current uses (agriculture irrigation and food production, hydroelectric energy production, industry, and potable water) not only for Pyrenees region residents, but also a much wider area affecting millions of people.

In order to ensure the resilient management of the waterways that guarantee the good quality and sufficient quantity of this fundamental resource for different uses, it is necessary to improve awareness as to the state and availability of water resources at their source based on Pyrenean massif-scale studies, as well as promoting integrated management measures that take the entire territory into account, particularly the most vulnerable sectors.

LINES OF ACTION

- 3.1. Evaluating the availability of water resources based on climate change scenarios and demand models on a regional level.
- 3.2. Promoting water supply and demand management in the most vulnerable sectors.



CHALLENGE 4.

Tackling the progressive loss of biodiversity and landscapes due to global and climate changes

Pyrenean biodiversity is comprised of ecosystems that are characterised by a great richness of endemic species with reduced distribution ranges, specific habitat requirements, and limited dispersal capacities, which make them particularly vulnerable to climate condition variations. Climate change and man-made impacts favour a loss in biodiversity through physiological and phenological changes to plants and animals, population distribution changes, and the increased risk of alien species propagation. The movement of animals and plants in search of appropriate climate conditions will influence the connectivity of the Pyrenees region's natural spaces and some protected areas that are now interconnected, with certain species being left isolated if new ecological corridors are not designed or reinforced.

Climate change may also cause significant changes to the landscape derived from the accelerated deterioration process of certain iconic high-altitude mountain landscape elements, such as bogs, glaciers, and glacial lakes, among others.

In order to face this progressive loss of biodiversity, it is first necessary to improve knowledge on the impacts that climate change has on habitats and sentinel species, particularly through monitoring and surveillance networks. It is also necessary to act to promote adaptive landscape management, as well as habitat and species conservation, improvement, and restoration, in particular those most vulnerable, including connectivity between sensitive populations and habitats.

LINES OF ACTION

- 4.1. Promoting management that is adaptable to the landscape, and active management of the protected natural space system.
- 4.2. Improving knowledge on climate change's current and forecast impacts on particularly sensitive Pyrenean species and habitats.
- 4.3. Protecting biodiversity and the most vulnerable species through conservation, improving and restoring their habitats.

CHALLENGE 5:

Anticipating emerging diseases and infestations

The interactions between plants and their natural enemies are influenced by climate conditions and, in large part, temperatures. Possible changes to the distribution area of certain crops and their increased vulnerability due to climate stress could cause changes to the distribution and propagation patterns of the most common diseases, as well as an increased risk of propagating emerging diseases and those that are rare at present.

Climate change also favours the establishment of new alien species in the Pyrenees region, facilitating their transport and later settling through the establishment of favourable climate conditions. Given that invasive alien species tend to be opportunistic and generalist, they tend to adapt better than most native species to rapid climate changes.

Anticipating the problems associated with invasive alien species, and the appearance of diseases and infestations must start with identifying and monitoring them, strengthening surveillance systems, and cross-border alert systems. Based on this knowledge, prevention, monitoring, control, and management plans must be strengthened and coordinated.

LINES OF ACTION

- 5.1. Strengthening and coordinating infestations, invasive alien species, and vulnerable Pyrenean species management, control, monitoring, and prevention plans.
- 5.2. Strengthening improvements to cross-border emerging disease, invasive species, and infestation alert systems.

CHALLENGE 6:

Facing climate extremes to preserve ecosystem services

Pyrenean ecosystem alteration puts at risk a multitude of valuable and fundamental assets and services that they provide, such as sensitive ecosystem and species preservation, ecological continuity maintenance, scientific and educational values, and the territory's tourism appeal. Pyrenean forests, mountain pastures, lakes, and bogs are ecosystems that provide numerous services. Soils also play a particularly important role in the production of ecosystem services, and changes in land use can have grave consequences: biodiversity loss and soil erosion, flood and mudslide risk, increased greenhouse gas emissions, depletion of the soil's organic carbon, etc.

In order to ensure the provision of these services, it is necessary to preserve the ecosystems that they provide, and to do so it is necessary to protect them from climate extremes such as droughts, heatwaves, and intense rainfall, among others, promoting multi-functional and resilient management of these spaces. Preserved ecosystems will then allow for the application of nature-based solutions meant to take advantage of ecosystem services, like reducing natural risk of floods, landslides, soil erosion, and forest fires, while maintaining them at the same time.

LINES OF ACTION

- 6.1. Promoting adaptable management of Pyrenean soils and natural ecosystems in favour of their multi-functionality, improved resilience against climate extremes, and the ecosystem services they provide.
- 6.2. Developing tools and methodologies for the management and prevention of climate and natural hazards on a Pyrenean scale through the use of nature-based solutions (Nbs).



CHALLENGE 7.

Maintaining tourism appeal while taking into account irreversible changes to the landscape, among others

For most tourists, the destination's climate conditions are a determining factor when it comes to planning a trip. In fact, it is highly likely that expected increases in climate variability in the coming decades will lead to changes in current tourism destination selections, with positive and negative repercussions on the tourism flow dynamics on both sides of the Pyrenean massif.

Greater variability in snow cover thickness and duration is already posing a challenge for some ski resorts, and could be a challenge for others that will have to adapt in order to guarantee the sustainability of their activity. Climate change is also causing environmental alterations with negative effects on certain Pyrenees region landscapes and environments.

This could have a negative impact on certain Pyrenean landscapes and environments, thereby reducing their tourism appeal. Aspects such as the presence or absence of certain emblematic flora and fauna species, ecosystem quality, and the state of iconic natural formation such as glaciers or frozen caves are being affected by climate change, which involves a loss of tourism appeal.

On the other hand, increased temperatures and the appearance of milder temperatures in spring and autumn, together with increased minimum temperatures, could have a positive impact on mountain tourism as the summer season is extended, favouring the selection of relatively cool mountain destinations instead of beaches and sunny areas.

In these conditions, deseasonalising the current offer appears necessary in order to maintain the range's tourism appeal, adapting tourism development models towards a reduction in snow-related activities, and developing emerging opportunities in nature and mountain tourism. It is also important to promote sustainable tourism offerings that reduce the environmental pressure of tourism activities, taking into account tourism infrastructure exposure to different natural events and guaranteeing individual safety against risks that could be aggravated by climate change (floods, heatwaves, water and air quality deterioration, and permafrost melt).

LINES OF ACTION

- 7.1. Deseasonalising the current tourism product offer.
- 7.2. Promoting sustainable tourism offerings.



CHALLENGE 8.

Ensuring the performance and viability of the sectors at higher climate risk (agriculture, pastoralism, and the forestry sector)

The adaptation of agriculture and pastoralism to climate change is an important question for Pyrenean territories. Agriculture is at once an economic activity sector and a pull factor that helps supply local and national markets with quality, local products while maintaining mountain landscapes and local and patrimonial activities. Scientific studies describing the impact of climate change on agriculture and shepherding point to the impacts in terms of plant phenology, with the subsequent changes to crop calendars; the increase in the activity of so-called parasite animals that affect livestock; the expansion of certain infestations; flock behavioural changes, including during mountain grazing periods (the animals search for cooler conditions, climbing to greater altitudes); water stress caused by a lack of water and high temperatures; the decreased performance of natural grasses and forage crops. While there are uncertainties as to the exact magnitude of these impacts, it is likely that climate change will pose risks in the coming decades in addition to the sector's current socio-economic problems.

Forests play an active role in the mitigation of climate change as carbon sinks and deposits, as well as a source of renewable energy and materials through sustainable forest management. Nevertheless, Pyrenean forests are subject to diverse climate change impacts that put the functions and services that these spaces provide at risk. Climate change impacts species' demographic processes (growth, mortality, reproduction), thereby modifying the structure of the masses and their diversity. Droughts are the dominant factor affecting forests below 1000 m in altitude. They compromise regeneration abilities and/or cause a decline in some tree species (decay). Most forecasts anticipate an acceleration in the change, and greater forest vulnerability from 2050.

Nevertheless, there is still uncertainty regarding climate projections, particularly precipitation volumes and their annual distribution, the importance of extreme events, and the vegetation's response to these changes. The complex interactions between trees, other living beings, and the abiotic environment under the influence of climate change are still largely unknown. Therefore, identifying and better understanding the effects of climate change on our forests is necessary in order to take the most appropriate adaptation and mitigation measures.

In order to ensure the maintenance and viability of economic sectors, farming and grazing, and forest management in these conditions, it is necessary to improve knowledge and reduce uncertainty regarding major risks, possible negative effects, and future pressure on forests and farming and grazing ecosystems in the Pyrenees region. Acting to limit these activities being abandoned and encouraging their maintenance is also essential. This involves supporting and promoting the diversification and modernisation of agricultural, pastoral, and forestry activities facing global and climate change challenges.

LINES OF ACTION

- 8.1. Strengthening socio-economic activities associated with mountains, based on valuing ecosystems and species (eco-tourism, forest management, recollection, etc.), favouring their adaptation to climate change.
- 8.2. Developing knowledge on the evolution of natural hazards and the impacts of climate change on economic activities, infrastructure, and services.
- 8.3. Encouraging the maintenance of traditional agricultural, pastoral, and forest activities in the mountain areas, guaranteeing their role in sustainable forest management and greater resilience.

CHALLENGE 9.

Taking advantage of emerging mountain economy opportunities (renewable and efficient energy, biomass, the circular economy, new crops)

A mountain economy that is adapted to climate change must favour the development of emerging opportunities that mainly respond to the needs of Pyrenees region populations, both residents and tourists. This economy should allow for the Pyrenees region's self-sufficiency, an important concept that has been repeated by many stakeholders during the participatory process.

This economy must be based on implementing actions that promote local food, the energy that satisfies current and future local needs, the use of local wood in construction, the circular economy in general, and supporting emerging local industries (wool, plants, etc.).

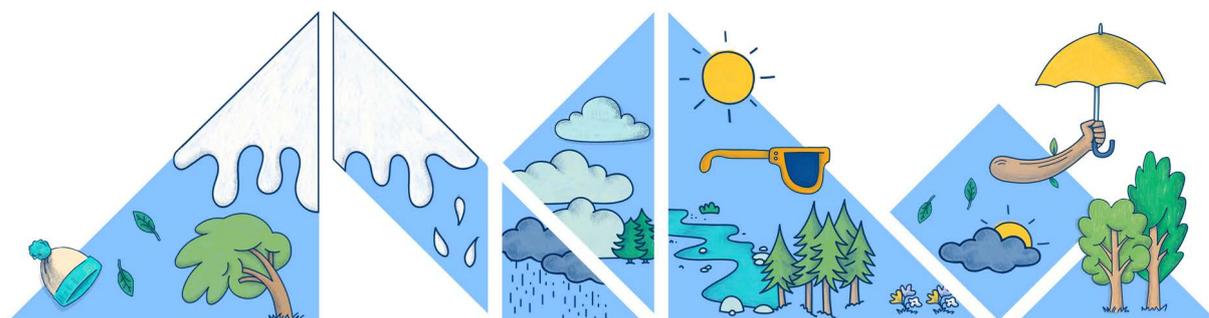
From an energy perspective, the increased variability of precipitation distribution across space and time, reduced river flows, and changes to thawing calendars could have a negative impact on the Pyrenees region's hydroelectric production capabilities. In terms of demand, we can foresee that climate change will affect its structure throughout the seasons: an increase in temperatures could reduce energy demand for heating in winter and autumn. However, we can foresee a significant increase in average energy demand in summer to satisfy the growing energy needs for air-conditioning in homes due to increasingly hot summers and more frequent and intense heatwaves, as well as supplies to the mobility sector. In this context, it seems important to analyse the real energy needs of the entire Pyrenean massif in terms of the reflection on Pyrenean self-sufficiency and the decentralisation of production. Once the needs are analysed, encouraging rational energy use in all socio-economic sectors will always be a priority, and renewable energy source diversification must be considered.

In terms of emerging opportunities related to local production, this would involve promoting the quality of local, regional, and organic products over those from intensive production models. An important aspect will be the circular management of forest activities, and the promotion of producer-to-consumer wood to mitigate climate change, favouring carbon capture, and minimising energy and transportation costs.

10. <https://www.cairn.info/revue-sciences-eaux-et-territoires-2019-2-age-38.html>

LINES OF ACTION

- 9.1. Promoting actions to encourage renewable energies.
- 9.2. Promoting circular and local production activities, while also encouraging green employment production.



CHALLENGE 10.

Ensuring optimal levels of preparation, prevention, and training for climate extremes, emerging diseases, and natural hazards

Natural hazards typical of mountain areas unfold as a result of weather events (intense or prolonged rain or snow, freezing/thawing cycles, high temperatures, etc.), and will affect the territories that are exposed to them, including where socio-economic activities are located. The combination of natural events (type, intensity, return period), exposure, and the vulnerability of the affected socio-economic systems (habitats, roads and other urban infrastructure, land use, economic activities, etc.) determines the natural level of risk (sinking, mudslides, landslides, floods, etc.). These natural events threaten the safety of the territory's residents and tourists, as well as the integrity of the landscape that is sometimes changed irreversibly. Although the Pyrenees region has not been affected by major fires to date due to the relatively high moisture of combustibles, today they are increasingly exposed to this risk.

In order to guarantee optimal levels of preparation for new changing scenarios, we need to promote training measures and create a space for exchanges between experts. At the same time, promoting a greater culture of risk in society is fundamental so that mountain risks can be perceived and how they can be affected by climate change is seen. On a global level, climate change influences the propagation and appearance of new infestations through various factors: new environmental and climate conditions that will create spaces ripe for the development of new harmful and/or invasive species that could reinforce their ability to develop and expand, and lastly the greater frequency and intensity of the states of abiotic stress that would make crops more sensitive and vulnerable to disease-causing organisms. The development of these diseases affects livestock health, their well-being, their reproductive output, and their resilience against diseases in general. On the other hand, climate change could also directly or indirectly lead to the appearance of new zoonotic diseases.

In order to prevent the propagation and appearance of new diseases, or the expansion of those that already exist, it is essential that we fully understand the climate factors that determine the distribution of these pathogens and their vectors. Likewise, we must reinforce coordination between the different territories' various disease monitoring initiatives and agencies. In this sense, cooperation is fundamental, and coordination between existing initiatives is key.

LINES OF ACTION

- 10.1. Reducing Pyrenean infrastructure vulnerability to geological and natural hazards, and climate extremes (green infrastructure, energy, housing, roads, and transport).
- 10.2. Strengthening cross-border health initiatives and systems monitoring pathogens, emerging diseases, and climate extremes.
- 10.3. Promoting cross-border professional training actions on climate change, involving all sectors of the population.

CHALLENGE 11.

Taking advantage of emerging Pyrenees region opportunities in the face of a demographic challenge

From a socio-economic and demographic perspective, the Pyrenees region is a heterogeneous bioregion. Although in no way uniform, in recent decades the Pyrenees region has experienced a phenomenon of depopulation and progressive abandonment of agricultural, forestry, and livestock activities. This phenomenon has implications from a landscape and socio-economic perspective, which generally brings with it the reduced resilience of bio-physical systems (loss of mosaic landscape, reforestation, loss of biodiversity in pastures), and socio-economic systems (a lack of generational renewal, seasonal labour availability, etc.).

However, adaptation to climate change to improve resilience may offer opportunities both in restarting traditional agroforestry activities to manage landscape resilience, and the diversification of socio-economic activities like tourism and the promotion of renewable energy systems.

At the same time, other phenomena associated with global change, such as the coronavirus crisis, have changed certain demographic dynamics, favouring a return to rural and mountain areas thanks to the possibility of working remotely.

All these elements point to complex future scenarios in which it will be necessary to produce more resilient urban structures that are adapted to possible demographic and social changes. At the same time, the energy transition towards diversified renewable energy production models, and building refurbishment to improve their energy efficiency, are opening a window of employment opportunities that may contribute to a stable Pyrenees region population.

LINES OF ACTION

- 11.1. Promoting forms of land use in the Pyrenees territory that are compatible with conservation and can mitigate the effects of climate change.
- 11.2. Promoting an urban Pyrenean structure that is resilient to climate change.
- 11.3. Promoting rural and urban environment energy efficiency improvements, creating job opportunities.

CHALLENGE 12.

Reaching optimal levels of public environmental education and awareness on climate change

Mitigating and adapting to climate change is not only a challenge, it can also be understood as an opportunity to change lifestyles, allowing for the development of a more fair and balanced world, where models of progress reference solidarity, equality, cooperation, participation, respect for nature, and sustainability in the use of natural resources.

In this context, environmental education becomes a powerful tool to raise awareness on the need for a change of model, that in turn translates into lifestyle habit changes towards ones that are more sustainable and, as such, healthier.

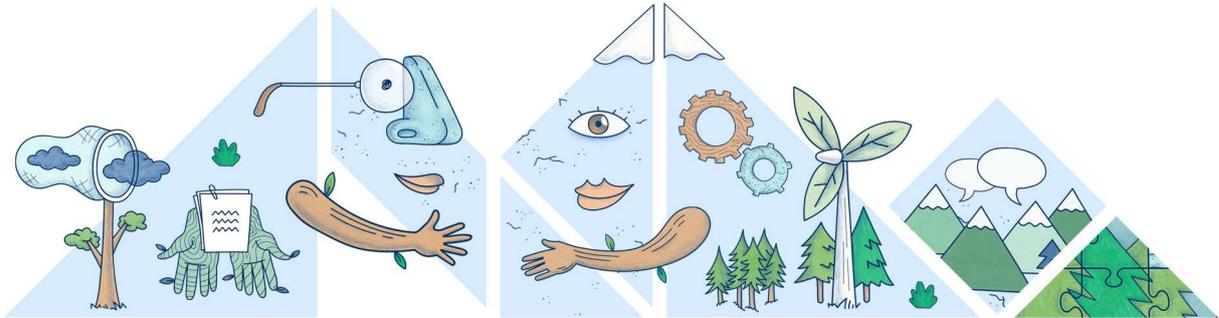
Among the goals to reach in the area of environmental education in the Pyrenees region, developing public awareness is essential in order to contribute to the reduction of greenhouse gas emissions, better prepare for future climate scenarios we will have to adapt to and, in general, favour a change in the development model towards one that is more supportive and respectful of the environment.

There are many entities and players in the Pyrenees region that work in the field of environmental education. There are also many citizen science initiatives whose aim is to involve the general public in scientific research activities where citizens actively contribute.

In order to raise public awareness, it will be necessary to coordinate and maintain, or even develop different environmental education networks present in the area, strengthen existing Pyrenean citizen science initiatives, extending them throughout the region, and offer a space for exchanges and dialogue between scientists and environmental education professionals to adapt informative materials to the specific characteristics of each territory and their different needs.

LINES OF ACTION

- 12.1. Promoting and maintaining initiatives to involve the public in awareness-raising actions and research programmes.
- 12.2. Promoting actions and producing components for outreach, environmental education, and Pyrenean area awareness-raising directed at a broad target audience.



CHALLENGE 13.

Maintaining and adapting the OPCC Governance system

The Pyrenean Climate Change Observatory is the Pyrenees region cross-border cooperation initiative led by the Pyrenean Work Community since 2010. Their governance is based on various participation bodies comprised of representatives of the CTP's members, scientific organisations, and representatives from the territories.

Within the framework of the Pyrenean Climate Change Strategy, the current bodies of governance must be strengthened and adapted, integrating new players with different perspectives and initiatives. The new governance must be inclusive and robust in order to face the challenge of applying the strategy with as much participation as possible from stakeholders across the region, particularly the private or business sector.

On the other hand, as a European and international benchmark entity, the OPCC must ensure proper internal management with a workforce that coordinates and serves as a bridge between the Pyrenean community and the international community.

LINES OF ACTION

- 13.1. Ensuring horizontal coordination between regional climate policies in the Pyrenees region.
- 13.2. Ensuring vertical coordination with European and state climate policies, influencing the implementation of European climate policies in mountain areas.
- 13.3. Ensuring PCCS coordination and management.



CHALLENGE 14.

Fostering more resilient systems of operations and organisation

Climate change is a cross-cutting issue for all socio-economic and natural systems, and requires new forms of governance and interaction. The Pyrenees region is a vast territory where numerous sectoral, administrative, and public structures overlap. The PCCS must be capable of integrating all perspectives, completing effective transfers and, at the same time, optimising resources to make governance functional.

The challenge is ensuring the flow of information between the various nodes, and maintaining a balance despite the diversity and types of players and organisations that represent the socio-economic sectors, the different layers of public administration and, lastly, the territories of the CTP.

In addition, solid governance of the strategy itself must be ensured, with a time horizon of 2050, but sufficiently flexible and dynamic to adapt to the new situations of the future, and also take advantage of the synergies with other Pyrenean territory initiatives and networks.

LINES OF ACTION

- 14.1. Energizing and contributing to dialogue with the territory's sectoral actors: forestry structures, business and public associations, CC scientific committees and networks, natural park networks, etc.
- 14.2. Strengthening and assisting local entities in achieving European Green Deal goals.



CHALLENGE 15.

Increasing the visibility of the Pyrenees in terms of climate change and participating in European and international networks

Climate change is a world-wide threat, and sharing information on a global scale is necessary to understand the situation in the Pyrenees region.

There are European and international networks dedicated to the study of the climate and to defending mountain areas, and interaction with these networks presents an opportunity for enhancing the Pyrenees region's visibility. We have the challenge of sharing and unifying the voice of mountain regions in Europe and around the world in order to lay bare that these regions are particularly vulnerable to climate change.

Today it is more important than ever to work together in networks with European and international initiatives, sharing resources and observation methodologies, and creating learning communities to carry out climate change adaptation actions.

Scientific evidence shows that mountain areas are particularly sensitive to the effects of climate change, and it is necessary to take advantage of synergies with networks that already act in the field of climate change and mountains, establishing agreements with international institutions and organisations and, at the same time, promoting international initiatives from the Pyrenees region.

LINES OF ACTION

- 15.1. Disseminating the Observatory's activities and project advancement within the CTP's territory so that the population and players are made aware.
- 15.2. Actively participating in international networks and projects with other mountain areas.
- 15.3. Establishing relationships of mutual interest with players and European institutions connected to our activities.
- 15.4. Strengthening the geoportal as a visibility tool.

THE CONTRIBUTION OF CHALLENGES AND LINES OF ACTION TO THE STRATEGIC GOALS AND THE STRATEGY'S FOUNDING PRINCIPLES

The following tables show how the lines of action contribute to the PCCS's strategic goals, and the founding principles on which they are based.

SYSTEM	CHALLENGES	LINES OF ACTION
CLIMATE	1. Having updated, processed climate information that is accessible for all Pyrenees region actors	<p>1.1. Promoting innovation and improving and transferring scientific knowledge</p> <hr/> <p>1.2. Updating Pyrenees-scale climate databases and making them available to the territories</p> <hr/> <p>1.3. Updating the calculation of key sectoral climate change indicators on a mountain-range level</p> <hr/> <p>1.4. Providing continuity to cross-border climate variability mediation and monitoring systems, introducing innovative technologies</p>
	2. Taking advantage of international networks to increase the visibility of mountain climate change vulnerability	<p>2.1. Taking part in national and international mountain area climate change networks</p> <hr/> <p>2.2. Promoting synergies and collaborations with European and cross-border organisations from other mountain areas</p>

**STRATEGIC
GOALS**

**FOUNDING
PRINCIPLES**

SG1

1, 2 and 3

SG1

2

SG1

1, 2 and 3

SG1

1, 2 and 3

SG5, SG1

1 and 5

SG5, SG1

1, 4 and 5

SYSTEM

CHALLENGES

LINES OF ACTION

RESILIENT NATURAL SPACES

3. Ensuring the resilient management of Pyrenean rivers and good water quality, particularly at river headwaters

3.1 Evaluating the availability of water resources based on climate change scenarios and demand models on a regional level

3.2. Promoting water supply and demand management in the most vulnerable sectors

4. Tackling the progressive loss of biodiversity and landscapes due to global and climate changes

4.1. Promoting management that is adaptable to the landscape, and active management of the protected natural space system

4.2. Improving knowledge on climate change's current and forecast impacts on particularly sensitive Pyrenean species and habitats

4.3 Protecting biodiversity and the most vulnerable species through conservation, improving and restoring their habitats

5. Anticipating emerging diseases and infestations

5.1. Strengthening and coordinating infestations, invasive alien species, and vulnerable Pyrenean species management, control, monitoring, and prevention plans

5.2. Strengthening improvements to cross-border emerging disease, invasive species, and infestation alert systems

6. Facing climate extremes to preserve ecosystem services

6.1. Promoting adaptable management of Pyrenean soils and natural ecosystems in favour of their multi-functionality, improved resilience against climate extremes, and the ecosystem services they provide

6.2. Developing tools and methodologies for the management and prevention of climate and natural hazards on a Pyrenean scale through the use of nature-based solutions (NbS)

STRATEGIC GOALS

FOUNDING PRINCIPLES

SG1, SG2

1 and 2

SG1, SG2, SG3

1, 2 and 3

SG2,SG4

1, 2, 3 and 4

SG1, SG2, SG4

1, 2 and 3

SG2,SG4

1, 2 and 4

SG2, SG4

1, 3 and 4

SG2, SG4

1, 3 and 4

SG2, SG4

1, 2 and 3

SG1, SG2, SG4

1, 2 and 3

SYSTEM

CHALLENGES

LINES OF ACTION

ADAPTED MOUNTAIN ECONOMY

7. Maintaining the tourism draw of the Pyrenees region, taking into account irreversible changes to the landscape, among others

7.1. Deseasonalising the current tourism product offer

7.2. Promoting sustainable tourism offerings

8. Ensuring the performance and viability of the sectors at higher climate risk (agriculture, pastoralism, and the forestry sector)

8.1. Strengthening socio-economic activities associated with mountains, based on valuing ecosystems and species (eco-tourism, forest management, recollection, etc.), favouring their adaptation to climate change

8.2. Developing knowledge on the evolution of natural hazards and the impacts of climate change on economic activities, infrastructure, and services.

8.3. Encouraging the maintenance of traditional agricultural, pastoral, and forest activities in the mountain areas, guaranteeing their role in sustainable forest management and greater resilience

9. Taking advantage of emerging mountain economy opportunities (renewable and efficient energy, biomass, the circular economy, new crops)

9.1. Promoting actions to encourage renewable energies

9.2. Promoting circular and local production activities, while also encouraging green employment production

**STRATEGIC
GOALS**

**FOUNDING
PRINCIPLES**

SG3, SG4

1, 3 and 4

SG3, SG4

1, 3 and 4

SG3

1, 3 and 4

SG1, SG3, SG4

1, 2 and 3

SG3, SG4

1 and 4

SG3

3 and 4

SG3

3 and 4

SYSTEM

CHALLENGES

LINES OF ACTION

POPULATION AND TERRITORY

10. Ensuring optimal levels of preparation, Prevention, and training for climate extremes, emerging diseases, and natural hazards.

10.1. Reducing Pyrenean infrastructure vulnerability to geological and natural hazards, and climate extremes (green infrastructure, energy, housing, roads, and transport)

10.2. Strengthening cross-border health initiatives and systems monitoring pathogens, emerging diseases, and climate extremes

10.3 Promoting cross-border professional training actions on climate change, involving all sectors of the population

11. Taking advantage of emerging Pyrenees region opportunities in the face of a demographic challenge

11.1. Promoting forms of land use in the Pyrenees territory that are compatible with conservation and can mitigate the effects of climate change

11.2. Promoting an urban Pyrenean structure that is resilient to climate change

11.3 Promoting rural and urban environment energy efficiency improvements, creating job opportunities

12. Reaching optimal levels of public environmental education and awareness on climate change

12.1. Promoting and maintaining initiatives to involve the public in awareness-raising actions and research programmes

12.2. Promoting actions and producing components for outreach, environmental education, and Pyrenean area awareness-raising directed at a broad target audience

**STRATEGIC
GOALS**

**PRINCIPLES
FOUNDERS**

SG4

1 and 4

SG1, SG2, SG4

1, 3 and 4

SG3, SG4

1, 2 and 4

SG3, SG4

1 and 3

SG1, SG4

3 and 4

SG3, SG4

3 and 4

SG5

1, 2 and 3

SG5

1, 2 and 3

SYSTEM

CHALLENGES

LINES OF ACTION

GOVERNANCE

13. Maintaining and adapting OPCC governance

13.1. Ensuring horizontal coordination between regional climate policies in the Pyrenees region

13.2. Ensuring vertical coordination with European and state climate policies, influencing the implementation of European climate policies in mountain areas

13.3. Ensuring PCCS coordination and management

14. Fostering more resilient systems of operations and organisation

14.1 Coordinating and encouraging dialogue with the territory's sectoral stakeholders: forestry structures, business and public associations, CC scientific committees and networks, natural park networks, etc

14.2. Strengthening and assisting local entities in achieving European Green Deal goals

15. Increasing the visibility of the Pyrenees in terms of climate change and participating in European and international networks

15.1. Disseminating the Observatory's activities and project advancement within the CTP's territory so that the population and players are made aware

15.2. Actively participating in international networks and projects with other mountain areas

15.3. Establishing relationships of mutual interest with players and European institutions connected to our activities

15.4. Strengthening the geoportal as a visibility tool

**STRATEGIC
GOALS**

**FOUNDING
PRINCIPLES**

SG5

1

SG5

1 and 5

SG1, SG2, SG3, SG4, SG5

1 and 4

SG4, SG5

1, 2 and 4

SG4, SG5

1, 3 and 4

SG5

3 and 2

SG5

1, 2 and 5

SG5

2 and 5

SG5, SG1

1, 2 and 5

PYRENEAN CLIMATE CHANGE STRATEGY GOVERNANCE

A strategy like the PCCS that is transnational and inter-sectoral and using a systematic focus, has intrinsic organisational complexity that can only be addressed through the lens of social innovation, promoting participation, and driving multi-level connections.

In order to guarantee its proper application, the aim of this section is to present how, as the main promoter of this new strategy, the CTP's OPCC will organise the necessary system of relationships and connections between players, territories, and decision-makers on different administrative levels.

Since its creation, the OPCC has shared principles of good governance, for which reason it proposes a slight evolution on the basis of its current governance in order to integrate and guarantee greater participation from all Pyrenees region stakeholders necessary to effectively apply the PCCS. The changes proposed are the fruit of work carried out within the framework of the consultation and participation process that resulted in this strategy. During the PCCS's first phase of development, the different stakeholder groups were identified first.

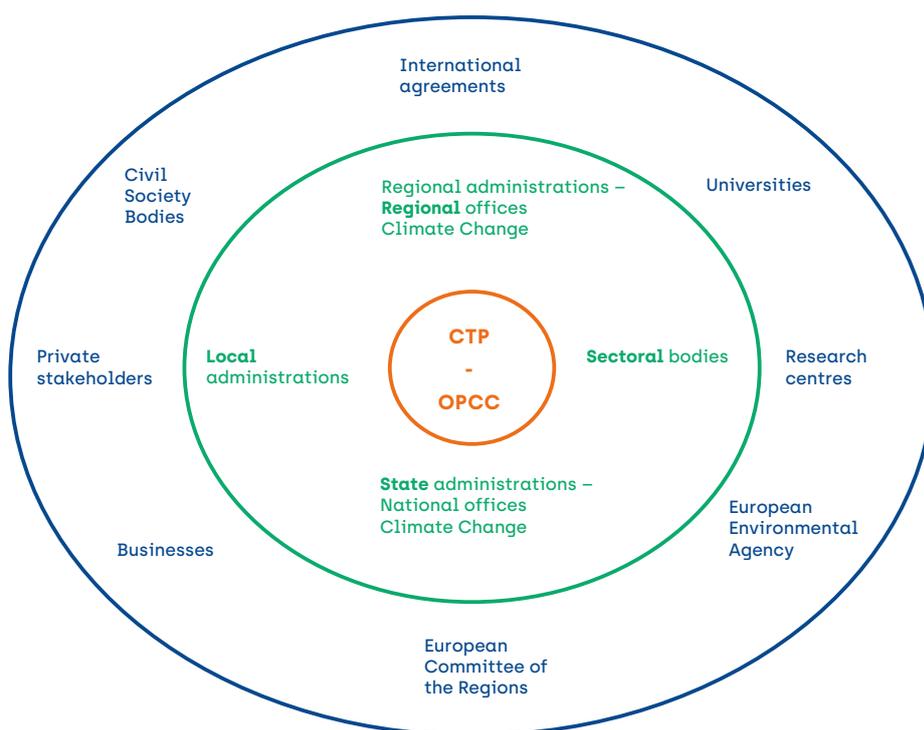


Figure n°15: Parties interested in the PCCS's governance.

In addition to defining the different bodies that contribute to governance, it is also essential to properly define the functions and role of each in the strategy's four substantial roll-out phases: application, communication, financing, monitoring, and decision-making.

	IMPLEMENTATION	COMMUNICATION	FINANCING	MONITORING	DECISION
Civil Society Bodies					
Universities and research centres					
Regional administration and Andorra					
Companies and private players					
Sectoral organisations					
States					
Local organisations					

Table 2: Participation of the parties interested in the different phases of the PCCS

In order to guarantee the effective inclusion of all these players and guarantee that they can perform the functions entrusted to them, a proposal was made to maintain the current OPCC organisation with a few innovations. The governance system will allow all stakeholders to be informed at all times, thereby contributing to the decisions that are made on the PCCS's development and application.

As it has been up to now, the decision-making body will continue being the CTP's Executive Committee, where the Principality of Andorra and the regional administrations are present. The other existing committees are also maintained (technical, advisory, and coordination), and a proposal was made to create a new participation and monitoring body (the PCCS monitoring board).

The following presents the key functions of the various bodies that will constitute the PCCS's governance for the OPCC:

CTP Executive Committee

The decision-making body of the Working Community of the Pyrenees that already exists. This committee brings together the designated representatives from each of CTP's seven member territories.

It is comprised of two representatives from each CTP territory. It has direction and decision-making functions:

- Approving the OPCC's financial and technical resources and means.
- Approving the joint management and preparation of the common actions, particularly within the framework of European programmes and projects.

Technical Committee of Climate Change Referents

This is the technical body that assists the Executive Committee and the Pyrenean Climate Change Observatory's technical team, which already currently exists. Their activity is coordinated by the OPCC's technical team..

It is comprised of the designated representatives from the CTP's seven territories with competencies in the subject of climate change.

Their function within the PCCS involves guidance, technical validation, and establishing priorities:

- Technical validation and supervision of the OPCC's actions,
- Guaranteeing horizontal coordination with regional strategies,
- Acting in their administration and territory as a liaison with the OPCC,
- Being active in the communication and dissemination of the OPCC's activities in their territory,
- Acting as a point of contact in terms of encouraging and coordinating local players,
- Informing the OPCC as to CC initiatives of interest in their territory,
- Maintaining the flow of communication with the Executive Committee regarding OPCC initiatives

Advisory Committee for the Technical Committee

With an advisory and orientation consultation function, as its name indicates, it must guarantee the technical and scientific rigour of the orientations and actions that the OPCC undertakes. Currently, this body is already in the OPCC's governance system, although its reorganisation is being considered in order to achieve improved dynamics.

It is comprised of the Pyrenean massif's scientific community, public sector organisation representatives, representatives from other European-level mountain networks, and one representative from the European Environment Agency. At the Executive Committee's request, it may participate in their meetings.

Its specific PCCS functions are:

SCIENTIFIC COMMUNITY

- Sharing current and future Pyrenees region research orientations for CC
- Acting as OPCC ambassadors, presenting reference documents/actions such as the climate bulletin
- Supervising and participating in OPCC monitoring report chapters on the impact of CC in the Pyrenees region

PUBLIC SECTOR ORGANISATION REPRESENTATIVES (AGENCIES)

- Advising on the needs identified in their respective areas of work.
- Guaranteeing vertical coordination with the climate change strategies.
- Sharing background data and information that is relevant to the OPCC.
- Acting as OPCC ambassadors, presenting reference documents/actions in the climate bulletin

REPRESENTATIVES FROM OTHER MOUNTAIN AREA NETWORKS AND THE EUROPEAN ENVIRONMENT AGENCY AS OBSERVERS

- Sharing work and areas of research.
- Participating in joint initiatives that help raise awareness on mountain area problems and climate change

In order to properly stimulate this organisation, **it could be organised around thematic groups** according to research needs agenda, allowing for a better application of this new strategy..

Coordination Committee

This organisation is of the greatest interest for guaranteeing coordination and promoting synergies in the execution of actions and projects developed by the PCCS. This organisation is currently operating. It is comprised of:

- Pyrenean entities that act as project coordinators and/or leaders with the PCCS,
- Representatives from the joint secretariat of the POCTEFA cross-border cooperation programme for its climate change pillar,
- Representatives from the public organisations responsible for climate change on a state level that provide financial aid and/or actions or projects.

Its functions include coordinating the PCCS's execution through the various projects and initiatives.

The coordination committee will be organised and its dynamic will be based on the programming and planning of the projects under way.

The PCCS's Monitoring Board

This organisation is created specifically for the PCCS with the aim of guaranteeing territorial participation and transparency throughout the PCCS's development.

As its name indicates, this body will be responsible for monitoring the PCCS.

It was proposed during the participation process to respond to the expectations expressed by the PCCS's participants and stakeholders. This governance body will include socio-economic agents from the areas of local authority and civil society that are not now represented in the OPCC's governance. It will be a space for meeting and connecting with territorial players and individuals included in the various committees. This monitoring table will report back on the strategy's development, and will share information and generate a two-way exchange from which proposals to consider may arise.

In particular, this table will include entities that represent networks of players (link entities), guaranteeing connection with a wider range of the territory's entities (scientific networks, natural park networks, social and environmental association networks, local entity networks and economic sectors, volunteer networks, environmental education, and citizen science).

It will be constituted to reflect and integrate the diversity of players, competencies, and themes present in the Pyrenees region in the most equitable way possible. Each organisation that is asked to take part in this Monitoring Board will nominate and appoint their representatives.

The members of the Technical Committee and the Advisory Committee, as well as members of the Coordination Committee will also be a part of this Monitoring Board if they so choose. In order to guarantee the connection with these organisations, at least one representative from each of these committees will be proposed to participate in the Monitoring Board.

It will be a flexible organisation that is able to adapt to any changes necessary in the coming years, according to the "living" and adaptable governance principle. Its composition and operations will be regulated in a simple way so as not to add an additional level of governance that could complicate the PCCS's application. **The most meaningful expression of this body's participatory dynamics will be a biennial conference that will be worked on beforehand by commissions or working groups.**

The Board will be informed as to the PCCS's implementation progress through information from the PCCS's other governing bodies: the Coordination Committee, the Technical Committee Referents, and the Advisory Committee.

Based on this information, it will have two main functions, which will be transparency and public participation in the execution phase:

- Ensuring the proper implementation of the PCCS in accordance with its goals, schedules, and detected needs
- Maintaining a two-way connection between the Pyrenean territory's entities and the PCCS
- Debating proposals to improve the PCCS's implementation
- Identifying initiatives and synergistic projects

Schematic representation of governance

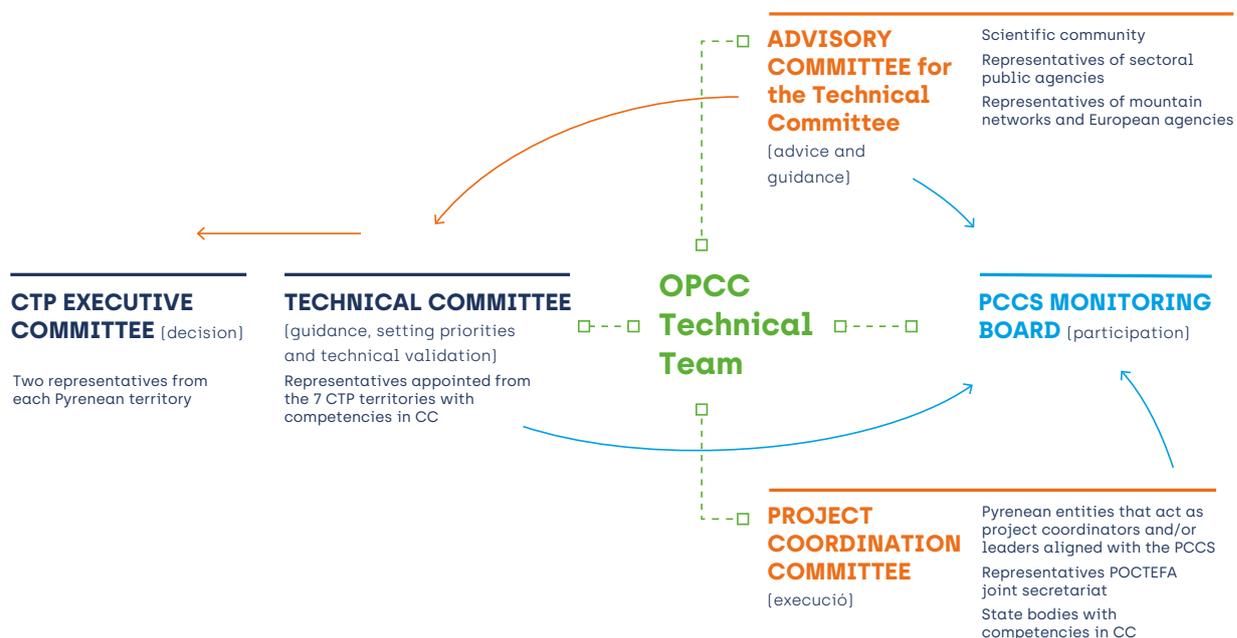


Figure 16: Ad hoc structures to guarantee the PCCS's proper function.



Figure 17: Composition of the PCCS's Monitoring Committee.

Pyrenees Climate Change Strategy:

A climate action cooperation strategy

«ANNEX»



INTRODUCTION

Between 1 and 3 October 2021, the Trans-Pyrenean Youth Forum was held in El Pueyo de Jaca (Huesca) in the framework of the Pyrenean Youth project with co-funding from the Erasmus+ programme. This event was attended by 63 young people from the 7 territories that are part of the Pyrenees. During the forum, the concern of young people about climate change was highlighted. This document contains the ideas that emerged from the participatory workshop held during the forum.

The representation of young people from the territories was as follows:

TERRITORY	PARTICIPANTS
Andorra	5
Aragón	7
Catalunya	9
Euskadi	10
Nouvelle-Aquitaine	12
Occitanie	7
Navarra	12

CONTRIBUTIONS FROM YOUNG PEOPLE

This document reflects the opinions of the group of young people who participated in its drafting; it does not reflect the point of view of the CTP or its members. The contributions have been grouped according to the system structure of the Pyrenean Climate Change Strategy EPiCC.

SYSTEM 1.

CLIMATE

1. Establish a cross-border research centre.
2. Radically change the production system. Faced with the urgency of a problem that condemns humanity, we cannot bet on reformist pseudo-solutions that compromise with capitalism. Sustainable development is not up to the task. Solutions: stop submitting to the productivist and consumerist logic of the market. Organise degrowth.
3. Allocate funds for new meteorology and research projects.
4. Creation of a daily simulator and indicators on the Pyrenees to show people what is happening. With images to compare.

SYSTEM 2.

RESILIENT NATURAL AREAS

5. Observation, conservation, control-protection of autochthonous species of flora and fauna.
6. Promotion and creation of natural parks that can be visited and are open to the public; presentation of endemic fauna and flora and dissemination in more distant territories.
7. Dumping waste in nature. Consider penalties.
8. Support water reuse projects for toilets (e.g. from the adjoining sink).
9. Have wastewater treatment systems that differentiate between heavily polluted wastewater (toilet, washing machines) and less polluted wastewater (kitchen, shower).
10. Pest prevention: seed collection. Example: Boxwood.
11. Knowledge, recognition and consideration of Pyrenean species that can be the object of beneficial measures and cooperation.
12. Creation of a genetic reserve of flora and fauna in danger of disappearing in order to reintroduce them later on.
13. Reforestation with autochthonous species.

SYSTEM 3

ADAPTED MOUNTAIN ECONOMY

14. Promote other tourism ideas for the territories most affected by climate change. Increase this funding for measures to be taken.
15. Increase annual tourism (not based on skiing seasons for example) with green alternatives to control pollution, e.g. using typical public transport, local production.
16. Tourist circuits adapted to the climatic and seasonal conditions of mountain areas.
17. Creation of a territorial network of sustainable tourism in the CTP.
18. Investment in new, more efficient renewable energies in Pyrenean areas.
19. Encourage the withdrawal of any tax on renewable self-consumption (e.g. own solar panels).
20. Creation of artificial aquifers in the rocky massifs with hydroelectric exploitation at the exit.
21. Implementation by law of mandatory domestic renewable energy supply within a period of 10-15 years.
22. Cooperative local communities, diversified renewable energies (self-sufficiency).
23. Thinking about new employment trends and new sources of employment, teleworking, TIC, etc.
24. School education in the treatment of nature and motivated from a young age.
25. Impose a 12-month occupancy of houses with sanctions in case of non-compliance. Limit new construction – reduce the construction footprint and offer more housing at a better price.

26. Prioritise short-circuit marketing (elimination of intermediaries between small producers and consumers), regardless of borders.
27. Support and promotion of local produce and free trans-Pyrenean trade to promote the survival of biodiversity.
28. Financial support from the institutions for agricultural and livestock cooperatives.
29. Promotion of sustainable and local agriculture and livestock farming.

SYSTEM 4

POPULATION AND TERRITORY

30. Fund research into tropical diseases: treatments, vaccines _ Not just surveillance!
31. Reduce: consumption (second-hand shopping, electricity, meat), travel, waste, size of housing
32. Recovery of old Pyrenean trails: wealth of heritage, improvement of biodiversity (mosaic model), biomass, cross-border exchange of material and human resources.
33. Creation of a transnational and multilingual Pyrenean emergency unit.
34. Production and distribution of documentaries or educational videos.
35. Financing of public awareness days (CTP _).
36. Reduction of erosion of the natural environment
37. Prohibiting the circulation of low occupancy vehicles or impose carpooling in the mountains: limit the risks arising from excessive traffic in the mountains and reduce the carbon footprint.
38. Get informed, search, share: follow influencers on linkedin or Youtube, participate in a "Climate Mural", look for a job with a positive impact on the climate, sign petitions, speak out.
39. Seek consensus among all the actors involved in order to create a reliable and resilient network of stakeholders in the event of crises.
40. Direct communication of measures with the European Union and collect the funding they can provide.
41. Encourage cross-border cooperation in changing the economic model of the resorts on both sides of the border: relocation, shared services, etc.
42. Communication of ideas with a forum or a conference with the citizens, so that there is direct communication.
43. Organisation of a national climate summit and, subsequently, take the results to the COP and European institutions.
44. Cooperation in Europe and the world: we cannot change the territorial situation if we do not globally reduce our consumption and change our way of life.

Territories CTP



Govern d'Andorra



RÉGION
**Nouvelle-
Aquitaine**



**Generalitat
de Catalunya**



**Gobierno
de Navarra**  **Nafarroako
Gobernua**

