Water resources and alpine rivers: adaptation to the challenges of climate change

Report of the conference organized in the framework of the French Presidency of the Alpine Convention

18 & 19 February 2020

Impérial Palace, Annecy, France

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This conference was organised by the French Presidency of the Alpine Convention 2019-2020 (French Ministry for the Ecological and Inclusive Transition) with the support of ASTERS - Conservatory of Natural Areas of Haute-Savoie and Val&Monti / OXALIS Scop SA.

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Permanent Secretariat of the Alpine Convention

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Introduction

The water conference "Water Resources and Alpine Rivers: Adapting to the Challenges of Climate Change" held on 18 and 19 February 2020 in Annecy, was convened within the framework of the French Presidency of the Alpine Convention. It was based on the work already carried out by the Water Management Platform of the Alpine Convention and on the Alpine Climate Target System 2050 drafted by the Alpine Climate Board. The aim of the Presidency was to gather suggestions from a broad group of experts and stakeholders to come up with concrete courses of action benefitting water resources and Alpine rivers in a climate change scenario.

Unfortunately, the Alps have become a laboratory for climate change. However, on a more positive note, and considering that every challenge has become a global one, the Alps have also become a testing ground for the implementation of sustainable policies. These policies are designed to implement nature-based solutions with a range of mutual benefits. The aim of the proposals formulated at the end of the conference is to:

- contribute to the final conclusions of the Alpine Conference in December 2020 and to the future work programme of the Alpine Convention;
- more specifically, to support the operationalisation of the Alpine Climate Target System 2050 by identifying and mobilising stakeholders in the implementation of the "Water" pathways.

The first part of this document highlights the main proposals that could inspire the future work of the Alpine Convention. The proposals were put forward by the discussion tables held during the conference. The second part summarises the speakers' presentations as well as the topics emerged in plenary discussions.

The names and affiliations of the speakers and roundtable moderators, as well as the titles of the presentations, are listed in Annex 1 (Conference Programme). Abstracts of the presentations are provided in Annex 2.

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Part I: Main proposals that could inspire the future work of the Alpine Convention

The proposals presented below summarize the work of discussion tables on the following subjects:

- Conservation of wild rivers
- Renaturation of degraded alpine rivers and conservation of biological corridors
- Strengthening of upstream/downstream and transboundary solidarity, optimization of water resources.
- The "Water" pathways for the implementation of the Alpine Climate Target System 2050

They are also the result of plenary discussions aimed at generating proposals for additional measures to improve the functional state of Alpine rivers and water resources. The starting assumption, drawn up during the conference, is that solutions already exist, and that they must now be shared and implemented.

1. Conservation of wild river potential

These proposals are the result of a discussion focused mainly on the threat posed by small-scale hydropower, which still often appears to many actors as a solution both for energy transition and the creation of financial resources in rural areas, but this is only partially the case. The aim was not to condemn small-scale hydropower, but rather to promote dialogue and exchange between various local stakeholders. Apparently, this issue is not sufficiently addressed in the Alps, despite the hundreds of small hydropower projects identified.

Proposals:

- Initiate exchanges at European level to eliminate the existing discrepancies between EU policies on renewable energy and the restoration of biodiversity;
- Improve local dialogue, which is clearly insufficient, particularly between conservation and renewable energy stakeholders. More tools are required to improve debate and understanding of energy issues and the interconnections of biodiversity and renewable energy;
- Improve knowledge of hydrology, ecosystem functioning, operational tools to make the right choices;
- No installation of micro-power plants on biodiversity reservoirs, List 1 rivers, in national parks and obviously in wild rivers. In some cases, renewable energy is definitely the second priority;
- Take into account the hydrological changes linked to climate change, which means that summer low-water levels will affect project profitability (improve knowledge of hydrology in a context of climate change);
- Extend the "Wild Rivers" tool to other Alpine rivers that are not currently protected and which feature a very rich biological diversity.


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2. Restoration of degraded rivers and conservation of biological corridors

Proposals:

- Promote watershed approaches, transboundary approaches when necessary, aimed at developing monitoring and early warning systems, conservation strategies for Alpine rivers, and rules for socio-economic development so as to avoid a worsening of the situation;
- Turning requirements into operational measures and concrete actions on the ground;
- Encourage the participation of local actors (educate, raise awareness, spread out knowledge) for a better acceptance of restoration projects;


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- Produce model case studies, provide methodological tools applicable at the local level;
- Revitalize rivers promoting more natural conditions (compared to a reference state to be defined);
- Promoting cross-border cooperation in restoration projects;
- Promote the flow of sediment from upstream to downstream where the works in place may block sediment flow in rivers;
- Revise the concept of "instream flow", which is not always appropriate, moving towards a more adaptive management of flows downstream of works that obstruct the natural stream flow;
- Put in place methodological and financial tools to monitor the long term effectiveness of implemented restoration measures;
- Preserve and reclaim the areas along watercourses (wetlands);
- Put in place effective policies for the management of invasive alien species (update species lists, propose appropriate management measures).

3. Sharing water resources and strengthening upstream-downstream solidarity

Proposals:

- Promote the development of hydro-climatic models that provide essential knowledge about the impact of climate change on water availability and demand in a given area, taking into account various scenarios based on current knowledge;
- Encourage local actors, and in particular local elected officials, to develop socio-economic development models to satisfy long term water requirements (in terms of quality and quantity);
- Propose operational governance models to ensure efficient implementation of water resource management actions;
- Promote integrated water resource management and cooperation between the countries of the Alps for a better management of water resources, natural hazards, shortages, etc. To this end, discuss the opportunity to draft a protocol of the Alpine Convention devoted to water issues;
- Better define the ecosystem services produced in the upper part of watersheds and used downstream: need for definition, classification and prioritization for inclusion into public

policies (and to enable those who use these services to fund them);

- Continue monitoring water resources and water uses;
- Ensure knowledge exchange consistency;
- Develop local consultation and provide information at the local level (elected officials, citizens, tourists);
- Manage urban policy by limiting urban sprawl and promoting water infiltration at the source;
- Adapt tourism policies by taking better account of the impacts of these practices on water resources, without losing sight of the sustainability of the ecological value of the Alps;
- Promote wise use of water, with practices that consume little water and guarantee public health (tourism, types of culture).

4. Implementation of the Alpine Climate Target System 2050

The Alpine Climate Board (ACB) has reached the final stage in the development of implementation plans for ten action areas of the Alpine Climate Target System 2050. This system was adopted by the Ministers of the Alpine States at the 15th Alpine Conference in April 2019. The Conference mandated the ACB to operationalise the target system and to take the first steps towards the dual objective of "Climate Neutral and Climate Resilient Alps 2050". Water is one of the domaines covered by the Alpine climate target system.

Three implementation pathways were developed involving experts and various representatives (Member States, NGOs, consultants, etc.) and were presented and discussed during the workshop "Setting up teams for the implementation of the Alpine Climate Target System 2050":

- Tools and methods for drought management in the Alps;
- Implementation of an Alpine-wide approach to integrate climate change into transboundary water management;
- Implementation of Alpine-wide flood risk management founded on nature-based solutions.


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Within the limited time available, the session first focused on the discussion of the contents of the pathways and then began to consider the stakeholders to be involved. The participants mentioned a wide range of stakeholders who should be invited to join the water "implementation teams": farmers, stakeholders of existing projects in flood risk management and transboundary river management, industrial associations, cultural associations with transboundary networks, companies focusing on soil and water bioengineering, universities, environmental NGOs, regions, municipalities, etc. Concrete proposals for implementation teams were also put forward: CIPRA International, WWF, Birdlife, Friends of Nature, Swiss Data Cube, INRAE (Institut national de recherche pour l'agriculture, l'alimentation et l'environnement, FR) and EPFZ (ETH Zurich, CH). It appeared crucial to use the existing know-how and expertise of stakeholders to further develop the implementation pathways.

This workshop was a pilot session for the "Matchmaking" workshop scheduled by the Alpine Climate Board. At this event, the ACB will present the implementation pathways for all the sectors covered by the Alpine Climate Target System 2050 and invite participants from all over the Alps to join implementation teams. More in-depth discussion will follow on identifying the target stakeholders, on leadership, the role of the Alpine Convention and its bodies, sources of funding and starting points to trigger the process. Potential partners recommended at this conference will be invited to the Matchmaking event, which is scheduled to take place on 30 June 2020. It will be linked to a Climate Communication Conference (30 June/1st July 2020) organised by ALPACA, the Alpine Partnership for Local Climate Action, with the slogan, for both events, "Listening, sharing, connecting".


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5. Other proposals

5.1 Improving knowledge

A need for knowledge building has been expressed on many occasions, on the premise that we better manage what we know. The adaptation strategies to be developed also depend to a large extent on the actual knowledge acquired on a given topic. The Alpine range is often regarded as an open-air research laboratory. As climate change is more impactful in the mountains rather than in lowland regions, it seems vital to focus on the upper part of watersheds to take fast and effective adaptive measures in these areas.

Proposals:

- To capitalise on existing knowledge efforts, through a closer exchange of experience and feedback between the different Alpine areas;
- Improve ecological knowledge about high-altitude habitats, especially aquatic ecosystems, with the aim of better anticipating the measures needed to preserve them;
- Experimenting with the acclimatization of species from high altitude watersheds to lowland habitats;
- Quantify and study the variability and availability of water resources over time, as a result of climate change;
- Quantify water uses;
- Improve the efficiency of wastewater treatment, including the treatment of pollutants with little or no treatment to date.


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5.2 Raising awareness, consultation

Emphasis has been placed on the need for awareness-raising and consultation of the water system stakeholders (from the citizens as users of the resource, to the politicians, as those who ensure the correct implementation of water management measures). The aim is to raise collective awareness of the stakes, and gain the endorsement by regional stakeholders for a better implementation of management measures for adaptation. Knowledge is not supposed to remain the preserve of specialists!

Proposals:

- Train and inform on the status quo and the findings;
- Use existing communication tools (e.g. map of the Inn River Basin) to raise awareness among decision-makers and the local population about changes in hydrological regimes, and their impacts on water resources and river ecology;
- Adopt participatory tools, involving the citizens;
- Involve young people, include them in the decision-making process;
- Deepen the discussion on climate change mitigation policies.


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5.3 Governance and public policy

- Need to strengthen and extensively apply financial incentive instruments all across the wide Alpine valleys, for instance the regional centres for integrated river basin management (IRBM), called Water Agencies in France;
- Implement reinforced governance in water management, as is the case for GEMAPI and its sector (aquatic management and flood prevention) which in France, from January 1, 2018, was attributed to public inter-municipal cooperation with their own tax system[1];
- Adapt public policies (with special reference to land use planning) to the specificities of high-altitude territories.

[1] *Implementation of the MAPTAM Decentralization Laws of 2014 and NOTRe of 2015. After the transposition of the 2007 Flood Directive into the Grenelle II law of 2010, these two laws specified the governance of water and aquatic environments, as well as the obligations of the communities in terms of flood prevention and management of aquatic environments.*

PART II: Conference summary

This section is devoted to the presentations made by the conference speakers on February 18 and 19. The names and references of the speakers and the titles of their presentations can be found in Annex 1 (conference programme). Abstracts of the presentations are provided in Annex 2.

Introduction to the conference

Building on the work already carried out by the Water Management Platform of the Alpine Convention and on the Alpine Climate Target System 2050 drafted by the Alpine Climate Board and adopted by the Alpine Conference in 2019, this conference aims to propose concrete pathways for future actions, involving the Alpine Convention and all other stakeholders in the Alps.

1. Water in connection with the Alpine Convention

1.1 The Alpine Convention

The Alpine Convention is an international treaty signed in 1991 whose mission is the protection and sustainable development of the Alps. It was ratified by the eight countries of the Alpine range: Austria, France, Germany, Italy, Switzerland, Liechtenstein, Monaco, Slovenia and Switzerland, as well as the European Union. The Contracting Parties share a common territory and collaborate in various fields to contribute to its protection and sustainable development: nature and biodiversity, climate change, energy, forests, green economy, mountain agriculture, natural hazards, population and culture, spatial planning, soil protection, transport, tourism and water management.

On 4 April 2019, at the Alpine Conference in Innsbruck, France officially took over the presidency of the Alpine Convention from Austria. Brune Poirson, State Secretary to the French Minister for Ecological Transition and Solidarity, chairs the Alpine Conference.

1.2 The work of the Water Management Platform in the Alps

The Alpine Water Management Platform was in operation from 2009 to 2019. Throughout this period, and in the framework of the implementation of the first Action Plan on Climate Change in the Alps of the Alpine Convention, it gathered knowledge and issued recommendations on different aspects. More specifically, the Platform developed guidelines for the construction, optimisation and rehabilitation of small hydropower plants with a view to the protection of aquatic environments and biodiversity. The Platform also dealt with the management of hydromorphological processes and, in recent years, with measures adopted in the Alps to deal with drought.

The Water Management Platform in the Alps also collaborated with the EUSALP Action Group 6, jointly led by the Permanent Secretariat and the Land Carinthia, whose subgroup on water explored green infrastructure solutions.

2. Alpine rivers in times of climate change

2.1 State of play

With decreasing snow cover and melting glaciers, the hydrological regimes of all Alpine rivers are changing. The frequency and intensity of floods in autumn, winter and spring, as well as summer droughts, will increase significantly, extending intermittent river regimes. These changes will have a significant impact on water availability and the water cycle, and on an increase in natural hazards: destabilized slopes and increased debris accumulation.


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High-altitude freshwater ecosystems, as diverse habitats with valuable and highly specialized biodiversity, are also highly vulnerable to the effects of climate change and indicators of alterations. Their resilience appears to be limited. Specialized species, capable of living in extreme conditions, will gradually be supplanted by more numerous and more "common" species. In addition to changes in the composition of ecosystems, the Alpine landscapes, especially the floodplains downstream, will also be transformed.

In 1992, CIPRA (International Commission for the Protection of the Alps, established in 1952) published a study indicating that only 10% of Alpine rivers could be considered to be in a good ecological status, i.e. 5,500 km out of the approximately 58,000 km of Alpine rivers surveyed. It proposed to use the "Biosphere Reserves" system to protect them.

In 2013, the WWF Alpine Programme (European Alpine Programme / Save The Alpine Rivers, EALP / STAR) published a study[2] showing that the situation had not really changed, both in terms of the proportion of rivers in a good ecological status (very good


© Anton Vorauer

ecological status, since the Water Framework Directive had been issued by that date) and in terms of protection.

Still in 2013, according to IUCN, strong protection measures had been applied to only 4% of the rivers in the Alps.

In addition to these environmental predictions, societal changes (hydropower, public supply, irrigation, heating/cooling, snow production, increased land requirements for human habitats and infrastructure) will increase pressure on ecosystems, mainly in downstream areas.

[2] *Source: University of Vienna - University of Natural Resources and Life Sciences, BOKU*

2. Inspiring practices for the Alps

Integrated approaches at the watershed level: from knowledge about issues to the implementation of actions in the field

The main measure for pre-emptying the effects of future environmental and socio-economic changes is to develop integrated approaches at the river basin level, sometimes requiring transboundary cooperation. Feedback on shared experience highlights the value of participatory processes, involving all stakeholders in the region. The effectiveness of these approaches often requires good coordination between the project partners, who must appoint a common coordinator, and the local level. Developing maps and graphs to visualise the phenomena is essential to promote local understanding and ownership. The implementation of operational actions to remedy the observed conflicts requires continuity of people's engagement, participation and long term local commitment.

Preserving the still intact jewels of biodiversity

In 2013, it was estimated that the remaining wild rivers in France accounted for 788 km out of the 8830 km of French alpine rivers. Since 2013, about ten sites have been labelled "Wild Rivers" in the French Alps. Hopefully other alpine jewels can be included!

Restoring degraded watercourses

River restoration, by increasing the natural retention capacity of river floodplains, is one of the concrete actions that can be implemented as part of more comprehensive adaptation strategies. Sharing the lessons learnt, as happened with the work presented on the Leysse River in France, leads to restore free space to watercourses in less vulnerable sectors, by reconnecting minor riverbeds to their related areas (wetlands playing a role in storage, purification, key biodiversity areas, etc.). It also stimulates the aquatic ecosystem (non-rectilinear profiles, concentration of water at low water levels to avoid sharp rises in temperature, etc.). These developments should not neglect the need for vulnerability management, which is constantly increasing.

3. Alpine water resources management and water-related conflicts

3.1 State of play

Climate change is manifesting itself at a faster rate in the Alps than elsewhere: since the end of the 19th century, temperatures have risen by almost 2°C (twice as much as the average for the northern hemisphere). According to climate projections, by 2100, temperature increases in the Alps will be between +2.6 and +3.9°C, and as much as +4.2°C above 1500 metres.


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Under the influence of changes in precipitation patterns (strong inter-annual variations), soil degradation and the gradual melting of glaciers (which have already lost between 20 and 30% of their volume since 1980 and could further lose between 30 to 70% of their volume by 2050), the availability of water resources is also changing. Availability is a decisive factor for the supply of drinking water to the population as well as for the economic development of foothills and plains (agriculture, household needs, hydropower, river navigation, irrigation, tourism or cooling of thermal or nuclear power stations, etc.). This situation, combined with societal changes and increased demand from water users, tends to perpetuate and further intensify conflicts.

The factors of future water availability and demand are therefore strongly affected by climate change - which could multiply related conflicts, especially since demand is partly seasonal or time-specific (irrigation in summer, cooling during heat waves, water for artificial snow or electricity in winter) and often not aligned with natural availability.

Water quality is also affected by increasing anthropogenic pressures (persistent pollutants from industries, households, agricultural waste), especially during drought periods (low flow levels in receiving bodies and high temperatures). These conflicts are more prevalent in mountain valleys characterized by urbanization and intensive farming. Finally, climate change reinforces phenomena such as heavy erosion and landslides (increased risks for populations).

These are often cross-border issues affecting many different levels. They are also cross-sectoral and involve a wide range of users, practitioners, institutions and disciplines.

3.2 Inspiring practices for the Alps

Anticipate situations of shortages and identify critical target areas

As shown by a large-scale pilot study carried out by the Rhone-Mediterranean-Corsica Water Agency on the Rhone-Mediterranean watershed, in France, setting priorities for action in target sectors, i.e. the most critical ones in terms of water resources, is an important prerequisite for the deployment of tools, financial resources and finally for implementing actions aimed at resolving conflicts. Vulnerability maps are very helpful for targetting priority areas.

On a more local scale, thanks to the data provided by field managers, critical periods for future (or even current) more accurate water use estimates can be obtained (mismatch between available resources and water needs), when we apply different hydro-climatic and socio-economic scenarios. These modeling tools are very useful to become aware of the issues involved. Since local policies are often limited to a short time horizon, the main challenge is to encourage local decision-makers to plan the development of their territory over a longer period of time.


© Andreas Hollinger

It is worth noting that areas under stress can initially reduce their water requirements, at least partially, through adaptation measures: four-season tourism, modification of agricultural practices (crops adapted to hydro-climatic conditions, drip irrigation). However, other, more radical measures may be necessary to meet their future challenges. Strong measures to change land use planning are sometimes needed to prevent a potentially significant impact on the local economy.

Proposing concerted and integrated actions in coherent territories: the case of watersheds

As demonstrated in the case of the Roya, the watershed level appears to be a coherent unit for managing water resources. Acting at this level requires not only cooperation between upstream and downstream stakeholders, but sometimes even transboundary cooperation regulated by international conventions. Many steps of this type have already been taken and have proved their relevance. The first step is a consultation process gathering all water management stakeholders around the table, including users, with the aim of ensuring sustai-

nable development for these high altitude river basins. Initially, joint actions will be aimed at improving knowledge on the impact of climate change and proposing a governance model that will eventually lead to efficient management actions.

4. Conclusions of the conference

By Luca Cetara, Eurac research and Italian delegation to the Alpine Convention

1) Since many years, water has been a key subject for study and action for the Alpine Convention. This is evidenced by the "cursus honorum" recalled by the Secretary General yesterday afternoon, as well as by the preparatory documents of this conference. The latter sum up fifteen years of history, while testifying a rare case of "lifelong learning", probably associated to the substantial common identity across the Alps and the significant availability of water resources - with cultural as well as scientific implications, despite climate change.


© Walter Köck

2) It is worth noting that the Water Management Platform of the Alpine Convention and the previous editions of the Alpine Water Conference made important contributions to several of the topics addressed during the conference: integrated management, river development, renaturation of water bodies, impacts and adaptation to climate change, droughts, opportunities and risks of hydropower production, sediment transport, implementation of the EU Water and Flood Directives in the Alpine region, flood risk management and the introduction of a new voluntary governance of water resources through tools such as river contracts.


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3) On closer examination, one of the reasons why water has become so "popular" in times of climate instability is probably that climate change primarily affects water resources: droughts, floods, water availability insufficient to meet demand, little snow and a lot of water in rivers, for example, to mention a topic dear to the Alpine tourism sector.

4) It is no coincidence that climate change steadily recurs in speakers' reports, participants' concerns and management student projects. The first conclusion, not an original one, is that we must continue to address this challenge, with particular reference to a sensitive issue like water management in the Alps.

5) In the Alps we are probably not used to considering water as a scarce resource, at least historically. This makes the reduction scenarios relatively more dramatic than elsewhere: there is a subtle difference between an already critical situation (typical of other environments where water resources are indeed scarce) and a potentially critical situation (where a reduction prospect of more than 30% could reverse sustainability conditions).

6) Consider the runoff reduction scenarios presented for Lower Engadine in the next 30 years: it might be more complex to manage a relative shortage in the heart of the Alps than to manage an absolute shortage in a desert region, because of the intensity of the variation and its effects in absolute terms.

7) In line with the traditional approach of the Alpine Convention with reference to water resources, we have listened to several examples of integrated resource management (the river basin committee and the Water Agency in the case of Annecy, for example, but also the Autonomous Province of Bozen/Bolzano and the Roya transboundary river contract). They show a wide variety of approaches applied throughout the Alpine regions, possibly suggesting a role for the Convention in proposing how to bring together the main management methods adopted in the Alps.

8) We might assume a need for governance methodologies for complex (water) systems and coordination between EU directives, jurisdictional systems, regulations and national guidance, which could support examples of concerted action for sustainable management of water and the associated ecosystems. The Alpine Convention could probably cast light on them and promote the exchange and synthesis of best practices; many were already presented (Bozen/Bolzano, Annecy, Engadine, Inn).

9) We know that the Floods Directive calls on us to consider water as a (healthy) vector of natural risks and that the Water Platform of the Alpine Convention calls for a combined application of the Water and Floods Directives. Many local authorities and civil protection systems have at their disposal an enormous amount of information on floods, damages, affected regions and have tried to identify the responsibilities of the different public and private bodies in planning operations, areas of responsibility and, last but not least, financial resources - as these are usually very costly interventions. Even more in line with the spirit of the Treaty, the wish has been expressed for a joint commitment by the Contracting Parties regarding the implementation of Article 8 of the Flood Directive. Pursuant to Article 8, international coordination is required to draw up a single flood risk management plan for transboundary river basins shared with other Member States or third countries.

10) It would be ambitious and even a bit boring to try and summarize yesterday's plenary debate and also the specific outcomes of roundtable discussions, even for this forum. I will therefore confine myself to a few comments concerning on the one hand, the history of the Alpine Convention and its water-related activities, and on the other hand, the challenges underlying the conference we are about to close.

11) The restoration of watercourses and renaturation of Alpine water bodies in accordance with the aims of European directives, not always easy to implement due to the ecological and morphological conditions of Alpine rivers, are expressly included in the first challenges taken up today.

12) The preservation and conservation of intact river ecosystems - the first challenge - probably requires a common identification of these water bodies in the Alpine region and a relatively homogeneous approach to their management in ecological, economic and regulatory terms. A non-binding

identification of these ecosystems in the Alpine region would probably provide a scientifically based framework for policy makers as well as the regional and local administrators involved in the management choices related to these ecosystems.

13) Alpine specificity is of course equally related to high altitude environments, which might be more or less impacted by the global hydrological cycle, and showing consistent patterns in different parts of the Alpine range.

14) Let me also mention the other important topics of communication and citizens' involvement that have emerged. They remain a key reference for any democracy and the main source of funding for the work and measures suggested here. Just yesterday, one of the comments showed how citizens' participation becomes even more desirable when planning funding and expenditure that directly affect them. An increased awareness of the complexity and multiple benefits that can result from the sustainable management of a resource now subject to the fierce law of scarcity, can be seen as an opportunity for the Alpine Convention to play a role of "social sustainability".


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15) In this respect, many enlightening experiences with tools clearly oriented in this direction have been carried out: the maps shown to us by many speakers have the merit of immediacy, not to mention the superb video.

16) From a geomorphological point of view, the analysis of the documents produced by the Convention on the subject seems to highlight the issue of sediment transport both from the point of view of preserving the natural character of rivers and of reducing hydrogeological and hydraulic risk, with obvious impacts also on the production of hydroelectric power


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17) The second challenge addressed by this conference is the restoration of degraded Alpine rivers and the conservation of their ecological corridors, with a view to reduce soil degradation and its impacts on water bodies and the use of "stream branching" and "natural regulation" techniques. There are good examples of efforts made to find the proper balance, albeit they are obviously prone to criticism because of the perfectibility of human action. In areas devoted to production (agricultural and often also urban and industrial), some interventions are complex and can generate conflicts related to preserving the distinctive elements of the Alpine landscape, the most profitable cash crops and, in general, past land uses. The question about what are the physical and ecological characteristics that make a renaturation intervention possible, feasible and desirable in an Alpine environment, in accordance with the Habitats Directive, might certainly be raised within the framework of the Convention itself.

18) River basin governance must necessarily include upstream and downstream areas, acknowledging the mountain contribution to water supply and the ensueing benefits. However, there is a need to generate a shared governance system that should not be perceived as top down. Conversely, the benefits for all areas (and parties) concerned should be clearly recognized for all the parties involved, and more information spread on them – not an easy task, only hinted at in welfare economics textbooks.

19) In this (potentially limitless) field, the use of resources, as well as finding agreement on it, play a key role. While mountains provide most of the ecosystem services related to the availability, quality and regulation of water resources, this does not mean that their provision comes for free. We often recognize opportunity costs, i.e. what we could do but fail to do, or use of resources we do not take advantage of, to allow ecosystem services to flow. In other cases, the costs are directly related to carrying out activities to improve the flow or use of these services.

20) Public policies at all levels have so far been focused on measures related to water supply: efforts have therefore been made to increase resource availability to meet the demand of fairly heterogeneous categories. Conscious water demand management is probably becoming relevant to the Alps too, although in the past, water availability was never perceived as a challenge. The feasibility of this approach depends to a large extent on the degree of user awareness about services that in the Alpine environment may require more punctual explanations than elsewhere. But it also depends on the use we will be able to make of it and on the deliberate actions taken by the Alpine Convention to bring out the topics emerged in the discussion of these two days to contribute to the implementation of the new CAP and the European Green Deal, which are expected to fulfil many of the wishes shared here.

21) Some voluntary instruments already exist, they are rather frequently applied in some Alpine countries. They could provide a relatively well-defined structure for this type of exchange and are increasingly being applied across borders, as we have heard in the case of Inn and Roya, to name but two examples.

22) The fourth challenge is the implementation of the climate objectives approved at the last Alpine Conference in Innsbruck, also for the water sector.

23) Finally, it should be noted that - incidentally - in each of the areas examined, appropriate modes of action for active implementation or support by the Convention and its organs have been indicated, considering the international character of the instrument. They should be taken into account so as to develop a pan-Alpine action for the management and protection of Alpine water resources in the context of climate change.


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24) At the same time, there is probably a need to identify and define the legal and financial instruments required for adoption by administrators, stakeholders and citizens, as well as any good practice that would help to successfully tackle the range of critical issues affecting a river basin - with particular reference to the priority challenges identified by the Convention over the years and those discussed during these two days.

Annexes

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Annex 1 : Conference Programme

Water resources and alpine rivers: adaptation to the challenges of climate change

The high altitude watersheds, water-producing areas on which the downstream regions largely depend, are also the first victims of climate change. Adaptation strategies must be developed in coordination with local policies and actors in order to guarantee a rational use of water resources now and in the future, and a good functional state of alpine rivers.
Building on the work already produced by the Water Management Platform of the Alpine Convention and the Alpine Climate Target System 2050 prepared by the Alpine Climate Board, this conference aims at proposing concrete pathways for future action, involving the Alpine Convention and all other relevant stakeholders in the Alps.


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DAY 1

Tuesday, 18 February 2020

12:00 Welcome lunch

13:30 Welcome speeches

Alexandra Bonnet, Deputy Director of European and International Affairs and Chair of the Permanent Committee of the Alpine Conference, French Ministry for the Ecological and Inclusive Transition
Thierry Billet, Vice-President of the Grand Annecy agglomeration
Martial Saddier, President of the Rhone-Mediterranean Basin Committee, Member of the Parliament

14:00 Introduction to the conference programme

Claire Simon, Val&Monti
Aude Soureillat, ASTERS - Conservatory of natural areas of Upper Savoy

14:15 Bundling forces across the Alps: the role of the Alpine Convention for the sustainable management of alpine water resources and rivers

Preserving or re-establishing healthy water systems is among the primary objectives of the Alpine Convention. To this effect, the former Water Management Platform and the Alpine Climate Board of the Alpine Convention have designed common strategies and guidelines, which will be outlined in this talk.
Alenka Smerkolj, Secretary General of the Alpine Convention

Focus topic 1: Alpine rivers in times of climate change

14:35 Overview

Impacts of climate change on alpine aquatic eco-systems

Alpine freshwater ecosystems - current status and future challenges in management and conservation.
Leopold Füreder, ISCAR, UIBK, Austria

Alpine streams in the face of climate change

This talk will present the general consensus on alpine stream response to current and ongoing climate change.
Christopher Robinson, Eawag/ETHZ, Switzerland

15:05 Inspiring practices from around the Alps

Integrated River Basin Management in the Lower Engadine

Development of strategies for a sustainable water management under changing climatic conditions – an Alpine region acts for the future.
Angelika Abderhalden, Foundation Pro Terra Engiadina and UNESCO Biosfera Engiadina Val Müstair, Switzerland

River basin management in South Tyrol: experiences, examples and perspectives

River basin management plans are integrated plans for a sustainable territorial development. Aspects such as flood protection, land use, water management and ecological requirements are taken into consideration. This presentation will tell about examples from South Tyrol and in particular the transition from a project to a process. Furthermore, examples for the implementation of concrete measures will be presented.
Willigis Gallmetzer, Provincial warning centre, Autonomous Province of Bolzano-Bozen/South Tyrol, Italy

Restoration work on the Leysse in Chambéry: For a safer and livelier river

In the plain of Chambéry, the River Leysse has historically been very constrained between containment systems which have led to the impoverishment of its biodiversity and the disappearance of areas for the proper functioning of the river. In addition, flood protection works no longer fulfil their role satisfactorily as evidenced by the many historic breaches and the very low level of protection given to highly urbanized areas. The community has therefore embarked on a major program of restoration of watercourses with the ambition of combining protection against floods and ecological restoration of the environment.

Christophe Guay, GEMAPI department of Grand Chambéry, CISALB, France

Discussion

15:55 Coffee break

16:15 Plenary discussion: further steps to guarantee a good functional state of alpine rivers

- *Based on the presentations, what issues or ideas should inspire public policies, in particular the Alpine Convention?*
- *Which further important issues or measures have not been addressed but need to be mentioned?*
- *Are there issues that are not or insufficiently treated in research or policy and need to be emphasised?*

Facilitators: Claire Simon and Aude Soureillat

The collected input will serve as a base for further work within the Alpine Convention.

17:30 Field visit - renaturation of the Thiou riverbanks

City of Annecy

19:30 Dinner

at the Impérial Palace

DAY 2

Wednesday, 19 February 2020

9:00 Introduction to day 2

Claire Simon, Val&Monti
Aude Soureillat, ASTERS - Conservatory of natural areas of Upper Savoy

Focus topic 2: Management of alpine water resources and water conflicts

9:10 Overview

The future of water resources: drought at the alpine level

Latest events (mainly in the summer 2018) have demonstrated the vulnerability of Alps to drought impacts. Although some experiences with drought monitoring and management already exist in the region, further work on these topics is planned in the frame of the Alpine Space ADO project (Alpine Drought Observatory). The ADO project will build up a coherent approach to drought management policies and complement with other relevant projects.

Felix Greifeneder, Eurac Research, Italy

9:40 Inspiring practices from around the Alps

Overview of lessons learned from integrated and prospective analysis of water scarcity risk in Western Switzerland

Main conclusions on water scarcity modelling are drawn based on a cross presentation of two prospective studies carried out in Swiss catchments.

Marianne Milano, University of Lausanne, Switzerland

Climate change adaptation plan in the Rhone-Mediterranean basin: specificities of high watersheds

Faced with a general vulnerability to climate change for water management, the question is no longer whether to act, or even how, but where and which priorities should be given for investments?

Yves Picoche, Basin Interventions and Actions, Water agency Rhône Mediterranean Corsica, France

Franco-Italian cooperation along the Roya watershed and its tributaries
A cooperation has been ongoing for numerous years between France and Italy concerning the transboundary watershed of the Roya and its tributaries including scientific monitoring of the watershed, the development of an innovative governance model within the "Transboundary Protocol of Intent for the Roya watershed and its tributaries" and measures dedicated to the impact of climate change on the water resources of the valley.
Sylvain Michelet, CARF and Marie Genevier, BRGM PACA, France

10:20 Coffee break

10:40 Discussion tables

1. **Preserving wild rivers;** facilitators: Denis Caudron, Wild rivers programme, Association of the network of labelled wild rivers and Martin Arnould, Wild Rivers Conservation Fund, France
2. **Restoration of degraded alpine rivers and maintenance of biological corridors;** facilitator: Lara Flis, Water and Investment Directorate, Slovenian Ministry of the Environment and Spatial Planning
3. **Strengthen upstream / downstream and cross-border solidarity mechanisms / Promote concerted use of the resource, optimize the resource;** facilitator: Giulio Conte, Italian Ministry for the Environment, Land and Sea
4. **Establishing implementation teams for the Alpine Climate Target System 2050: Networking session for identifying stakeholders and implementation partners for the water pathways of the Alpine Climate Board";** facilitators: Helen Lückge, Climonomics; Elisabeth Sötz, WWF; Katharina Zwettler, Austrian Federal Ministry for Climate Action

The collected input will serve as a base for further work within the Alpine Convention.

12:00 Conclusions and perspectives

Summary, Luca Cetara, Eurac research & Italian Delegation to the Alpine Convention
Conclusions, Alexandra Bonnet, French Ministry for the Ecological and Inclusive Transition, French Presidency of the Alpine Convention

12:30 Closing lunch

Annex 2 : Presentation Abstracts

Alenka Smerkolj, Secretary General of the Alpine Convention

Bundling forces across the Alps: the role of the Alpine Convention for the sustainable management of alpine water resources and rivers

The Alpine Convention, signed in 1991, is the international treaty for the protection and the sustainable development of the Alps, ratified by all eight Alpine States and the European Union. Preserving or re-establishing healthy water systems is among its primary objectives, and topic of the 2nd Report of the State of the Alps.

Precipitation patterns vary greatly across the Alps, but all areas are strongly affected by climate change. Alpine watercourses are also heavily used for hydropower – one of many interests which may enter in conflict.

Between 2009 and 2019, the Water Management Platform of the Alpine Convention bundled knowledge and provided recommendations on the use of small hydropower, management of hydromorphological processes and measures to face drought, among other topics. The Platform cooperated with EUSALP AG6, led by the Permanent Secretariat of the Alpine Convention and the Land Carinthia, whose sub-group on water management explored, in particular, the use of green infrastructure solutions.

The Alpine Conference approved in 2019 the Alpine Climate Target System 2050, prepared by its Alpine Climate Board. This entails the three targets of an alpine-wide optimized water management, drinking water security and alpine-wide sustainable flood risk management. To reach these targets until 2050, implementation pathways have been elaborated, to be taken on by relevant Alpine stakeholders.

Leopold Füreder, ISCAR, UIBK, Austria

Impact of climate change on Alpine aquatic ecosystems

The water of the Alps is of special importance for the Alps, the surrounding areas and large parts of Europe. The water in the Alps is versatile, highly interconnected and demands areas that are cross-border or cover several administrative units. It is a diverse habitat with a valuable and special biodiversity, but it suffers from multiple needs, great exploitation pressure and climate change. Numerous regional and supra-regional directives are designed to protect water and to ensure sustainable use of water, but also contribute to a great potential for conflict.

The ForumAlpinum 2018 held an important debate on the conservation and protection of valuable water habitats, sustainable use and well-considered water management. It defined drivers of future water availability and water demand in the Alpine region and identified hotspots of water conflicts (including climate change). Because competition for the use and management of water resources in the Alpine region is likely to intensify, and additional situations of competition and even conflict are likely to arise, new cooperative approaches are required in water policy and management to prevent an increase of conflict over water use, water quality, and riverine space .

Due to harsh environmental characteristics (e.g. long ice-cover, oligotrophy) high-altitude freshwaters are very sensitive ecosystems where even slight environmental changes (e.g. input of pollutants, climate change) may substantially affect ecosystem function. Several examples demonstrate that these ecosystems and their components are highly vulnerable to climate change effects and indicators for alterations.

River restoration is the opportunity to mitigate CC-effects by increasing the natural retention capacity of riverine floodplains. A multitude of funding schemes is available, most demand for an integrated and interdisciplinary approach. Two ongoing projects demonstrate a cooperative approach required in water policy and management to prevent an increase of conflict over water use, water quality, and riverine space.

Christopher T. Robinson, Eawag/ETHZ, Switzerland

Climate Change effects on Alpine streams

The alpine landscape is being transformed by climate change. Glaciers are rapidly receding, and low elevation plants and animals are moving up valley just as rapidly. Most glaciers in the Alps will be gone or reduced dramatically in size by 2100, some will disappear even in the next decade or two. As glaciers recede, glacial forelands become exposed and new stream environments emerge and develop. Water sources for alpine streams are also changing, as well as the timing and amounts of precipitation. In fact, the extent of stream intermittency is substantial in alpine stream networks, reaching up to 90% in some basins. Treelines will move upslope, altering organic inputs into streams. Floodplain forests are already showing development in some areas.

Landscape models predict geo-hydrological, ecological and societal effects as glaciers, snow and permafrost areas change over time. For instance, precipitation patterns, surface runoff patterns, melt periods, and permafrost activity will all shift in response to climate change. These changes will alter flow regimes, extreme event frequencies, water availability and societal values of humans. These changes have major implications for waters downstream as well as the human settlements along such systems. A loss in alpine stream insects has been documented and novel species from lower elevations have colonized alpine streams, affecting biotic communities and the potential functioning of these systems. The diets of steam insects have been shown to shift in response to stream intermittency. Intermittency strongly dictates the kinds and numbers of species present in streams, thereby influencing the functional role of these streams in the landscape. The managers of alpine landscapes are currently developing monitoring and early warning systems, strategies for ecosystem conservation and water storage, as well as allocation and regulatory measures to meet future expectations of glacial loss.

A global assessment of alpine streams has demonstrated similar responses in terms of species loss, changes in the types of aquatic organisms present in alpine streams, and the primary production within such streams as the amount of glacial cover shrinks. Observed changes, of course, will reflect the degree of glacial coverage and melt dynamics over time. For example, geohazards, discharge and sediment loads will initially increase then decrease as glaciers recede. These changes in turn will influence organic carbon loads as well as nutrient and contaminant inputs into streams. Biodiversity will also see temporal changes, with initial losses in alpha diversity and an opposite trend in beta diversity. The metabolism or biotic pulse of streams will increase over time as glacier inputs decrease due to changes in water source (flow, sediment, temperature regimes). Society will feel the effects via changes in hydropower potential, tourism and even local demographics.

A recent study conducted in the Val Roseg in the upper Engadine in Switzerland highlighted some of these responses. The stream network was monitored over two years with flow and temperature sensors. The sensors revealed that 90% or more of the river network was intermittent over the annual cycle. Three stream types were found: perennial streams with permanent flow, seasonally intermittent streams that typically dried over winter, and periodically intermittent streams that responded to local precipitation events. Although streams went dry at different times in autumn, all streams resumed flow around the same time in spring in response to snowmelt and early precipitation events. Streams harbored different

assemblages of aquatic organisms in relation to the degree of intermittency. And importantly, the aquatic insects shifted their diets in response to changes in organic matter inputs and the quality of the organic matter. Terrestrially derived organic matter was consumed less in intermittent streams as the conditioning of this carbon source was poor as a food resource in contrast to that in permanent streams. Aquatic organisms relied more on instream primary production in the diet when these intermittent streams had water.

As alpine floodplains develop and treeline moves up in elevation, there is the expectation that terrestrial inputs will increase in local streams and influence the kinds and numbers of aquatic biota in alpine river networks. A reduced glacial input should allow the development of a fishery in streams that currently are fishless due to major glacial inputs. The biotic implications of this are essentially unknown. One thing is certain, fundamental changes are happening now and will continue to occur in the alpine landscape and these changes will be evident in the fluvial network and the flora and fauna inhabiting these networks.

Angelika Abderhalden, Fundaziun Pro Terra Engiadina and UNESCO Biosfera Engiadina Val Müstair

Integrated River Basin Management in the Inn River Basin (CH)

The management of water resources, rivers and water related infrastructure can be achieved through Integrated River Basin Management (IRBM). IRBM is a cross-sectoral, participatory approach which involves stakeholders at all levels in financial, societal and ecological sectors. The approach results in a long-term plan relating to use, protection and the supply of water, and is intended to ensure best possible efficiency for sustainable use. As procedural decisions are considered and determined by the stakeholders themselves, it is a natural outcome that these action-related decisions are met with high acceptance.

As an inner-Alpine dry valley, the Engadine is experiencing reducing levels of discharge due to both climate change and existing water conflicts between energy, tourism, agriculture and public sectors. Seasonal change is also impacting the availability of water and water scarcity is becoming increasingly common.

To prepare for the impacts of climate change (such as scarcity of water), an Integrated River Basin Management Plan was initiated in the region. By using a variety of participatory methods, this ongoing project aims to provide a long-term solution for the sustainable use and protection of water in the Engadine.

The Interreg Alpine Space Project SPARE (Strategic Planning for Alpine River Ecosystems) actuated the IRBM and successfully collated, analysed and adapted strategic river management planning approaches for different Alpine regions by testing innovative participatory methods.

Gallmetzer Willigis – Provincial warning center, Civil Protection Agency of the Autonomous Province of Bolzano – South Tyrol (IT)

River basin management in South Tyrol (IT): experiences, examples and perspectives

The Agency for Civil Protection of the Autonomous Province of Bolzano – South Tyrol (Italy) is responsible for the administration, construction and maintenance of watercourses in South Tyrol. The application of the European Water Framework Directive and the Flood Directive in South Tyrol is represented also by the river basin management plans, the aims of which are a sustainable development with consideration to the demands of: flood protection, development of housing, industry, water economy, ecology, tourism and agriculture. In the last 20 years 11 integrated territorial plans were realised.

The four main steps of this project were: analysis of the present situation, interconnection of the results, guidelines, and program of measures. All phases were accompanied by an intensive information and participation process of the representatives of the interested groups and of the different administrative offices. The different river basin management plans formed the basis for the realization of measures as natural risk mitigation, flood protection, river restoration or recreational measures.

The experiences gained up to today in South Tyrol show the importance of continuity in persons, processes, public engagement and public relation participation.

Within the alpine Space project HyMoCARES was developed a framework and tools to integrate additionally the approach of Ecosystem Services in alpine river basin planning and management with a special focus on river hydromorphology.

The river basin management as a principle of work is an effective instrument for guiding the administrative activities in river area management.

Christophe Guay, GEMAPI department of Grand Chambéry, CISALB, France

Restoration Works on the Leysse River in Chambéry: a safer, living river

The management of watercourses within the territory around Chambéry started during the Sardinian period (before the annexation to France in 1860). From the time of the annexation, under Napoleon III, up to the introduction of the GEMAPI law in 2018, successive authorities provided watercourse management operations.

Over time, waterways have therefore been managed and contained within embankment systems that have led to a loss of biodiversity and the disappearance of areas in which rivers could function effectively. Additionally, former flood protection structures no longer adequately met their intended purpose, as reflected in many breaches and in a very low level of protection. This mainly occurred in areas that became heavily urbanised after the 1950s, when industrial, commercial and residential areas replaced agricultural land. As a result, the community has embarked on a wide-ranging programme of works to restore its waterways, in a bid to combine flood protection measures with the environmentally friendly restoration of the environment. Accordingly, 4.6 kilometres of works along the Leysse River were completed in 2018, with the removal, consolidation or reconstruction of dykes along a 4.5 kilometre stretch of the river.

Felix Greifeneder, Eurac Research, Italy

The future of water resources: drought at the alpine level

Latest events (mainly in the summer 2018) have demonstrated the vulnerability of Alps to drought impacts. Although some experiences with drought monitoring and management already exist in the region, further work on these topics is planned in the frame of the Alpine Space ADO project (Alpine Drought Observatory). The ADO project will build up a coherent approach to drought management policies and complement with other relevant projects.

The Alps are considered the "water towers of Europe". Forty percent of Europe's freshwater springs from here and supplies many millions of Europeans. At the same time, this region is strongly affected by climate change, with consequences for the entire ecosystem. Rising temperatures and the resulting decline in Alpine glaciers, shrinking snow cover in winter and increased evaporation of water in summer have a significant impact on Alpine water resources. The events of recent years (especially the summer of 2018) also show the vulnerability of the Alps to the effects of droughts. The experience with measures for drought management and the conflicts of interest of water users (e.g. private households, tourism, agriculture) vary strongly within the region. The Interreg Alpine Space project ADO (Alpine Drought Observatory) aims to combine the competences from all Alpine countries, from science and practice, to develop an Alpine-wide platform with uniform tools for drought monitoring and management.

Marianne Milano, University of Lausanne, Switzerland

Overview of lessons learned from integrated and prospective analysis of water scarcity risk in Western Switzerland

Two research projects (ICCARE-Vaud financed by the University of Lausanne and MontanAqua financed by the Swiss National Foundation) were carried out to assess the vulnerability of Western Switzerland to water scarcity under climatic and anthropogenic changes. Integrated modeling approaches were developed considering the evolution of snow and ice depletion, water resources availability, water demands and land use. Applied in the canton of Vaud and the Crans-Montana-Sierre area (canton of Valais), changes in hydro-climatic conditions and water use trends were identified by mid-century as well as seasons most prone to water scarcity.

This presentation provides four main recommendations for future interdisciplinary assessments of water scarcity:

(1) scenarios accounting for both hydro-climatic and socio-economic changes must be set up to grasp the respective impacts of these changes;

(2) stakeholders must be involved to co-produce future water demand scenarios and test the capacity of plausible adaptation strategies to reduce water tensions;

(3) better knowledge of current water demands is required to reduce uncertainties;

(4) water resources availability must be considered as a function of both quantity and quality to explore whether water demands can be fully satisfied.

Yves Picoche - Director of Basin Operations and Initiatives

Climate change adaptation plan for the Rhone-Mediterranean basin: typical features of upper catchment areas

Given the extensive exposure of water management operations to climate change, the issue is no longer whether to act or even how to act; it is instead where and what investment priorities should be adopted. The *Rhone* Mediterranean *Corsica Agency* teamed up with researchers to identify the types of phenomena for which one should prepare. We are already acquainted with most of them: rising temperatures and evapotranspiration, increased frequency and severity of droughts, decreasing flows and rainfall-recharge, and declining snow stocks. These are phenomena that have been well analysed by the scientific community and consequently, adaptation strategies, commensurate with their associated vulnerabilities, can be designed.

The Water Authority spearheaded work on France's first basin plan, adopted in 2014, and designed to adapt to climate change. Requirements in terms of water-related adaptation measures were clearly outlined: the organisation of resource sharing through appropriate governance, the deployment of water-saving actions to reduce dependence on a resource that is expected to become scarce, the curtailing of practices and development projects that accelerate soil drying, the reduction of sealed soil surfaces, the restoration of wetlands, and the decompartmentalisation of rivers. The plan includes a package of 60 measures focused on adaptation measures.

To respond to climate change, the Basin Adaptation Plan identified which areas required urgent or more intensive action and focused its attention on them. By combining the intensity of the effects of climate change, as described by scientists, with a territory's vulnerability to such phenomena, vulnerability maps were developed.

Sylvain Michelet, CARF & Marie Genevier, BRGM PACA, France

Franco-Italian cooperation along the Roya watershed and its tributaries

The Roia/Roya River Valley runs through the Southern Maritime Alps, and the Italian-French border intersects the course of the river. During the past 15 years, territorial concertation activities have developed, mainly focused on the cross-border management of water resources. This process of increasing concertation has been possible thanks to European funding, channelled through the Interreg Alcotra Programme (Latin Alps Cooperation), which has backed a variety of projects implemented by Italian-French technical and institutional partnerships. The northern part of the valley lies in France and covers approximately 600 square kilometres, while the southern part, covering about 70 square kilometres, lies in Italy.

In the upper valley there are several dams and reservoirs, managed by the French company EdF, whereas Tirreno Power is the operator of a number of power generation plants in the Italian sector of the valley. In the lower Roia Valley, which is administratively Italian territory.

The French company EdF operates the dams and reservoirs that lie in the upper valley. Tirreno Power is instead the operator of a number of power generation plants in the Italian sector of the valley. The lower Roia Valley, which is administratively Italian territory, features a massive blanket of alluvial sediments with a major and indispensable aquifer, exploited by both French and Italian operators. The aquifer provides drinking water resources, with authorised withdrawals of 2,557 (two thousand five hundred and fifty-seven) cubic meters/sec, with an estimated 40 million cubic meters per year currently distributed by Italian and French aqueducts. This Italian-French agreement materialised in 2013 with the signing of the "Cross-Border Memorandum of Understanding/Convention for the River Roia Basin and its Tributaries" designed for the joint management of the river basin and development of activities intended to foster the sustainable development of the valley.

Annex 3 : Implementation pathway of the Alpine Climate Target System 2050 in the water sector

Alpine Climate Board

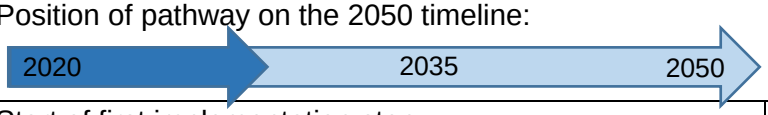
Implementation pathways “Water” of the Alpine Climate Target System 2050

27.2.2020

Implementation pathways

1 IP_W1: Implementation of an Alpine-wide approach for mainstreaming climate change into transboundary water management

Basic information	
Background and description of the pathway	*Climate change will put additional pressures on Alpine water resources: changes in precipitation patterns, reduced snow cover in winter as well as rising temperatures will have effects on the quantitative water balance and water availability. This is already affecting the runoff regimes of rivers, groundwater availability, discharges of springs as well as water levels in natural and artificial lakes. On regional scale, exceptional situations of both water scarcity and floods are expected to become more frequent and more severe, with those Alpine regions that are already affected by dropping groundwater levels and temporal water scarcity today being highly vulnerable in the future.* *At the same time, water management and its integration in spatial planning processes, is an element of climate mitigation and adaptation strategies which also needs to be coordinated at river basin scale. As surface water systems and groundwater aquifers in the Alps are highly interlinked across borders (all rivers flow into five main Alpine river basins), a common approach to deal with these additional challenges for water management is needed.* *The EU Water Framework Directive (WFD) already provides a set of guidelines for Integrated River Basin Planning, which also allows for integrating water management into climate mitigation and adaptation strategies as well as for closer integration between spatial planning processes and water management. In practice, all Alpine countries do already have river basin management plans according to the WFD, and several pilot projects on transboundary River Basin Management are on the way, but in most cases the transboundary focus is still missing, even for larger rivers which do cross two or more Alpine countries. To reach this objective, an Alpine-wide framework should promote transboundary planning tools and participation processes as well as enable intersectoral cooperation (administrative level) and integration of the key stakeholder groups within a river basin beyond the national processes of river basin management plans.*
Final output	• *Identification of hot spots regarding water conflicts and mapping of ongoing coordination activities at transboundary activities and transboundary rivers of great urgency for cross-border cooperation* • *Implementation of transboundary model projects in every Alpine country to promote a transboundary focus in mainstreaming climate change into water management and for integrating water management into spatial planning and climate mitigation and adaptation planning.*
Alpine specific character	*Rivers and lakes in the Alpine River Basins are closely interlinked and pressures on water resources have effects beyond regional and national borders. Also, Alpine waters have an effect on large downstream river basins.* *So far, the Alps have profited from sufficient water of good quality. But climate change shifts the scope of Alpine Water Management more and more towards managing fluctuations in water resources: Changing patterns in temperatures and precipitations increase the*

<table>
<tr><td></td><td colspan="4">frequency and volumes of floods. Simultaneously, droughts – hitherto a lesser concern and only an issue in the southern parts of the Alpine Arc – are an increasing threat. At the same time, climate change increases the users´ demands (for irrigation, cooling, artificial snowmaking and other recreation activities, hydropower etc.), see more about this topic in IP_W1: Tools and methods for drought management in the Alps) Atmospheric temperature increases and the average temperature increase in the Alpine area is nearly twice as high as in the surrounding areas. Because of that also the water temperature of surface and groundwater bodies of Alpine rivers and lakes rises. This directly affects water quality, aquatic ecosystems and their populations as well as biodiversity.</td></tr>
<tr><td>Link to mitigation and/or adaptation</td><td>Mitigation</td><td></td><td>Adaptation</td><td>x</td></tr>
<tr><td></td><td colspan="4">An optimized water management focuses on both quantitative and qualitative water status and has a link to flood and drought risk management, but increases the climate resilience of the river ecosystems as well as of the humans depending on the water resources</td></tr>
<tr><td>Implementation timeframe</td><td colspan="4">Position of pathway on the 2050 timeline:
 
</td></tr>
<tr><td></td><td colspan="3">Start of first implementation step</td><td>Now</td></tr>
<tr><td></td><td colspan="3">End of last implementation step</td><td>2026</td></tr>
<tr><td></td><td colspan="3">Starting point already available?</td><td>yes</td></tr>
<tr><td>Link to target system</td><td colspan="4">Direct link: T_E4: Alpine energy democracy/citizen involvement; T_Eco1: Preserved ecosystems and biodiversity; T_Eco2: Alpine-wide system of protected areas; T_Eco3: Maintained and restored Alpine ecosystem services; T_Eco4: Alpine ecological connectivity; T_W1: Alpine-wide optimized water management; "T_W2: Drinking water security; T_W3: Alpine-wide sustainable flood risk management; T_RD1: The Alps as model region for vulnerability assessments
Indirect link: T_SP2: Planning systems in risk management changed from passive to proactive; T_E2: Renewable decarbonized Alps; T_E3: Decentralized, sustainable energy solutions for the Alps; T_NH1: Alpine risk management; T_Agr1: Energy self-sufficiency of Alpine farms; T_S1: Minimised land-take and sealing; T_S2: Enhanced Alpine soil quality; T_RD3: Alpine-wide climate-data availability</td></tr>
<tr><td colspan="5">Sequence of implementation steps</td></tr>
<tr><td>Starting point and links to stock-taking</td><td colspan="4">RSA2: Water and water management issues (2009)
Guidelines on local adaptation to Climate Change for Water Management and Natural Hazards in the Alps (Platform Water Management, 2014) (stock-taking No. 8).
Initiative “Strategic planning: How to face drought periods in the Alpine Region” (stock-taking No. 10).
5th International Water Conference "Water in the Alps - and beyond: adapting Alpine and mountain river basins to climate change" (2014): online proceedings
7th International Water Conference (Breitenwang 2018, together with the ForumAlpinum)
Project SPARE - Strategic Planning for Alpine River Ecosystems (Alpine Space Programme)</td></tr>
</table>

	• *Project AlpWaterScarce - Water Management Strategies against Water Scarcity in the Alps (Alpine Space Programme)* • *Project C3-Alps - Capitalising Climate Change Knowledge for Adaptation in the Alpine Space: pilot activities on water management in France and Italy (Alpine Space Programme)* • *Project SILMAS – Sustainable Instruments for Lakes Management in the Alpine Space (Alpine Space Programme)* • *EEA (2009): Regional climate change and adaptation: The Alps facing the challenge of changing water resources. EEA Report No 8/2009.* • *Best practise examples presented at the AC Water Conference in Annecy in February 2020* • *EUSALP AG 6 study on Alpine Water Governance* • *EUSALP AG 7 list of rivers with a need for enhanced transboundary cooperation*
Step 1: Identification of hot spots regarding water conflicts, mapping of ongoing coordination activities at transboundary rivers and of transboundary rivers of urgency for cross-border cooperation **2021-2022**	*Based on the mapping exercise which was carried out during the ForumAlpinum 2018 in Breitenwang,[1] the approach will be systematically further developed with the objective to obtain a comprehensive conflict map for the Alpine region.* *This can be compared with the National River Basin Management Plans as well as the proposed hot spot analysis in pathway IP_W1 and links to ongoing activities on national or transnational level, e.g. as already initiated in the large Alpine river basins (e.g. Rhône, Inn, Ticino) as well as to activities of EUSALP AG6 and AG7. Ongoing coordination activities as well as information about transboundary rivers of urgency for cross-border cooperation shall be integrated in the mapping approach to allow a comprehensive overview of conflicts as well as status-quo. On this basis, model river basins are identified where increased cooperation between neighbouring countries would support the avoidance of conflicts between different water use interests, as well as increase the resilience of the river ecosystems and the adaptive capacities of the user management.*
Step 2a: Implementation of model projects for transboundary and climate-proof integrated water management **2022-2026**	*With respect to the model river basins, respectively regions identified in step 1, workshops will be organized to increase regional and transboundary cooperation, by promoting* • *Participatory & cooperative methods and water governance approaches to improve conflict management, especially making use of water-based spatial planning approaches* • *Nature based solutions and opportunities for water storage/retention management by considering ecosystem-based approaches as a priority (working with nature to avoid negative impact of grey infrastructures and to achieve various co-benefits i.e. through flood plains, afforestation, ecosystem restoration, etc.)* • *Innovative solutions to water reuse* • *Regulation of zones without any water extraction/water rehabilitation zones (e.g. linked to remaining riparian wetlands and springs from glaciers)* • *Consistency of water investment plans with climate change adaptation strategies* • *Making use of forecasting approaches in water management: Forward-looking assessment of groundwater resources (addressing demand side before considering*

[1] https://austriaca.at/0xc1aa5576%200x003a30da.pdf

	additional supply) and improved consideration of higher water temperatures and low water levels in the management of water resources in all the countries of the river basins.	
Step 2b: Broadening governance structures for effective conflict management **2023-2026**	*Based on step 1, new, respectively more effective alliances for managing water-related conflicts through integrative approaches are established for the identified model river basins, and disseminated into all major Alpine river basins. This includes all larger water users as well as stakeholders that represent the downstream needs. Also, the general public should be integrated into participatory processes to raise awareness on climate-related pressures on Alpine waters. Stakeholders that need to be integrated into this governance structure are mentioned below.*	
Stakeholders needed for implementation	• *Sub-regional, Regional and national administrations (as responsible for implementation of the Water Framework Directive (WFD) and related legislation on water and natural resources)* • *Authorities responsible for spatial planning* • *Organisations for protection of transboundary river basins (e.g. ICPDR) and other coordinators of river basin management plans* • *Authorities responsible for natural resource management and protection, water and nature stewardship organizations* • *Associations and stakeholders related to specific economic water use interests: electricity producers, agricultural sector, recreation and tourism, drinking water suppliers and households, etc.*	
Indicators for monitoring this pathway	• *Map of existing conflicts and model river basins (yes/no)* • *Model projects: number of transboundary model projects* • *Governance structures: Number of Alpine river basins which have climate-resilient transboundary river basin management plans, including broad stakeholder involvement processes*	
Link to other pathways	• *Direct link: IP_W2: Tools and methods for drought management in the Alps; IP_W3: Implementing of an Alpine-wide flood risk management, based on nature-based solutions* • *Indirect link: IP_E1: Set-up a network of regional energy coordinators; IP_E2: Enabling an Alpine-wide energy democracy; IP_NH1: Implementation of an Alpine-wide risk management plan, focusing on cross-border risks; IP_SP1: Alpine wide concept „Spatial planning for climate protection; IP_S1: Preservation and sequestration of carbon in soil with a focus on peatlands, moorlands and wetlands; IP_S2: Defining Alpine wide guidelines for minimised land take and sealing; IP_Eco1: Protection and management of vulnerable and Alpine specific landscape; IP_Eco2: Enhance transboundary cooperation on ecological connectivity of protected areas*	
Relevance of measure for the Alpine Convention		
Role of the Alpine Convention to implement the pathway	Implementation	• *ACB members and observers to support the identification of model river basins and to initiate the first steps of projects*
	Governance set-up	• *ACB together with other thematic working bodies to promote water governance processes in Alpine river basins.*
	Twinning/know-how transfer	• *ACB to support twinning approaches between model regions/between model regions and follow-up activities.*
	Outreach	• *The lessons learnt of the transboundary model regions to be disseminated in all larger Alpine*

		river basins, encouraging transboundary cooperation
	Knowledge hub	• *Methods for stakeholder involvement processes* • *Methods for creating a common landscape identity for transnational river basins*
Integration in the ACB communication strategy	Content	*Information on results of model regions, lessons learned, etc.*
	Tools	

2 IP_W2: Tools and methods for drought management in the Alps

<table>
<tr><th colspan="2">Basic information</th></tr>
<tr><td>Background and description of the pathway</td><td>Due to their generally large water availability and the specific topographical conditions in the Alps, the impacts of climate change on drinking water security will - on an overall level - be less pronounced than in other European regions. However, in combination with seasonal shifts in precipitation and higher evapotranspiration in summer, some regions in the Alps (e.g., inner-Alpine dry valleys, peri-Alpine locations in the South and East, areas with high water needs) are already affected by temporal droughts. These droughts lead to recurring bottlenecks in water supply during dry periods as well as to impacts on hydropower generation and artificial snowmaking due to changing capacities of water reservoirs. In line with climate change projections (changing interactions between glaciers and river water regimes, changing snow distribution and precipitation patterns), it has to be expected that these regions that are already prone to water scarcity will become highly vulnerable drought hotspots in the future (affecting drinking water, process water for industry and SMEs, hydropower generation snowmaking). Thus, a common approach to deal with drought management throughout the Alps seems necessary.
Furthermore, following the approach introduced at EU level by the Water Framework Directive and taking into account SDG 6, the use of the water resources should carefully take into account the water availability in the whole river basin, thus considering also the possible needs and pressures coming from other drought hotspots downstream. Also, it needs to be ensured that drought management measures are in line with the preservation of ecosystems and their services.</td></tr>
<tr><td>Final output</td><td>• Map with drought “hot spots” under different climate scenarios and water uses which are affected in these hot spots (drinking and process water, hydropower, artificial snowmaking, ecosystems of the wetlands, agriculture, etc.)
• Early warning systems for water scarcity linked to intervention measures in identified “hotspot” regions
• Concept/recommendations on improving water efficiency and infrastructure for use of raw water/process water and water reuse</td></tr>
<tr><td>Alpine specific character</td><td>As Alpine water systems as well as water uses are closely interlinked across borders, a transnational approach to dealing with threats from droughts and thus to drinking water security seems necessary.</td></tr>
<tr><td>Link to mitigation and/or adaptation</td><td><table><tr><td>Mitigation</td><td></td><td>Adaptation</td><td>x</td></tr></table></td></tr>
<tr><td>Implementation timeframe</td><td>Position of pathway on the 2050 timeline:
2020 → 2035 → 2050<table><tr><td>Start of first implementation step</td><td>Now</td></tr><tr><td>End of last implementation step</td><td>2050</td></tr><tr><td>Starting point already available?</td><td>yes</td></tr></table></td></tr>
<tr><td>Link to target system</td><td>• Direct link: T_E4: Alpine energy democracy/citizen involvement; T_Eco3: Maintained and restored Alpine ecosystem services; T_W1: Alpine-wide optimized water management; T_W2: Drinking water security; T_S2: Enhanced Alpine soil quality; T_RD1: The Alps as model region for vulnerability assessments</td></tr>
</table>

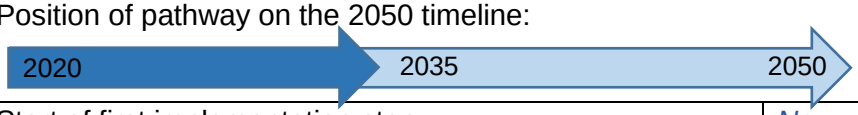
	• *Indirect link: T_Eco1: Preserved ecosystems and biodiversity; T_Eco2: Alpine-wide system of protected areas; T_Eco4: Alpine ecological connectivity; T_Agr1: Energy self-sufficiency of Alpine farms; T_W3: Alpine-wide sustainable flood risk management; T_S1: Minimised land-take and sealing*
Sequence of implementation steps	
Starting point and link to stock-taking	• *RSA2: Water and water management issues (2009)* • *Guidelines on local adaptation to Climate Change for Water Management and Natural Hazards in the Alps (Platform Water Management, 2014) (stock-taking No. 8).* • *Initiative "Strategic planning: How to face drought periods in the Alpine Region" (stock-taking No. 10) and report "Facing droughts in the Alpine region. Experiences, approaches and common challenges" of the Water Platform of the Alpine Convention (2019)* • *Project AlpWaterScarce (stock-taking No. 67)* • *Project C3-Alps – Capitalising Climate Change Knowledge for Adaptation in the Alpine Space (pilot activities in France and Italy; Alpine Space Programme) DriDanube projects and other projects implemented for international river basins.* • *EUSALP AG6 recommendations and good practices on green infrastructure solutions* • *Project ADO (Alpine Drought Observatory), approved and co-financed by the Alpine Space Programme in late 2019*
Step 1: **Hot-spot analysis** **2021-2022**	*Based on the dataset and conflict analysis identified in the pathway "Implementation of an Alpine-wide approach for mainstreaming climate change into transboundary water management" an Alpine-wide climate impact modelling/assessment approach will identify potential drought "hot-spots" under different climate scenarios, taking into account current climate sensitivity of regional water supply systems. This requires a common methodology as well as the identification of a common threshold on how to identify hot spots as well as the application of comparable climate scenarios and tools. This hot-spot analysis shall consider that water scarcity can result from different regional characteristics, so that a classification of hot-spots seems necessary (see e.g. AlpWaterScarce recommendations).* *As final output, an interactive map with potential drought hot spots and an overview on affected water users in these hot spots under different scenarios and for different timeframes shall be established.*
Step 2a: **Set-up early warning and emergency plan** **2022-2025**	*Based on results in previous projects (see starting points above), early warning systems as well as intervention concepts for these hotspots will be developed.* *Up to now, occurrence of droughts is recognized at a late stage, when the signs become visible and when a drought is already underway. It is thus necessary to develop methods and (short-term/seasonal) forecasting techniques to identify drought situations at an early stage and to trigger relevant measures. The early warning system can be linked to the early warning system for natural hazards (see pathway IP_NH1 "Implementation of an Alpine-wide risk management plan") and should be in line with ongoing activities at EU level[2] as well as adaptation strategies developed at different policy levels.*

[2] E.g. the European Drought Observatory: https://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1000

	To trigger effective measures, an early warning system should also include a coordinated emergency plan. This requires the development of an intervention concept including a coordinated prioritization of water uses and regulatory measures for water saving which come into force at specific tipping points. Such an intervention concept considers the effects that those measures have on ecological services of affected areas. Developing and achieving agreement on these measures will require participatory processes with affected stakeholders and water users.	
Step 2b: Concept for infrastructural measures to reduce consumption of drinking water **2022-2025**	*Careful and economical use of drinking water resources needs awareness-raising on water saving behaviour, but it can also be effectively supported by infrastructural measures. To reduce the consumption of high quality drinking water for non-drinking purposes, such as water toilets and irrigation as well as for artificial snowmaking, separate raw and/or processing water systems should be developed and installed, in particular in "hotspot" regions prone to droughts. This would also reduce the effects of droughts on other water uses.*	
Step 3: Continuous monitoring and re-evaluation of hotspots **2025-2050**	*In order to continuously improve the early warning system and emergency plan, actual drought and water scarcity situations shall be monitored and re-analysed (including information on new demand seasonality, socio-economic data etc.). The early warning system will be improved accordingly.* *In addition, effects of measures of the emergency planning concept will be evaluated to allow a future fine-tuning of measures.*	
Stakeholders needed for implementation	*See pathway IP_W2 "Implementation of an Alpine-wide approach for mainstreaming climate change into transboundary water management"* *Stakeholders representing industry and SMEs, hydropower generation, nature protection authorities/organizations, agricultural sector, winter tourism and recreation planning, District Authorities with a proper knowledge of the downstream needs.*	
Indicators for monitoring this pathway	• *Hot-spot analysis: qualitative description of results* • *Early warning system and emergency planning: set-up (yes/no), number/percentage of vulnerable Alpine regions which have early warning systems in place.* • *Concept/recommendations for raw/process water systems available*	
Link to other pathways	• *Direct link: IP_W1: Implementation of an Alpine-wide approach for mainstreaming climate change into transboundary water; IP_S1: Preservation and sequestration of carbon in soil with a focus on peatlands, moorlands and wetlands; IP_S3: Supporting measures to preserve and enhance Alpine soil quality IP_Agr2: Moving to organic and climate-friendly methods in Alpine farming* • *Indirect link: IP_E1: Set-up a network of regional energy coordinators; IP_E2: Enabling an Alpine-wide energy democracy; IP_NH1: Implementation of an Alpine-wide risk management plan, focusing on cross-border risks; IP_NH3: Support measures to enhance individual risk precaution; IP_Eco1: Protection and management of vulnerable and Alpine specific landscape*	
Relevance of measure for the Alpine Convention		
Role of the Alpine Convention to	Implementation	• *ACB can initiate/coordinate the hot-spot analysis: identify lead partner as well as project team to conduct the analysis.*

implement the pathway	Governance set-up	• *ACB in coordination with other relevant bodies of the AC can trigger the establishment of a consortium to develop blueprints for early warning systems and emergency plans.*
	Twinning/know-how transfer	• *ACB can ensure transfer of best practices/experiences with emergency plan (make use and update the stock taking report)*
	Outreach	• *Raise awareness on early warning system and emergency plan*
	Knowledge hub	• *Map with hot-spots could be linked to ACB hub.*
Integration in the ACB communication strategy	Content	*Information on hot-spot analysis, set up of early warning system, etc.*
	Tools	*Interactive map with hot-spots* *Early warning system and emergency plan.*

3 IP_W3: Implementing of an Alpine-wide flood risk management, based on nature-based solutions

<table>
<tr><th colspan="2">Basic information</th></tr>
<tr><td>Background and description of the pathway</td><td>Changing precipitation patterns, especially extreme rainfall events, in combination with changes in snow run-off will lead to changes in flood risk in the Alps. In many regions more frequent and more severe floods risk to cause increasing damage and growing economic losses if no – or the wrong – adaptation measures are taken. Flood hazard zones are likely to extend in many places, while at the same time on-going expansion of settlements and cumulating economic values increase the damage potential independently of climate change.
As the Alpine water system is extremely interlinked and many river systems are transboundary, a coordinated flood-risk management which avoids upstream-downstream conflicts needs to be implemented, prioritising as much as possible “nature based solutions” or “soft” adaptation measures (e.g. “passive flood protection” by means of spatial planning and natural retention areas vs. river engineering and structural protection measures, as well as proper forest management). The advantage in nature based solutions lies in their flexibility towards different kinds of disaster (different water flow or precipitation patterns, floods as well as droughts).
Nature based solutions however are only effective if even selective measures are planned in a coordinated way. Therefore transboundary cooperation is crucial.
Knowledge on regional natural risks and information on self-empowerment shall be used and spread.</td></tr>
<tr><td>Final output</td><td>• Recommendations on flood risk management in the Alps with a focus on green/ecosystem-based solutions are disseminated
• Enhanced transboundary coordination for flood management and exchange of experiences in the Alps</td></tr>
<tr><td>Alpine specific character</td><td>Alpine water systems are strongly interlinked so that extreme rainfall events can lead to cumulative risks and a common approach to dealing with these risks is necessary.</td></tr>
<tr><td>Link to mitigation and/or adaptation</td><td><table><tr><td>Mitigation</td><td></td><td>Adaptation</td><td>x</td></tr></table></td></tr>
<tr><td>Implementation timeframe</td><td>Position of pathway on the 2050 timeline:
 

<table><tr><td>Start of first implementation step</td><td>Now</td></tr><tr><td>End of last implementation step</td><td>2030</td></tr><tr><td>Starting point already available?</td><td>yes</td></tr></table></td></tr>
<tr><td>Link to target system</td><td>• Direct link: T_SP2: Planning systems in risk management changed from passive to proactive; T_E4: Alpine energy democracy/citizen involvement; T_NH1: Alpine risk management; T_Eco1: Preserved ecosystems and biodiversity; T_Eco3: Maintained and restored Alpine ecosystem services; T_W1: Alpine-wide optimized water management; T_W3: Alpine-wide sustainable flood risk management; T_S1: Minimised land-take and sealing; T_RD1: The Alps as model region for vulnerability assessments</td></tr>
</table>

	• *Indirect links: T_NH3: Individual risk precaution; T_Eco2: Alpine-wide system of protected areas; T_Eco4: Alpine ecological connectivity; T_Fo1: Potential of protective mountain forests fully used; T_W2: Drinking water security; T_S2: Enhanced Alpine soil quality*
Sequence of implementation steps	
Starting point and link to stock-taking	• *RSA7: Natural Hazards Risk Governance* • *Alpine Strategy for the adaptation to climate change in the field of natural hazards* • *Guidelines on local adaptation to climate change for water management and natural hazards in the Alps* • *EUSALP AG6 Green infrastructure solutions for an integrated and sustainable water management. Recommendations and good practices* • *Project SPARE - Strategic Planning for Alpine River Ecosystems (Alpine Space Programme)* • *Project AdaptAlp – Adaptation to climate change in the Alpine Space (Alpine Space Programme)* • *Project CLISP – Climate Change Adaptation by Spatial Planning in the Alpine Space (Alpine Space Programme)* • *Compliance with the Flood Directive* • *Considering the Flood Risk Management Plans of the EU Member States*
Step 1a: Dissemination of recommendations for Green(er) Infrastructure **2021-2025**	*For instance the document "Green infrastructure solutions for an integrated and sustainable water management - Recommendations and good practices", adopted by EUSALP in 2019, already compiles good practice examples from Alpine countries and highlights recommendations for different types of rivers, with a specific focus on the dilemma of climate change adaptation needs and spatial pressure in the Alps.* *This document, as well as further already existing recommendations, can be adapted for use under the Alpine Convention and disseminated by integrating it into the agendas of different regional workshops already happening in the Alps.*
Step 1b: Application of recommendations for specific model cases **2021-2025**	*Ongoing planning processes for flood management on Alpine rivers will be identified, and discussions started on how those could take into account the recommendations (see Step 1a).* *At the same time, better coordination of planning activities in all countries of transboundary rivers are promoted by ACB members and respective representatives of the Alpine Convention contracting parties.*
Step 1c: Enhance better cooperation between countries on transboundary rivers **2021-2025**	*At the same time, better coordination of planning activities in all countries of transboundary rivers is promoted by ACB members and respective representatives of the Alpine Convention contracting parties.* *This allows for a larger planning frame on the spatial level, and therefore enhanced effectiveness of the individual measures.*
Step 2: Extension of early warning system on floods **2025-2030**	*Floods are one of the most common natural hazard in the Alps. In cooperation with the pathway "IP_NH1: Implementation of an Alpine-wide risk management plan on natural hazards", it will be checked how flood prevention measures can be integrated in the early warning system.*

Stakeholders needed for implementation	*Public authorities (flood risk management, water management, forest management, civil protection, spatial planning, nature conservation) at local, regional and national level* *Municipalities* *Involvement of local and regional citizens (risk governance approaches)*	
Indicators for monitoring this pathway	• *Increased awareness for nature based solutions at national, regional and local level* • *number of flood management plans the recommendations are applied to* • *number of transboundary rivers with increased coordination of the flood management planning*	
Link to other pathways	• *Direct link: IP_NH1: Implementation of an Alpine-wide risk management plan, focusing on cross-border risks; IP_NH2: Implementation of an Alpine wide monitoring of permafrost and geomorphological processes related to permafrost warming* • *Indirect link: IP_E1: Set-up a network of regional energy coordinators; IP_E2: Enabling an Alpine-wide energy democracy; IP_NH3: Support measures to enhance individual risk precaution; IP_W1: Implementation of an Alpine-wide approach for mainstreaming climate change into transboundary water management; IP_W2: Tools and methods for drought management in the Alps; IP_SP1: Alpine wide concept „Spatial planning for climate protection"; IP_S2: Defining Alpine wide guidelines for minimised land take and sealing; IP_Eco1: Protection and management of vulnerable and Alpine specific landscape*	
Relevance of measure for the Alpine Convention		
Role of the Alpine Convention to implement the pathway	Implementation	• *Best practices: ACB together with other relevant bodies of the AC and the PSAC adapts the existing recommendations for AC needs ACB members identify and take opportunities for dissemination of the recommendations*
	Governance set-up	• *AC National Focal Points call on national and regional authorities to implement recommendations* • *AC supports interlinkage of flood management planning as well as early warning systems*
	Twinning/know-how transfer	• *Bottom-up initiatives as developed within the network as well as the pilot projects should be assisted through partners in ACB, e.g. members of the ACB support application of nature-based approaches in flood planning* • *Members of ACB or other Alpine Convention bodies can use contacts within their country/region to extend the approach.*
	Outreach	-
	Knowledge hub	*Knowledge hub of ACB can be used for disseminating information on best practices. Also, a platform/sharepoint for existing flood risk coordinators could be linked to the hub.*
Integration in the ACB	Content	*Information on best practices, pilot projects, early warning systems.*

communication strategy	Tools	*Early warning system could be linked to ACB hub.*