

## PermaNET



### *Permafrost long-term monitoring network*

- AS priority area: Environment and Risk Prevention
- Duration: 15/07/2008 - 30/09/2011
- [Project webpage](#)
- [Project on the website of the Alpine Space Programme](#)

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## Project summary

“Permafrost is highly sensitive to climatic changes. Permafrost degradation and related natural hazards affect traffic routes, tourism areas, settlements and infrastructures. The main problem is a lacking strategy for the consideration of these newly observed specific impacts of climate change in risk prevention and territorial development. With the joint development of a common strategy for dealing with permafrost and related hazards under changing climatic conditions and the creation of an Alpine-wide monitoring network the project aims at preventing natural hazards, at contributing to sustainable territorial development and at the implementation of good governance practices. Outputs are an Alpine-wide permafrost monitoring network, a permafrost map for the entire Alpine Space and guidelines for the consideration of permafrost in risk and water resources management. The project arises the awareness of decision-makers and responsible authorities to this topic and provides Alpine-wide decision bases and strategies.” Source: [PermaNET project summary](#)

## Hypotheses

- [Sensitive Alpine territory requires appropriate and diversified measures \(consensus-oriented multi-stakeholder approach\)](#)
- [Alps are a hotspot for maintaining and restoring ecosystem services](#)

## Keywords

- [climate change](#)
- [prevention](#)
- [governance](#)
- [water management](#)

## Topics

- [Developing access to information and knowledge](#)
- [Limitation of natural disaster impacts](#)
- [Enhancing and protecting natural resources and natural heritage](#)

## Results

[Results](#) of a project can be differentiated in [outputs](#), [outcomes](#) and [impacts](#) of an intervention. Source: [OECD Glossary of Key Terms in Evaluation and Results Based Management](#).

## Outputs

Output	Category	Language(s)	Target group	Remark
<a href="#">The Alpine Space permafrost monitoring network</a>	Network	EN	Civil servants / administration; scientists; specific institutions	<p>"The Alpine-wide monitoring network now consists of 40 key monitoring sites which are measuring different parameters and characteristics of permafrost in rock and debris covered soils".</p> <p>Source: <a href="#">The Alpine Space permafrost monitoring network</a>. A <a href="#">table of the permafrost monitoring sites</a>, an <a href="#">overview map of permafrost monitoring sites in the Alps</a> and a <a href="#">handbook for the installation and maintenance of an alpine-wide permafrost monitoring network</a> that describes the use of selected permafrost detection and monitoring methods are available.</p> <p><b><a href="#">In depth information about Alpine Space permafrost monitoring network</a></b></p>
<a href="#">PermaNET synthesis report</a>	Report	EN, IT, DE, FR	Policy makers; civil servants / administration; scientists	<p>In order to disseminate the project's results and recommendations to reduce hazards in a permafrost environment to policy stakeholders, local stakeholders and experts, the synthesis report was elaborated. Some recommendations for policy makers at the end of the document. <b><a href="#">In depth information about PermaNET synthesis report</a></b></p>
<a href="#">Alpine Permafrost Index Map - APIM</a>	Map	EN	Civil servants / administration; specific institutions; scientists	<p>"The Alpine Permafrost Index Map (APIM) [...] shows an index of the estimated likelihood of permafrost occurrence for the entire Alps. The legend and the interpretation key provide further information and allow the map user to refine the interpretation of the color code shown on the map using more detailed information of the terrain considered. The map is intended for practitioners such as public authorities or individuals involved in the construction and maintenance of infrastructure in mountain areas." Source: <a href="#">Alpine Permafrost Index Map - APIM</a>. <b><a href="#">In depth information about Alpine Permafrost Index Map - APIM</a></b></p>

Output	Category	Language(s)	Target group	Remark
<a href="#">Inventory of permafrost evidence</a>	<a href="#">Database</a>	EN	Civil servants / administration; specific institutions; scientists	"It shows the locations where the existence of permafrost was proven. [...] It allows researchers, institutions, or monitoring services to register their existing data within the newly standardized scheme in a user-friendly manner." Source: <a href="#">Inventory of permafrost evidence</a> . <b>In depth information about inventory of permafrost evidence</b>
<a href="#">PermaNET documentary</a>	<a href="#">Public relation</a>	EN	Civil society / citizens	A documentary film about the permafrost monitoring activities in the entire Alpine Space. <b>In depth information about PermaNET documentary</b>
<a href="#">Education tool kit</a>	<a href="#">Tool</a>	EN, DE	Civil society / citizens	"In the superior context of general education dealing with permafrost it helps pupils (i) to understand natural processes and achieve environmental competences, (ii) to get an exemplary insight into the world of (applied) natural sciences, and (iii) to learn about the crucial importance of sustainable development for the entire Alps following the "philosophy" of the Alpine Convention." Source: <a href="#">Education tool kit</a> , p. 2. <b>In depth information about education tool kit</b>
<a href="#">Permafrost-related hazards and permafrost degradation report</a>	<a href="#">Literature review</a>	EN	Scientists; specific institutions	"A state of the art report about permafrost-related hazards and permafrost degradation. The 4 chapters deal with <a href="#">rock glaciers</a> , <a href="#">debris flows</a> , <a href="#">rockfalls</a> , and <a href="#">local ground movements</a> and their effects on infrastructure. Each chapter summarizes present knowledge about these processes and their relationship to the climate change, and is illustrated by several recent case studies in the Alps. These case studies show the variety of effects on infrastructures in high mountain area." Source: <a href="#">Permafrost-related hazards and permafrost degradation report</a> . <b>In depth information about Permafrost-related hazards and permafrost degradation report</b>

Output	Category	Language(s)	Target group	Remark
<a href="#">Methods sheets / operational approaches for detection and monitoring of slope movements and ground temperature in permafrost areas</a>	Methodology	EN	Scientists; specific institutions	The six method sheets are about <a href="#">dGPS</a> , <a href="#">GPR</a> , <a href="#">DInSAR</a> , <a href="#">ERT</a> , <a href="#">TLS</a> , and <a href="#">terrestrial photogrammetry</a> . “Basic principles of each method are summarized, before listing their possible applications, and the main results, opportunities and limitations; each sheet is completed with references and illustrated with some figures. Comparisons between some pairs of these methods were realized, and a SWOT analysis completed this assessment.” Source: <a href="#">Methods sheets</a> . <b>In depth information about methods sheets / operational approaches for detection and monitoring of slope movements and ground temperature in permafrost areas</b>
<a href="#">Permafrost response to climate change report - WP 5.3</a>	Report	EN	Scientists; specific institutions	The report shows that “ongoing climate change has a number of complex influences on the ground temperature but also ground stability on the mountain permafrost of the European Alps.” Source: <a href="#">Permafrost response to climate change report</a> , p. 5. <b>In depth information about Permafrost response to climate change report</b>
<a href="#">Permafrost and water resources management report - WP7</a>	Report	EN	Scientists; specific institutions	“Rising air temperature has caused the release of highly concentrated meltwater from active rock glaciers. In response to the enhanced release of ions and heavy metals high altitude lakes, which are drained by meltwater from rock glaciers, can experience a substantial change in water chemistry. [...] Climate change induced permafrost degradation may have major impacts on ecosystems, landscape stability and on people and their livelihoods.” Source: <a href="#">Permafrost and water resources management report</a> . <b>In depth information about Permafrost and water resources management report</b>

## Résumé of project outputs

### Results which are directly or indirectly suitable or applicable for practitioners / politicians and civil servants / administration:

- The *inventory of permafrost evidence*, the *APIM*, the *handbook for the installation and maintenance of an alpine-wide permafrost monitoring network* and the *methods sheets / operational approaches for detection and monitoring of slope movements and ground temperature in permafrost areas* are suitable for application by researchers and practitioners. In particular, it is desirable the integration of these results and of the standardized methodologies elaborated in the context of national and regional monitoring and measurement programs in order to obtain higher level results. Merging the different monitoring techniques and models would allow to make the most of the potential of existing data and would make possible to better quantify the evolution of permafrost and related risks over a wide area. These results can be used to effectively monitor the evolution of permafrost in the Alps because they represent one common knowledge base.
- The *guidelines for consideration of permafrost in natural hazards* are defined by PPs as a decision-base for decision makers and local authorities supporting the development of regional/local adaptation and risk management strategies. The recommendations are still at a very general level, but this is in line with the mainly scientific character of the project and the objective of simply rising the awareness of decision-makers and responsible authorities to permafrost. The recommendations briefly present all the tools that have to be used if there is the presence of permafrost in a specific location in order to proceed with on site and detailed studies that have to be made before making conclusions and decisions in risk management. However, it is not explained to civil servants how to concretely implement these products in their daily practice.

### Which of the project results are usable for which aspect of SSD and which are the most relevant for practitioners / politicians and civil servants / administration?

The most relevant results for practitioners, civil servants /administration and decisions makers are:

- The *Alpine permafrost monitoring network*.
- The *inventory of permafrost evidence*.
- The *APIM*.
- The *guidelines for consideration of permafrost in risk management*.
- The *methods sheets / operational approaches for detection and monitoring of slope movements and ground temperature in permafrost areas*.
- The *recommendations to consider permafrost in drinking water resource management*.

These first five results are all relevant for these topics of sustainable spatial development:

- **Limitation of natural disaster impacts** (taking preventive measures + reducing the vulnerability of settlement structures) -> it is clearly stated that permafrost has to be considered in natural hazard management and regional development. The increased awareness gained thanks to the project on the existence of permafrost and its adverse effects on economic activities is helpful for improving the efficiency and sustainability of infrastructure investments in high mountain areas.
- **Developing access to information and knowledge** -> the creation of a network has allowed to identify and compile existing knowledge about permafrost in the Alps. The diffusion of knowledge in the natural science field is made possible by the (almost) full accessibility to the project results.
- **Enhancing and protecting natural resources and natural heritage** (use the resources and the territory sparingly and compatibly with the environment) -> economical activities, settlements and infrastructures in high mountain areas should be developed compatibly with the specific

characteristics of areas with permafrost because with scenarii of permafrost degradation in the future decades, these areas will be exposed at a much higher risk due to permafrost-related risks.

- Another SSD topic that is in part addressed by the recommendations to consider permafrost in drinking water resource management (WP7) is [reducing environmental damage](#) -> permafrost degradation may have impacts on ecosystems due to the presence of heavy metals particles.
- The toolkit and the film documentary are important to make people aware of the crucial importance of permafrost and the necessity to promote natural heritage as a basis for a sustainable living in the Alpine Space.

Are there results which need further steps to be useful for practitioners / politicians and civil servants / administration?

- The *permafrost monitoring network* has to be further developed because the different scenarii suggest that permafrost degradation will accelerate in the next decades. Thus, high mountain areas and mountaineering activities would be exposed at a much higher risk due to permafrost related hazards. The state of permafrost should be documented on the base of more monitoring stations and standardized data covering a wider area because permafrost monitoring is important for its contribution to understanding issues related to the environment, climate change and natural hazards. In WP 5.3 it has clearly been highlighted that no sufficient information is available to study the long term thermal reaction of permafrost to climate change (no more than 10 years of recorded data in any sites).
- The link to the *inventory of permafrost evidence* has to be replaced in the project website. At the moment it is impossible to have access and for researchers that weren't project partners it is impossible to know where the output can be found (<http://www.alpine-permafrostdata.eu>).
- The *permafrost map (AIM)* has been modeled on the base of the state of knowledge before the project closure. In order to be more useful for potential users, 3 steps are required:
  1. The map has to be tested to validate its real quality. The map is built with the same criteria for all the Alpine Space countries, it can be the object of a validation experiment settled-up through the whole Alps.
  2. The spatial resolution (30 m) should be enhanced and information about local grounds conditions/factors that allow to refine the estimate should be added.
  3. The map should be updated with new datasets of permafrost evidence (collected in the inventory) in order to have a finer definition of the permafrost distribution in some areas.
- The influence of permafrost to debris flow process related knowledge has to be extended to become effectively useful for practitioners / politicians and civil servants. In WP6 it has been showed that there exists a few examples of debris flows where permafrost partially influences the hazard situation. Therefore, the influence of permafrost to debris flow process is relevant only for a small part of the Alpine Space territory. Nevertheless, the safety of access roads and pass roads in high alpine areas is affected by these phenomena. The knowledge about the interrelation between permafrost and debris flow activity, the characteristics of materials subjected to permafrost action and their evolution with evolving temperatures is still poor in regards to the high relevance of roads in the Alpine countries.
- WP7 results are valid only for a limited area (one region) because pilot activities were very restricted. It is necessary to gain a better understanding of the problem related to chemical composition of water from permafrost areas and to check if the results obtained (high contents of heavy metals) are a systematic characteristics of hydrological systems with permafrost melt water because this problem has serious implications for people's health and ecosystems.

Which kinds of stakeholders have been involved, how have their competences been used in the project and are there options for a better implementation?



The final report states that “for specific issues, observers, relevant stakeholders from NGO's, tourism industry and electric power production companies were invited to participate. Collaboration between different stakeholders and sectors coupled with close ties to other key institutions (e.g. tourism industry, drinking water supply, ski resorts,) provides a wide field of experiences and allows interdisciplinary and holistic approach.” Even if the PPs were only research centers and regional authorities, the list of observers shows that a wide panorama of different actors has been involved and well-represents the different typologies of actors that operate in high mountain areas where permafrost may be present. It seems however to be options for a better implementation. It is not clear in fact to what extent the important knowledge and expertise that has been accumulated on permafrost occurrence, evolution and related hazards in the Alpine Space has been communicated to relevant users and stakeholders outside the research world, the national and regional authorities involved in the fields of natural hazards management, civil protection, environmental protection, water resources management and the observers. According with the available information, it seems that the dissemination has not been so large, because since there is no evidence of conference or public events (except for the final conference) and because one of the main actions of the project PermaNET-CAP (not financed) was to diffuse knowledge to stakeholders. It will be fundamental to better inform about mountain permafrost and management of related issues the different categories of professionals working in high mountain environments (ski resort managers, cable-car societies, hazard managers, mountain guides, ...).

Are the results (tool, method, indicator, recommendation) directly or indirectly addressing the strategic objectives for the Alpine Space?

The project and its results mainly address the objective of a sustainable managed biodiversity. More in detail, the project enhances the prevention and mitigation of natural hazards and management of their consequences, with specific regard to climate change impacts. It improves the prevention against natural hazards and risks and the governance in natural hazard and risk management through a common decision base that allows saving costs. The project addresses also the requirement that the high mountain areas remain an attractive place for living and for recreational activities. The products developed in the project support the security of high alpine road, ski resorts, mountain trails, infrastructures like huts and alpinism activities.

What could be long-term outcomes of this project? If none, why low impact? Why high impact? What is needed to achieve outcomes in the long-run?

The PermaNET project provided the bases for the establishment of a transnational permafrost monitoring network in the Alps that could be the most relevant long-term outcome of the project. However, the long term continuation of the transnational permafrost monitoring network of researchers and practitioners can only be insured if national networks and national funds for permafrost monitoring activities are established. It is necessary to define ways to coordinate the transnational network and to find financial support for the maintenance of what has been already established and the development of new monitoring stations. The establishment and labelling of national network has to be supported by national agencies (like PERMOS in Switzerland that is the first country in the Alps that has coordinated permafrost activities on a national scale) that will have the obligation to contribute to the European transnational network and to use the standardized methodologies in order to have harmonized and comparable data on an alpine wide scale.

## **Outcomes and Impacts**

Unlike project outputs, outcomes and results cannot be described in a standardised way. Therefore,



they are listed as free text.

### Achievements that could be further implemented

- Not used data bases -> concerning the Italian situation, the Lombardia Region (it wasn't a PP of PermaNET) has its own monitoring activities and data that have never been integrated in the inventory.
- Not planning implementation of recommendations and effective use of project results -> PermaNET provided general decision based-tools for the authorities and companies working in high-mountain areas, but no binding documents or mandatory provisions for infrastructures in alpine areas with permafrost evidence. There is no evidence that the results and the knowledge generated are effectively used in natural hazard management practice and in territorial planning. The project has mostly focused on the knowledge and scientific content production; effective communication and transfer paths to target groups still have to be designed and consequently the application of PermaNET results in governance contexts has still to be done. The products and tools developed by the project haven't been adapted to the needs of the different typologies of possible end-users.
- Not disseminated knowledge -> The results of PermaNET have to be made accessible to less-scientific target groups, their use has to be promoted at all pertinent levels and stakeholders must be helped in integrating permafrost issues in their practice. The knowledge generated still needs to be better capitalised in different institutional settings.
- Better options to expand knowledge -> in order to enlarge the database data concerning the instability phenomena in high-mountain environment that is extremely important for the analysis of risk and natural hazards related to mountain permafrost degradation, training and education of stakeholders like high-mountain professionals (mountain-guides, refuge and hut operators, climbers, alpinists) in reporting pictures, dates and locations of instability would be important and can lead to the collection of very important data.

### Remaining gaps

- Not covered spatial areas -> the distribution of monitoring sites is uneven and doesn't cover the entire Alpine Space. Gaps should be filled with new monitoring sites in order to gain a better understanding of the evolution of permafrost at the alpine level. The main constraint in the implementation of new monitoring sites is represented by the necessity of having national/regional funds for installations.
- Gaps between projects results and implementation -> practical-use/integration of PermaNET results and tools by less-scientific target groups and into the existing policies or into new regional and local adaptation strategies is still missing. The use of PermaNET results hasn't been promoted at pertinent levels of regional and local administrations. PermaNET was essentially a scientific project that has allowed to compile the existing knowledge on permafrost, but its products need further adaptation in order to be effectively used by civil servants and authorities and to effectively contribute to sustainable territorial development and good governance.

### Emerging contradictions

none

### **Accessibility of project results**

- [PermaNET outputs on the official website of the project](#)
- [PermaNET outputs on the website of the Alpine Space Programme](#)

[climate change](#), [risk management](#), [governance](#), [prevention](#), [water management](#)

## Synergies

- [Climate change](#)
- [GIS based tools](#)
- [Educational tool kit](#)
- [Reducing environmental damage and natural hazard risk prevention](#)
- [Understanding water cycle](#)
- [Tourism](#)

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