Mountains for Europe's Future

A Strategic Research Agenda

An input to the Horizon 2020 Work Programmes and Calls 2018–2020
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Executive Summary

This strategic research agenda is the product of an enthusiastic year-long collaboration between researchers based in centres of excellence, across many different disciplines and European countries. Our primary goal is to highlight the importance of mountains in providing insights and solutions to many of Europe's pressing challenges. To this end, we call for the inclusion of specific call topics on mountain research within the 2018–2020 Work Programmes of Horizon 2020.

„Mountains for Europe's Future" aims to raise awareness of the many contributions that mountains make, and can make, to life in the lowlands. It communicates the growing pressures on mountain regions and provides an overview of key challenges and opportunities. Europe's mountains are not only amongst the regions where the effects of climate change are most evident, but are experiencing notable land use change and significant losses of rural populations. Some of Europe's less developed regions are in mountainous areas, yet mountains are among the most important providers of natural resources. Many mountain areas are at risk of becoming primarily touristic destinations for urban citizens, with negative impacts on cultural and natural heritage. Such challenges require original solutions that will bring benefits both in the mountains and more widely across Europe.

Interdisciplinary research in mountains can contribute very positively to addressing Horizon 2020 priorities, as well as to wider EU policy goals. Such research can play an important role in making mountain regions more competitive, innovative and able to contribute strongly to the European Commission's economic growth and sustainability agenda. Equally, mountain areas are places to develop and deploy new technologies, and can be test-beds for innovative solutions to many of Europe's most pressing challenges – not only in the mountains, but also in other areas with sparse populations and/or where access is a challenge. However, to date the Horizon 2020 calls have not adequately covered interdisciplinary research in mountain areas. Consequently, this document makes a compelling case for why this important gap should be filled within the 2018–2020 calls. The proposed research will also contribute towards implementing the European Commission's Action Plan for the Alpine Region, which makes a specific commitment to achieving its goals through projects financed under Horizon 2020.

We believe that the evidence and recommendations we present should encourage the European Commission to include specific call topics on mountain research within the 2018–2020 Work Programmes of Horizon 2020, and inspire researchers as they prepare their proposals.

The three sections of this document:

» 8 reasons why mountains are important at the European scale;

» 6 key recommendations for activities on mountain topics within Horizon 2020;

» 6 sets of proposals for interdisciplinary research in mountains to be included in future Horizon 2020 calls, structured according to the programme's Societal Challenges.
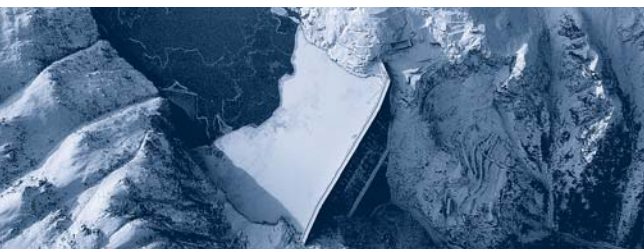
Why are mountains important ... for everyone?

For most people, the mention of mountains conjures up images of hiking and skiing, cows and cheese, fresh air and fresh snow. However, mountains are far more than inspirational backgrounds or a setting for bucolic farms and family hikes. Mountains actively provide ecosystem services for all Europeans, even those living in distant lowland regions. Every sixth European citizen lives in the mountains, and the quality of life of every European depends on the goods and services that mountains provide.

We need to shift our understanding of mountains. They can offer unique solutions and insights into many of the most pressing challenges currently faced by Europe – for example, how to ensure smart transport, clean energy, or sustainable tourism. Mountain regions must be viewed as places where new technologies can be tested and deployed, and as test-beds for innovative solutions to societal issues. The inclusion of call topics on mountains in the 2018–2020 calls of Horizon 2020 would help to ensure that this new understanding of the potential of mountains is fully in line with the major objectives of the Europe 2020 strategy for smart, sustainable and inclusive growth, and with the EU Strategy for the Alpine Region.

Today, Europe's mountains face a range of challenges that demand increased research efforts and concerted policy solutions. From shrinking populations to retreating glaciers, the future of mountains and the lowland populations that depend on their services hinge on how policy makers often in distant cities address the challenges of managing mountain resources and supporting mountain populations in a rapidly changing world. As the following eight points illustrate, answering these challenges – and taking advantage of the resultant opportunities – is fundamental to Europe's future.

1 - Mountain ranges transcend political boundaries

Mountain ranges cover 36 percent of Europe's area and cross many national borders. The Alps and the Carpathians, for example, are each shared by 7 countries, highlighting the need for research and policies that transcend boundaries. Mountains are often portrayed as high outposts for lonely shepherds or adventurous hikers. The reality is that mountain regions heavily influence, and are heavily influenced by, lowland areas – both nearby and distant – and are part of global

economic systems. However, the cause-effect relationships of these interdependencies are not well known. From timber and minerals to tourists and hydroelectricity, mountains and lowland areas are linked by dynamic flows of goods and services that are important to the well-being and security of people in all parts of Europe. Natural disasters originating in mountains have effects from local to regional scales, including downstream areas, e.g. floods, whose detrimental impacts can only be minimized by careful management of mountain resources.

2 - Mountains are part of Europe's cultural heritage

Europe's mountains and their cultural landscapes, which have evolved through centuries of interactions between people and ecosystems, are part of our common heritage. They are crucial not only for the identity for every sixth European who lives in the mountains, but also for over 150 million people who visit mountains each year for the recreational and cultural opportunities they offer. Mountains contribute to the security and health of mountain and non-mountain populations. In an increasingly urbanised, high-paced world, mountains represent crucial retreats where people can recreate, recharge and re-engage with nature and with themselves. Both tourists and people living outside mountain areas enjoy high-quality mountain products – such as cheese, mineral water and wine – that are emblematic of local cultures and can contribute significantly to mountain economies.

3 - Mountains are water towers

Mountains are the water towers of Europe, supplying disproportionate amounts of runoff to Europe's rivers in comparison to lowland areas. The Alps, for example, cover only 10 percent of the basin of the Danube but contribute 25 percent of its flow. For the Rhine, the respective proportions are 15 and 34 percent. Similarly, mountains provide a significant proportion of Europe's hydropower, a clean and renewable source of energy. Yet the temperature of mountain lakes, rivers and streams has increased in recent decades. The continuation of this trend, together with the continued retreat of glaciers, seasonal changes in runoff and snow cover, as well as more frequent and severe floods, will lead to significant changes in water availability, with impacts on both human and natural systems. Conflicts between users are likely to increase. All of these changes imply a greater need for more effective policies and management processes to address uncertainty.

4 - Mountains are biodiversity hotspots

Europe's mountains are centres of biodiversity. Alpine ecosystems above the treeline cover only 3 percent of Europe's area, but host 20 percent of its native vascular plant species. Mountains are also refuges for many endemic species, found in very restricted areas. Half of Europe's High Nature Value farmland is in mountain areas, and 15 percent of their total area is protected as national parks, nature reserves and other types of protected areas. Yet both intensification and land abandonment are homogenising the landscapes of many mountain areas, increasing their forest cover and reducing their biodiversity. While agricultural management on economically profitable sites is being intensified, remote areas and those with potentially lower yields are being abandoned. Mountains are also key habitats for large carnivores such as wolves and bears, as well as for large ungulates. The expansion of forests therefore both provides opportunities for reintroducing native species and represents a challenge with respect to conflicts between expanding carnivore populations, livestock and people.

5 - People need mountains, and mountains need people

Land abandonment is one symptom of a long-term negative trend in socio-economic conditions that characterises the rural parts of most mountain regions in Europe. Since the mid-20th century, advances in technology and globalisation have dramatically reduced the need for labour in agricultural production, and there has been a strong decline in birth rates in rural mountain regions. Together with increasing out-migration due to reduced economic opportunities, decreasing natural population balances have led to shrinking and ageing populations in many areas. These trends exacerbate the challenges for economic development and service provision that these regions face. They also represent challenges for landscape management and tourism, as the patchwork of forests and pastures that characterise agricultural landscapes are both important for biodiversity and attractive to tourists.

6 - Mountains are sentinels of change

Mountain areas are tightly linked to their surrounding regions and are experiencing rapid economic, demographic and land use changes. These will impact and alter pre-existing economic, social and environmental relationships. Furthermore, future climate change will affect mountainous areas and alter temperature and precipitation regimes, global radiation and relative humidity. These changes will have impacts on floods, droughts, snow cover, glacier and permafrost retreat, natural hazards and species. Species in mountainous areas, for example, are already experiencing a range shift towards higher altitudes due to increasing temperatures.

However, small-scale habitat diversity – a common feature in mountain environments – also safeguards mountain biota against species losses. All these predicted and ongoing changes will influence societies in mountains as well as in the adjacent lowlands and will challenge their adaptive capacities.

7 - Mountain economies are diverse and provide resources for the economies of wider regions

It is a common perception that mountain people live mainly in remote and isolated areas shaped by farming and tourism. However, mountain economies are not limited to primary and tertiary sector activities, nor are they independent of the surrounding lowlands. In EU Member States, only in Cyprus and Portugal is more than a fifth of the mountain population employed in the primary sector; in most mountain regions, the proportion is less than 10 percent. In the Alps, one of the world's most popular tourist destinations, tourism-related activities are concentrated in only 10 percent of Alpine communities. Depending on the availability of energy and raw materials, the proximity of major settlements in and around European mountains, and the accessibility of international transport networks, spatially concentrated manufacturing and secondary sector activities shape mountain societies and environments. Together with the expansion of information and communication infrastructure, all these interacting processes form a complex reality – both rural and urban – that is reflected in the great spatial variability of European mountain economies.

8 - Mountains have the potential to be viable, vibrant places to live and work

In most European mountain regions, outside urban areas, there is a lack of efficient and environmentally sustainable transport, including local roads and railways, of effective Information and Communication Technology (ICT) and of networks (e. g. limited broadband). The complex topography of mountain areas presents particular challenges in terms of transport access, which is essential for all economic activities. Similarly, there has been a lag in the installation of ICT infrastructures, which are essential for connecting mountains with the rest of Europe and the world. Addressing inadequate transportation and ICT infrastructure is vital not only for many aspects of economic development, but also for institutional development and capacity, governance, and the delivery of health, education and other services.

Europe's mountains are too important for the health of the continent's environment, economy and society to remain a low priority in research and policy discussions. Sustainable mountain development is therefore a fundamental response to environmental pressures and societal challenges. There is an urgent need for innovative approaches supported by novel, integrated policies that work across borders and between upland and lowland regions, and involve all concerned stakeholders. This implies an urgent need for increased research efforts and concerted policy solutions. These must take into account environmental and societal challenges, to effectively address the negative socio-economic trends that currently characterise many parts of Europe's mountains, and increase our ability to respond wisely to rapidly changing conditions not only in the mountains, but across our continent.

Key recommendations

Within the strategic framework of Horizon 2020 in the 2018–2020 calls to deliver excellent science for Europe, there should be increased attention to mountains, bringing benefits both to the continent's diverse mountain areas and to Europe as a whole.

We recommend that:

1. The 2018–2020 calls under Horizon 2020 should include specific topics on interdisciplinary research on mountains. This is vitally important, as such research can offer insights and solutions to many pressing challenges currently facing Europe. For example, many challenges in the climate and environment fields have not yet been adequately addressed in Horizon 2020 calls. We note that several call topics relating to the Arctic have been included in the 2016–2017 Work Programmes, and urge that a similar approach be taken for mountain research in the 2018–2020 calls.

2. Topics relating to mountain research in Horizon 2020 should focus on different mountain ranges across Europe, concentrating on solutions to specific challenges that could be applied to other geographical areas and have broader implications for EU policy priorities. To date, EU-funded research on mountains has concentrated on the Alps, Nordic and Iberian mountains, and those of the British Isles. Mountain ranges such as the Carpathians and Pyrenees have received less attention; the Balkans and Apennines even less. This implies the need for a targeted approach to strengthen the cohesion of European societies and territories.

3. Some research projects funded by Horizon 2020 in mountain areas should extend beyond the usual 2–4 year cycle. This is because many changes can only be identified and explored by research activities with longer and more flexible time frames, with scope for reiteration and continued investigation of changes and adaptation processes. Crucially, mountain environments present clear evidence of the effects of climate change over many years: the retreat of glaciers and the upward movements of plants on mountain summits are only two examples of these effects. However, the socio-economic implications of such effects and the processes that drive them are complex and not yet clear.

4. Horizon 2020 should continue to promote dialogue and cooperation between research and practice and to apply and disseminate research results using effective means of communication. To improve the uses and impacts of research, appropriate communication tools must be used to effectively reach different types of stakeholders – including policy makers, entrepreneurs, journalists, and the public – in different mountain ranges across Europe, as well as those outside the mountains who depend on the goods and services they provide.

5. Recognising that Horizon 2020 emphasises nature-based solutions towards greening the economy and achieving sustainable development, such solutions should be applied especially in mountain areas, where global and climate changes have crucial effects. This would build on the call topics of the current Environment and Climate Action Societal Challenge.

6. Horizon 2020 should lead to the strengthening of research infrastructure in mountain areas, especially those that are marginalised, and contribute to the productivity and competitiveness of mountain economies.

Proposals for research
Health, demographic change, and well-being

Rationale

One sixth of Europe's population lives in mountain areas, in both rural and urban settings. There are many interacting factors that influence demographic change. As these vary significantly at every scale across these mountains, there are few commonalities. Some mountain areas, especially in and around towns, cities and tourist resorts, have increasing populations; other places are attracting „amenity migrants", and many areas, especially rural areas, are losing population. However, there is one very widespread trend: in almost all rural parts of the mountains, populations are ageing. This means that a major challenge is to maintain and provide equitable services, especially in areas with limited accessibility. Access to quick diagnosis and treatment in remote areas is essential not only for active and healthy ageing but also for healthy communities. Although delivering high-quality health and social care in remote and rural areas is challenging, the increased usage of e-Health technologies can help to improve accuracy in the diagnosis of medical conditions and their subsequent management, facilitate self-care or on-going care closer to home, and reduce numbers of hospital admissions.

On an increasingly urbanised continent, mountains are core contributors to our physical and mental health and well-being. They provide many social and environmental amenities to the majority of Europeans living outside the mountains – as well as to mountain people. People living in mountain areas ensure the continued provision of these amenities benefiting all of us. This may be jeopardised by the increasing challenges to their social structures, especially when these challenges lead to decreases in the number of people active in agriculture and forestry.

In recent years, expertise in health and social care in remote and mountainous environments has been growing. Nevertheless, to solve the major challenges with regard to the health and well-being of mountain people and contribute to the strategic objectives of Health 2020, there is a strong need for enhanced European cooperation. Horizon 2020 represents an ideal opportunity to do this, building on the specific characteristics of mountain regions as unique test beds for developing innovative solutions to the challenges of preventing, diagnosing and treating the medical conditions of people living in remote areas with limited access to health and social care infrastructure. Such solutions need to be supported by strong leadership, participatory governance and capacity building, and should contribute to policy development.

The inclusion of specific health actions for mountain regions in Horizon 2020 will further enable the upscaling of evidence-based innovations into less-developed regions of Europe. Many of these are in mountainous areas, but the experience gained can be used much more widely. Future cooperation should also build on the success of the European Innovation Partnership in Active and Healthy Ageing in the areas of independent living, age-friendly environments and integrated care in the community, and enable new solutions to be tested in mountainous areas.

Additionally, human health benefits from experiencing nature. Communities in mountain areas, as well as their visitors, can benefit from positive interactions between nature, biodiversity, ecosystem services and health. In this context, ensuring the participation of the inhabitants of mountain communities in decision-making is vital for sustaining these communities and the environments on which they and millions of visitors depend for healthy lives.

Health, demographic change, and well-being

Proposals for research activities

Enhance sustainable e-Health technologies to prevent and manage disease

» Assess and test concepts for e-Health technologies to improve rates and accuracy of diagnosis in mountain areas.

» Develop innovative solutions to the challenges of preventing, diagnosing and treating medical conditions that afflict people in remote areas with limited access to health infrastructure.

» Evaluate ways to implement e-Health technology to enhance professional support, education and competency-based training for remote care workers and healthcare practitioners.

» Investigate potential means of supporting self-management through patient education and training, including evidence-based decision support and guidelines.

» Evaluate improvements in quality and equity of health outcomes in mountain areas and their economic benefits.

Foster health-based tourism in mountain areas

» Analyse existing approaches for health-based tourism in mountain areas and means for developing innovative strategies to provide health tourism that is based on key mountain assets.

Facilitate sustainable recreation and tourism development

» Assess the effects of recreation and tourism development on the communities and economies of mountain areas.

» Explore opportunities for innovative approaches to recreation and tourism development with low environmental impacts and high societal benefits to both mountain communities and their visitors.

Develop equitable models to provide services for all ages

» Explore models for multi-functional economies at household, settlement and regional scales to stop losses of young people from mountain areas.

» Study ways to promote age-friendly environments and integrated care units in communities in mountainous areas.

» Evaluate how governance systems that include participatory decision-making can ensure socially and economically sustainable and healthy communities in mountain areas.

Food security, sustainable agriculture and forestry

Rationale

Europe's mountain areas contain 15 percent of the continent's Utilised Agricultural Area and produce 11 percent of European agricultural output, mainly from pasture and grassland farming systems. In general, these use less fertiliser and are less mechanised than farm management systems in lowland areas. However, farming at high elevation requires small-scale farming systems due to topography, and these tend to be less productive than more intensive lowland farming systems. Nevertheless, mountains represent a significant production potential that will be needed as demands for food and energy increase. There is therefore a strong case for collaborative research at the European level to investigate new ways of producing not only food and forest products, but also renewable biological resources and converting these into vital products and bio-energy. A key priority should be to create more resilient and resource-efficient value chains. Research on all of these topics would contribute directly to the implementation and reform of the Common Agricultural Policy and the future orientation of the European Bioeconomy Strategy.

The lower profitability of traditional farming practices, compounded by climate change, the ageing of farming populations and, often, lack of interest among younger generations, mean that these systems are at risk of disappearing. This would lead to further land-use changes in mountain areas and endanger the provision of a range of public goods. This is critical not only for food security but also for many ecosystem services deriving from these low-input systems. Joint action across the European research community is crucial for addressing this challenge because finding strategies to overcome the effects of global and climate change will have positive effects across Europe's mountain regions and downstream.

Forests cover 41 percent of Europe's mountain area: a proportion that is increasing. These forests have become essential for many mountain economies, particularly since the advent of new technologies for harvesting timber in difficult terrain. Many of these forests are not particularly productive, but play key roles by regulating the water cycle and by protecting settlements and other infrastructure from natural hazards such as avalanches, rockfalls and floods. They also represent a great potential for biomass production and carbon storage, especially given the increasing levels of CO_2 in the atmosphere. In all of these regards, there is great potential for mountain forests to contribute to the implementation of the EU Forest Strategy and the Environment Action Programme.

Given the effects of climate change, forests and extensive agricultural systems are also likely to play increasingly important roles in regulating water flows and preventing floods in mountain areas and adjacent lowlands. The Horizon 2020 Work Programme 2016–2017 considers forest production systems that are resilient to climate change and natural disturbances; future calls should especially emphasise mountain forests within wider landscapes that provide a wide range of ecosystem services at regional scales.

The competitiveness of mountain farm and forest businesses is restricted by higher production costs due to difficult topography, remoteness from markets, poor accessibility and sparsity of businesses, resulting in high transport costs, limited economies of scale and inefficient supply chains. Yet diversification in mountain areas can address these challenges by combining agriculture, forestry, tourism and small and medium-sized enterprises (SMEs) in multi-sectoral economies. Recognising the potential of diversified activities, stakeholders in some mountain areas are already actively engaged in shaping rural development activities to overcome marginalisation and enhance their attractiveness, fostering a „rural renaissance" that is included in the Horizon 2020 Work Programme 2016–2017. This contributes to an increased quality of life for mountain people and should be emphasised in future calls.

Food security, sustainable agriculture and forestry

Proposals for research activities

Redefine the role of quality production in the bio-economy of mountain areas

» Explore preconditions and prerequisites and enhance opportunities for the production of high-quality food, agricultural products and non-timber goods (e.g. mushrooms, medicinal plants).

» Assess local varieties and improve them to increase yields for food security.

» Assess climate change impacts on agronomic practices and productivity in mountain areas.

Identify tree species and varieties that are adapted to future mountain climates

» Study the impacts of changing environmental and climatic conditions on the ecosystem services delivered by mountain forests and the species and varieties best suited to provide these.

Improve the use and promotion of territorial labelling to support sustainable agriculture and forestry

» Evaluate means for increasing linkages within production chains, and with tourism and external users, in order to improve the delivery of high-quality products, improve the renewable biological resource cycle, support regional economies and ensure the provision of ecosystem services in mountain areas.

Develop and promote innovative technologies (bio-based innovations)

» Explore opportunities to implement resource-efficient value chains that lead to the development of new products in mountain areas and are supported by social innovation processes.

Improve business management, marketing and supply chains

» Assess innovative approaches to enhance the competitiveness and resilience of mountain agriculture, forestry and the bio-economy.

Capitalise on geographically-specific opportunities

» Identify ways to ensure the long-term provision of public goods within multi-functional economies, secure environmental quality, sustain cultural heritage and improve the well-being of mountain people.

Secure, clean and efficient energy

Rationale

The production, storage and efficient use of renewable energy is a European and global imperative. Mountain areas in general have above-average potential for producing renewable electricity from water, sun, biomass and wind. In the past, decentralised hydropower production has been fundamental to socio-economic development in many mountain valleys. New green energy infrastructures, however, do not automatically result in a fair and equal distribution of economic or social benefits among rural populations. In particular, the intensifying problem of effectively and fairly producing and distributing energy across Europe affects mountain communities disproportionately because of the high costs of constructing and maintaining transmission networks, cold temperatures in winter, and the often lower incomes of mountain people.

Alongside the manifold opportunities, electricity production, storage and transmission in mountainous regions entail risks. Due to the harsh climate and steep terrain, a range of natural hazards – including avalanches, landslides, floods and strong winds – jeopardise extensive energy infrastructures. This reality is gaining importance as global warming leads to increasing numbers of such events. In addition, renewable energy production can have adverse effects on the environment and society, for instance through fragmentation and losses of habitats and changes in landscapes and water flows.

There is a strong case for strengthening mountain-oriented energy research in Horizon 2020. Mountainous regions will play a crucial role in achieving Europe's 2020 energy and climate targets in terms of energy production and storage. Energy-related research and innovation activities in mountain regions can strengthen Europe's energy security, support electricity market integration, improve energy efficiency and help to decarbonise the economy in line with the Energy Union strategy.

In a mountain context, energy-related research and innovation must consider the potential impacts of renewable energy production, altered resource use and management practices on the environment and society. Activities supported by Horizon 2020 should pay attention to challenges that are unique to mountainous areas, such as climate change impacts on resource availability, natural hazards, accessibility and rural development. The anticipated increase in electricity production and storage in mountain regions may also reactivate discussions of models for upland-lowland compensation.

Secure, clean and efficient energy

Proposals for research activities

Undertake integrated assessment of the availability and use of natural resources for renewable energy production

» Assess and model the present and future availability of renewable energy sources in mountain regions in view of anticipated demands for these resources, in order to develop integrated perspectives on resource use for energy production for electricity, heat and fuel.

» Explore means to enhance energy security in mountain areas through resource diversification, risk prevention and mitigation strategies by strengthening energy resilience and supporting local „smart" grids.

Evaluate the ecological and socio-economic impacts of renewable energy production, storage and transmission

» Assess the impacts of renewable energy production, storage and transport on natural resources (e.g. on the water-energy nexus; biomass exploitation on biodiversity), land use and landscapes in mountain areas.

» Investigate the socio-economic effects of new or altered energy production, storage and transmission technologies and related processes, and the impacts of changed energy market structures on mountain communities.

Implement innovative and competitive strategies for energy efficiency

» Identify low-carbon technologies and practices for mountain SMEs and communities in order to generate and secure jobs, reverse the population decline in mountain areas and accelerate energy system transformation in mountain and other sparsely-populated areas.

» Evaluate energy saving and efficiency potentials in the residential and tourism sectors, adapted to local conditions and the specific architecture of mountain settlements. The resulting best practices should include demand management, funding schemes and participatory and informative actions.

Develop green energy model regions

» Investigate the potential for energy cities and regions in mountain areas to be models for decentralised/autonomous energy regions in other parts of Europe.

» Examine and assess various possibilities for energy storage (e.g., pumped storage hydropower, charging electric vehicles) to increase the efficiency and availability of renewable energy systems, and to support the development of mountain communities as self-regulating local energy hubs.

» Optimize local energy systems and energy efficiency interventions in mountain communities to provide decision-makers and communities with more reliable, objective and supportive tools, and to enhance social acceptance of renewable energy sources.

Smart, green and integrated transport

Rationale

Mountain areas are crossed by some of Europe's key transport corridors and are also among the continent's most important recreation areas, with over 150 million tourists per year. However, motorised transport has negative impacts on mountain regions, including air pollution, noise and excessive land take. The growing need for coordinated European research on these interlinked themes can be addressed through Horizon 2020.

The 2011 Transport White Paper set a target for a 60 percent cut in transport emissions by 2050, and the convergence of the energy and transport agendas was recently underlined in the 2015 Energy Union strategy document. The transport sector must therefore make a substantial contribution to achieving greenhouse gas emission and energy consumption targets. The necessary strong measures cannot be limited to urban areas. Europe's transition towards more sustainable processes requires the active involvement of mountain areas, which face particular challenges in improving the sustainability of their transport systems. Consequently, there is scope for Horizon 2020 to include call topics on sustainable mobility and transport in mountain regions, linked particularly to the challenges of climate change.

One path for research is alternative fuel deployment, particularly electro-mobility. Other specific priorities are the development of sustainable local mobility systems, sustainable logistics systems and intelligent transport systems (smart infrastructure, multimodal ticketing, regional travel apps, etc.). Achieving sustainable mobility in mountain regions requires not only technological improvements but also changes in transport demand and travel behaviour. Given the focus on integrating social sciences and humanities research in Horizon 2020, this programme provides a unique possibility to fund transnational interdisciplinary research.

An initial problem about understanding mobility patterns in mountain areas is the lack of data. In national surveys, accessing information on mountain visitors and residents requires complex analysis, and the small numbers of people involved often make the results non-significant. Targeted tourism mobility studies tend to concentrate on international visitors who represent a minority of tourism trips. There is therefore a research gap regarding tourism within countries that have both mountain resorts and sizeable cities outside or on the fringe of mountain areas: this situation concerns at least half of Europe's countries.

The transport behaviour of mountain inhabitants also remains largely unknown. In many mountain areas across Europe, the supply of public transportation is insufficient for residents to use it regularly. Where public transport is available, there are indications that local residents use it less than visitors. This is a problem because tourism alone is unlikely to guarantee the financial viability of these bus or train lines. In the current financial and political context, there is a risk of mountain bus and train services being cut in several countries. This would lead to further isolation of vulnerable populations in these areas. It is therefore necessary to assess which criteria mountain residents use to decide whether to embrace or reject public transport services.

Coordinated qualitative, quantitative and spatial approaches are required to understand the complexity of mobility in mountain regions, and establish practical interventions and best practice scenarios. Many case studies exist for cities but it is not known which, if any, apply to mountain areas where remoteness and seasonality play an important role. The key challenge is to define the most cost-effective and equitable investments in sustainable mobility within mountain areas.

Smart, green and integrated transport

Proposals for research activities

Assess the parameters of mobility in mountain areas

» Evaluate the parameters of daily mobility (number, length, duration, purpose and mode of trips) for residents and visitors.

» Investigate leisure time mobility patterns interlinking urban areas and nearby mountain regions.

» Analyse the driving forces, for both residents and visitors, of transport mode choices in mountain areas.

Deploy new mobility systems in mountain areas

» Identify pathways for introducing and mainstreaming alternative fuel systems (in particular electro-mobility), sustainable local mobility systems, sustainable logistics systems and intelligent transport systems (smart infrastructure, multi-modal ticketing, regional travel apps, etc.).

Implement practical interventions to increase acceptance and use of public transport and other sustainable modes

» Assess how to effectively combine behavioural changes and technological improvements in order to achieve a mode shift towards public transport, walking and cycling by both mountain inhabitants and visitors.

Propose integrated transport solutions

» Evaluate how to improve links between long-haul transportation and local distribution services within and close to mountain areas.

» Investigate how a single transport intervention, infrastructure or service may be used by local people, by visitors and for the transport of goods.

Quantify the environmental and public health benefits associated with the transport behaviour of mountain inhabitants and tourists, as well as the transport of goods.

» Use strategic impact assessment to identify and quantify the social, economic, environmental and public health gains and trade-offs (e.g., with regard to greenhouse gas emissions, air pollution, land use changes, noise, congestion, accidents) associated with each intervention.

Climate action, environment, resource efficiency and raw materials

Rationale

The protection, conservation and enhancement of the natural capital of Europe's mountains requires more coordinated research at the European level. For millennia, mountains have supplied water, minerals, timber and non-timber forest products to both mountain and lowland populations. Rivers originating in mountains connect them to the lowlands, providing water for agricultural, domestic and industrial use. All of these services are threatened by climate change.

Europe's mountains have a higher than average vulnerability to climate change. They are warming faster, snowlines are rising, and the timing and amount of discharge are changing. Warming also increases the risk of avalanches and melts permafrost, increasing frequencies of rockfalls and debris flows. Forest fires have become more common and larger. The increased number of extreme events, such as intense rainstorms, has increased the incidence of landslides. These changes affect mountain agriculture and livestock practices, not only directly affecting the livelihoods and economies of mountain citizens, but also altering the availability and quantity of resources used by lowland communities.

Mountain areas are key to Europe's environmental sustainability. In the context of European policies favouring a circular, resource-efficient, green and competitive low-carbon economy, mountains provide valuable resources such as water and other sources of renewable energy. However, their tourist resorts are at the other end of the Recycle-Reuse-Recover cycle, having to deal with waste materials. Thus, in line with the EU Environment Action Programme (EAP), it is essential to recognise the interactions of mountain and lowland regions so that the populations of both continue to benefit from the resources that mountains provide. For example, wine agriculture is increasing in mountain regions; this sector generates co-products and by-products that require sustainable use. Straw has gained increasing attention as biomass feedstock, but potential trade-offs with its use for soil improvement need to be considered. In livestock production, manure and other by-products can be used both as fertiliser and as sources of bio-energy or valuable bio-products. In these and other cases, impacts on air, soil and water require evaluation.

Mountains are also iconic and important in relation to other objectives of the EAP, e.g., sustainable forestry, halting biodiversity loss and natural protection against flooding. In mountain forests, climate mitigation options such as biomass production for energy might lead to increased demands for land and water. Increased demands for food and feed will increase pressures on water resources and land, and may increase greenhouse gas emissions. Such pressures will be compounded by the impacts of climate change, further modifying the availability and suitability of these resources as well as affecting agricultural and/or forestry productivity.

Biodiversity provides us with various ecosystem services; its deterioration and loss jeopardises their provision. Changes in wildlife life cycles and range distributions will alter the composition and location of ecosystems. Given that 20 percent of European plant species live in above treeline, and that 60 percent of mountain plant species may be extinct by 2100 due to climate change, a strong strategy to limit impacts to mountain biodiversity is clearly needed.

There is clear scope within Horizon 2020 to include topics relating to the roles of mountains in addressing wider European and global challenges. Given the diverse challenges faced by Europe's mountain regions and the linkage of these challenges to the well-being of lowland populations, finding solutions is imperative. For instance, the EU Strategy for the Alpine Region (EUSALP) calls for solutions that promote sustainable management of natural resources and ecosystems and ensure the sustainable supply and use of raw materials. A greater focus in Horizon 2020 on such issues would constitute a unique possibility to make vital contributions across the mountain ranges of Europe and the world.

Climate action, environment, resource efficiency and raw materials

Proposals for research activities

Monitor mountain ecosystems

» Establish robust, versatile indicators to monitor the status and trends of mountain ecosystems at all levels (physical, chemical, biological and anthropic). Such a holistic approach should include assessment of changes in glaciers and associated hydrological and ecological effects, emphasising the roles of the seasonal snowpack for economies, people, water resources, and plant and animal species.

Decrease the physical vulnerability of mountain communities to natural and man-made hazards

» Develop and test user-friendly, transferable methods to assess physical vulnerability to hazards, define relevant indicators, and implement new technologies and products such as dynamic vulnerability maps.

Safeguard the future of mountain biodiversity

» Assess changes in the elevational distribution of species, interactions among surviving and new species (including invasive species), and shrinking habitats in order to define adaptive strategies to preserve biodiversity and maintain ecosystem services.

Establish holistic strategies for the long-term resilience of mountain social-ecological systems (SES)

» Evaluate the ability of mountain SES to adapt to climate variability and examine response strategies. Such research is based on the reality that, though mountain communities are linked to surrounding lowland regions, they have common and unique behaviours and can be considered standalone SES.

» Quantify the impact on mountain SES of ecological and economic processes, future needs for minerals and biomass, and resource policy and environmental management.

Europe in a changing world

Rationale

Steepness, elevation, harsh climates and limited space for permanent settlement characterise Europe's mountains. Over the centuries, their inhabitants have found many innovative ways to adapt to these physical characteristics. However, they also make mountain people and their economies vulnerable to the socio-economic crises and natural hazards that are becoming more frequent as a result of globalisation and climate change. Economic crises, for example, have had far-reaching impacts on the ability of the European economy to create growth, innovation and jobs in mountain regions – and thus on their potential to contribute to the delivery of the first priority, „A new boost for jobs, growth and investment", defined by the Juncker Commission when they reviewed the Europe 2020 objectives.

The impacts of the recent economic crisis have highlighted the need to enhance access to education and training in mountain areas in order to foster equality and create sustainable employment. As many mountain residents live far from major education centres, it is essential to find ways to ensure that mountain people have access to educational and training opportunities that do not require them to leave the mountains. In this context, information and communication technology (ICT) platforms are essential not only for modernising education and training to eliminate the risk of digital exclusion, but also to facilitate networking and capacity building.

Europe's mountains include towns that have been key locations for trade and industry. Today, most of these urban centres depend on conurbations around mountain areas where large national and transnational enterprises are located. There is a lack of business models and ICT infrastructure for SMEs tailored to mountain circumstances; these are needed to improve the competitiveness of mountain towns and smaller settlements and reduce their dependency on lowland conurbations.

Small-scale cultural diversity characterises mountain areas and is apparent through the presence of diverse languages, customs and land use strategies. Mountain populations often include an increasing proportion of in-migrants (new highlanders) from the lowlands, who provide new ideas while bringing socio-economic potential and new cultural inputs. To develop sustainable socio-ecological systems within mountain regions, new solutions including participatory governance and multi-stakeholder involvement are essential.

Europe in a changing world

Proposals for research activities

Widen access to digital learning ecosystems

» Evaluate and develop digital learning ecosystems and knowledge transfer/exchange strategies to support new models for lifelong learning, specialisation and multi-disciplinary networks.

» Investigate new approaches such as distance learning, gamification and edutainment, as well as personal interactions, to simultaneously empower the cultural heritage of mountain people and their potential for innovation.

Facilitate the education of mountain people

» Explore the use of innovative educational models to enhance primary, secondary and tertiary education, including vocational education, in mountain areas to achieve education equality and high-employment economies able to support social and territorial cohesion, in line with the Erasmus+ programme.

» Evaluate means to integrate the traditional knowledge of older generations with the information-economy orientation of younger people.

» Investigate strategies, such as the use of new ICT tools, to avoid the digital exclusion of mountain areas.

Enable communication among mountain communities and between upland and lowland communities

» Examine ICT-based and other means to facilitate cross-border and upland-lowland communication to enhance social cohesion, preserve cultural heritage, balance territorial inequalities and counterbalance remoteness.

» Assess mechanisms to promote participatory governance and multi-stakeholder involvement within mountain communities in order to develop economies based on knowledge and innovation.

Encourage social impact and social innovation in mountain areas

» Explore effective methodologies of social impact assessment to better understand the role local communities can play in reversing negative trends in mountain areas.

» Evaluate social platforms for sustainable models and value generation in order to encourage the proactive role of communities in natural and cultural heritage management, promote territorial and social cohesion for more „inclusive growth", and strengthen community resilience through strategic development.

Help mountain societies to resolve economic crises

» Identify and test tools for social inclusion, new modes of governance, including roles for local administrations, opportunities for young people and SMEs through the implementation of innovative business models, and pathways to ensure gender equality at all levels of society.

Europe's mountain regions

Social inclusion of new highlanders in mountain areas

» Elaborate operational concepts for the social inclusion of new highlanders in partnership with local communities in order to optimise their contributions to, and investments in, the sustainable development of mountain regions.

„Mountain sensing" and crowdsourcing

» Implement multi-disciplinary research, methods of evaluation and techniques to draw a „mountain sensing" map (what communities think, need, wish) through visualising social information (e.g., social network conversations, public communication, big data, data-based networking) in order to collect and analyse opinions and integrate data to foster resilient mountain communities.

Alps (55)
Carpathian (17)
Apennines (11)
French / Swiss middle mountains (7)
Central European middle mountains I (4)
Central European middle mountains II (3)
Pyrenees (12)

Iberian mountains (20)
Western Mediterranean islands (8)
Eastern Mediterranean islands (5)
Balkan / Southeast Europe (8)
British Isles (17)
Nordic mountains (21)

This delineation of Europe's mountains was published in: European Environment Agency (2010) Europe's ecological backbone: recognising the true value of our mountains. European Environment Agency, Copenhagen. The perimeter of the Alps is that used by the Alpine Convention. The boundaries of the other regions were defined for the purposes of analyses within this report.

The numbers in brackets refer to the numbers of projects in each mountain region, as identified during the FP7 Support Action 'Mountain Sustainability: Transforming Research into Practice' (mountain.TRIP) (2009–2011).

"The health of the mountains is the wealth of the plains."

(Indian proverb)