

## **Belmont Forum Collaborative Research Action on “Mountains as Sentinels of Change”**

### **1. Background and rationale**

Mountains exist in many regions of the world and are home to a significant fraction of the world population and to half of global biodiversity hotspots. Mountains make essential ecosystem services available: acting as water towers of the world, they provide freshwater to many lowland regions for domestic use, irrigation, hydropower, or industry. They provide other ecosystem services such as unique flora and fauna, critical habitat for rare and endangered species, as well as wood, snow-based recreation, and others. But mountains are very fragile environments and are among the regions that are most sensitive to climate change and to the impacts of human activities.

Many studies have found that high elevation regions are particularly sensitive to global climate change and they are considered to be “sentinels of change”, since they respond rapidly and intensely to climatic and environmental modifications, with the danger of losing essential services, and menace the well-being of the people depending on high-altitude resources.

There is growing evidence, for instance, that the rate of warming is amplified with elevation, such that high mountains are experiencing more rapid changes in temperature than the global average or lower elevation regions. This elevation-dependent warming has important implications for the mass balance of the glaciers and associated runoff, for downstream communities, for ecosystems and biodiversity.

Individual mountain regions can have very different properties and can be affected differently by climate change, depending on their geographical position, shape, extension, altitude, vegetation cover and climatic regimes. However, high-altitude areas around the world share many characteristic and common features, including a unique ecosystem structure and hydrological cycle.

Given the global societal relevance of mountain regions, it is necessary to quantify the ongoing and expected changes in mountain environments, with special emphasis on the water cycle, ecosystems and biodiversity. To this aim, a global network of mountain research and monitoring stations should be developed in order to identify common problems as well as regional issues that should be addressed in the most significant mountain ranges of the world. Parallel to this, it is necessary to implement a modelling framework in order to develop climate, societal and environmental change scenarios specifically designed for the mountain regions. Model simulations of climate change in mountain areas are generally difficult to develop and they are highly uncertain because existing climate models, even at regional scale, do not adequately resolve complex topographic features and their effects on climate.

Only by increasing the observational and modelling efforts on mountains, can efficient adaptation measures and sustainable development strategies be developed.

The Belmont Forum ([www.igfagcr.org](http://www.igfagcr.org)) is a group of the world’s major and emerging funders of global environmental change research and international science councils. Understanding and coping with changes in the mountain environment and in the related services is central to the Belmont Challenge - “To deliver knowledge needed for action to mitigate and adapt to detrimental environmental change and extreme hazardous events” - and to Future Earth research themes. Belmont Forum funding is intended to add value to existing national investments.

## 2. Objectives, Themes and Fundamental Questions

Based on the above considerations, this call aims at fostering research on climate, environmental and related societal change in mountain regions, considering both new measurements, recovery of existing data, and the development and use of integrated modelling strategies by adopting a strong trans- and inter-disciplinary approach.

Attention to the hydrological, ecological, societal and economic implications of the ongoing and expected environmental changes is an essential component in the proposed projects, as well as the design of adaptation measures in the face of climate and global change, regional development and sustainable development strategies for mountain regions.

Five main themes have been identified that characterize the “Mountains as sentinels of change” Collaborative Research Action (CRA) Call. The themes of the call are:

- **Theme 1. Drivers of change**

The variety of natural and anthropogenic drivers that generate the observed and expected environmental changes in the mountains.

- **Theme 2. Ecosystems and Biodiversity**

The changes in ecosystem functions in response to drivers and the relationships between biodiversity and ecosystem services.

- **Theme 3. Water**

The mountain water resources and the changes in water availability due to environmental changes related to the different driving factors.

- **Theme 4. Hazards, Vulnerability and Risks**

The hazards that affect mountain regions and their impacts; the vulnerability of natural and human systems to drivers of change and impacts on society; the aggregated and cascading effects of multiple hazards.

- **Theme 5. Adaptation and Resilience**

The adaptation and mitigation strategies and implications for future generations, economies, and environments.

Theme 1, Drivers of Change, aims at the governing factors, both natural and anthropogenic, driving the environmental changes in the mountains. Such environmental changes affect Ecosystem and Biodiversity (Theme 2) and Water (Theme 3), whose understanding helps to assess Hazards, Vulnerability and Risks (Theme 4). Finally, proper strategies and decisions can be made for Adaptation and Resilience (Theme 5). Figure 1 highlights possible connections and relations among the different topics.

Themes 2 and 3 have a predominantly scientific nature, while Themes 4 and 5 mainly involve societal challenges; however, this Call seeks to advance research in the different disciplines connected with the five themes, highlighting their interconnections and approaching the problems from different and interdisciplinary points of view.

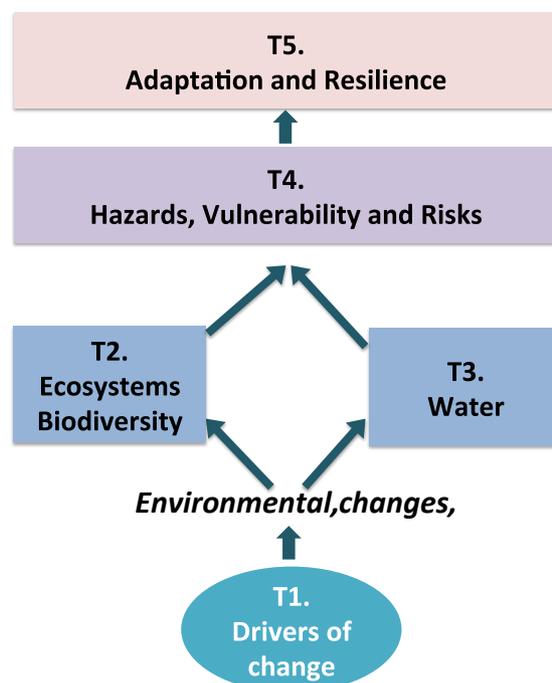


Figure 1: The Call Themes

#### *Theme 1. Drivers of change*

Mountain environments are subject to a variety of drivers of change. They include socio-economic factors (e.g., migration, urbanization, land-use, natural capital), political drivers (e.g., government policies), changes in population and lifestyle, biophysical factors, changes in frequency/ magnitude/ location/ duration/ nature of the hazards, and climate changes, which act as further stressors and are expected to exacerbate the impacts of the other drivers.

The contributions of these different drivers and their interactions/combinations are not fully understood and need to be addressed in a quantitative way.

The development of mountain specific and basin scale climate change scenarios represents an important step toward the fulfilment of this goal, achievable through specific actions, for instance by expanding the network of high-elevation stations to create a basis for the validation of regional climate models, by improving the cryosphere-hydrological modelling or by producing spatially and temporally downscaled climate information. This would also allow for the development of local scenarios (e.g., water demand and supply scenarios) for impact and assessment models (e.g., water-food impact models).

#### *Theme 2. Ecosystems and biodiversity*

Mountain regions host a great diversity of habitats and species, many adapted to specific extreme and harsh environmental and climatic conditions. The complexity of ecosystem functioning still poses uncertainties about the role of individual species and other components of biodiversity in the supply of ecosystem services, specifically when coupled with social-ecological systems.

Specific issues include the changes in ecosystem functions in response to drivers, the long-term effects of extreme events and their statistical variations (occurrence and intensity), the relationships between biodiversity and ecosystem services; the definition of indicators of functional biodiversity; the detection of hotspots and biodiversity dynamics; and the identification of invasive allochthonous species.

It is especially important to determine how the changes in ecosystem structure and functions affect the delivery of ecosystem services.

### *Theme 3. Water*

Global assessments of mountain water resources are challenging owing to the limited data available, to the great model uncertainties and to the many aspects that determine the hydrological cycle in the mountains. For example, changes in temperature and precipitation will impact freshwater supplies from mountain areas and will have implications for water availability downstream. Changes in water availability due to climate change are taking place at a time when pressure on water resources for irrigation and food production, industrialisation and urbanisation is increasing. In a world of growing water scarcity, it is urgent that the knowledge of present and future mountain water resources and freshwater supply is improved.

Along these lines, it is important to determine the changes in atmospheric motions over complex terrains, as well as to better understand the linkage to the processes controlling water storage and fluxes and surface, ice, and groundwater flows (aquifers). Other crucial issues are related to the relation of mountain water and hydrology to foreland, and in particular the impact on society of water availability and changes (including water security, governance, management, access and availability of natural resource, protection from hazards); to political/economic issues as resource management and conflict, and management compromises; to the tradeoffs between conservation and resource use/demand/development.

### *Theme 4. Hazards, Vulnerability and Risks*

Mountains are frequently affected, more than other environments, by natural hazards that act on different spatial and temporal scales, such as floods, landslides, avalanches, debris flows and glacial lake outbursts. Human activities can exacerbate the impact of these hazards. Climate change can also alter the frequency of extreme events that pose hazards to life in the vulnerable mountain regions.

Given the current and projected trends in global environmental change, exposure to risk and vulnerability in mountain regions and communities is expected to increase in the coming decades, since the projected increase of heavy rainfall, heat waves, or glacier melt will amplify hazards in many mountains worldwide, and in areas where they have not been known in the past. An estimate of the changes in frequency, magnitude, location, duration, nature of the hazards and their relationship to changes in drivers of different kind; of the socio-economic impacts of the hazards; of the vulnerability of natural and human systems to drivers of change and impacts on society; of the aggregated stress of multiple hazards and the cascading effects of multiple factors (landslides, pollution, fire, technological risk) are all critical factors for undertaking any adaptation measure to global change.

In addition to this, all aspects related to the assessment of uncertainties and their communication, as well as perception and communication of risk are also crucial points to be addressed.

### *Theme 5. Adaptation and resilience*

Managing the risks of climate change involves mitigation and adaptation decisions with implications for future generations, economies, and environments. One of the main challenges in this context is to understand how adaptation actions work and what the implications of adaptation measures for resilience of both ecosystems and human societies are.

It is increasingly clear that the lives and livelihoods of the people living in many mountain areas are at risk due to the impacts of climatic changes. Access to water, biodiversity, and many other environmental services is becoming more and more critical. What is needed are adaptation measures that enhance the resilience of the mountain communities and reduce their vulnerability, particularly in the short term.

An understanding of the likely trajectories of climate and climate changes in the mountains represents a pre-requisite for any strategy aimed at supporting adaptation of mountain communities and enhancing resilience.

Along these lines, relevant themes are the changes in interacting natural and human systems, the evolution of mountain socio-ecological systems, the impact of conservation policies and design of future protected areas in light of changes, tourism, hydropower and solar/wind energy, infrastructures (including tunnels, roads, cable cars, communication networks), agriculture/forestry/pastoralism and other land uses (bio-energy). In addition, migration and remittances are an important source of livelihoods for mountain areas and their interaction with several drivers of change (climate change, population dynamics, globalization etc.) is very important in order to build the resilience of mountain communities. Consideration of the issues indicated above should have direct impact on the governance, including regional planning issues – built environments, natural environment trade-off and restoration of degraded areas – and public policy evaluation.

### **3. The research approach**

We call for innovative and collaborative international research that should go beyond individual national efforts and should demonstrate sharing of ideas, resources, and research facilities to mutual benefit.

The project proposals should demonstrate a multi-scale approach, with strong interconnections between local/regional/global dimensions and trans-boundary interconnections. They should include assessments on the past, current and future state of the mountain environment.

Each project should include international trans-disciplinary and multi-stakeholder participation. Research outputs should be targeted towards decision-making (including public, private and communities) and innovation challenges (technological, organizational and institutional). All proposals must integrate across the natural sciences and social sciences and should include interdisciplinary, multinational approach, demonstrate strong relevance for user needs, and examine a variety of coupled interactions and feedbacks among relevant systems.

### **4. Call process**

This call for proposals encourages the formation of new international networks for 18-36 months, beginning in 2016. Several networks already exist focusing on some of the key elements of the mountain research on ecosystems, biodiversity, climate modifications, the many aspects of the hydrological cycle, the economic and societal impacts in the mountains and downstream, etc. However, there is a lack of research using integrated systems approaches: the research community is fragmented, with mostly national, non-interdisciplinary approaches, and there is a disconnect between the socio-economic studies of mountain and valley societies.

Therefore, proposals responding to this Call will be evaluated against their pertinence to the objectives of the Call and the added value of the proposed networks compared to existing ones. The proposals to the present Call must demonstrate that their project will deliver a significant contribution to advancing the formation of international networks of scientists, co-design of research questions with relevant stakeholders.

## 5. Eligibility information

All calls require eligible participants from three or more of the participating countries<sup>1</sup>. Clear added value of the international consortium should be demonstrated and, if relevant, the added value for national investments.

Researchers from countries not represented by any of the Partner Organizations can participate in the research project at their own expense. Where appropriate, some Partner Organizations could also support capacity building in some developing countries and for young researchers and technical staff in specific mountain areas.

Each consortium must also show clear links to users and include collaboration between natural and social sciences, and other sciences where relevant.

Consortium partners should identify a Leading Principal Investigator (LPI) for each proposal for application, management and communication purposes. The LPI is officially responsible for all communications with the Call Program Office, including the submission Proposal. These communications must be in accordance with the LPI's funding agency requirements.

## 6. Scientific follow-up

The projects are required to contribute to the overall Belmont Forum goals by participating in common annual synthesis conference held in a central location back-to-back with a scientifically relevant international conferences or events.

All data used and generated are required to be made publicly available in a long-term archive as soon as possible, with no embargo. The exception to this rule is any personal data protected by data regulations or that could otherwise harm communities or individuals. Only metadata describing the type of data being collected may be made available. This information can only be shared publicly by approval from the communities or individuals themselves.

## 6. Timeline

The Mountain as Sentinels of Change CRA is envisioned as a two-stage Call. Proposers will be asked to submit a pre-proposal and, for the projects that will successfully go through stage 1, submission of the full proposal will follow. Here below is the Call timeline:

- **Opening Date of the Call:** 18th March 2015
- **Closing Date for Submission of Pre-Proposals:** 1st June 2015, 11:59 PM UTC
- Opening Date for Full-Proposal Submission: 3rd August 2015
- Closing Date for Submission of Full- Proposals: 30th October 2015, 11:59 PM UTC
- Panel for Decision: December 2015
- Projects begin: March 2016

## 7. How to apply

All call documents and the submission portal can be found at the Belmont Forum Grant Operations website: <https://bfgo.org/>.

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<sup>1</sup> See participation requirements and national annex documents for more details.