



United Nations  
Educational, Scientific and  
Cultural Organization



International  
Hydrological  
Programme



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Programme

# Our global water towers: ensuring ecosystem services from mountains under climate change



Greenland reflections © Christine Zenino



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Paramo Biosfera Macizo del Cajas © ETAPA EP

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**Note from the coordinators:**

This policy brief is an outcome of discussions based on an overview paper presented at regional workshops in Africa, Asia, Latin America (2013) and a workshop held in Paris (2014) in the context of “Climate Change Impacts in Major Mountainous Regions of the World: Multidisciplinary Network for Adaptation Strategies (Africa, Asia, Latin America and Europe)”.

This project was undertaken within the framework of the IHP in collaboration with MAB, and funded through UNESCO’s Climate Change Intersectoral Platform.

This Policy Brief is a contribution to the VIII<sup>th</sup> Phase (2014-2021) of the IHP “Water security: responses to local, regional and global challenges”. It aims to transform scientific information and experience into action by answering local and regional needs for tools to improve adaption to global changes and build capacity to adrese and meet today’s global water challenges.

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**Mountains are of global importance because they:**

- **Supply more than half of humanity with water** for drinking, irrigation, industry, food and energy production. 23% of their area is essential to downstream water supply, and another 30% supports this supply to some extent.
- Occupy **24% of the Earth's land surface** and **1.2 billion people** live in and adjacent to them.
- Are centres of **biodiversity**, much of which is utilized by people for food, fibre, timber, and medicines. Many of the world's major crops were first domesticated in mountains, and they continue to function as vital gene pools.
- Contain a remarkably high proportion of the world's **cultural and ethno-linguistic diversity**, of value because of the embodied knowledge and as a key element for tourism.
- Are centres of **recreation** – contributing particularly to the wellbeing of the world's growing urban populations – and of tourism, which can bring diverse economic benefits to both the people of mountain areas and national economies.

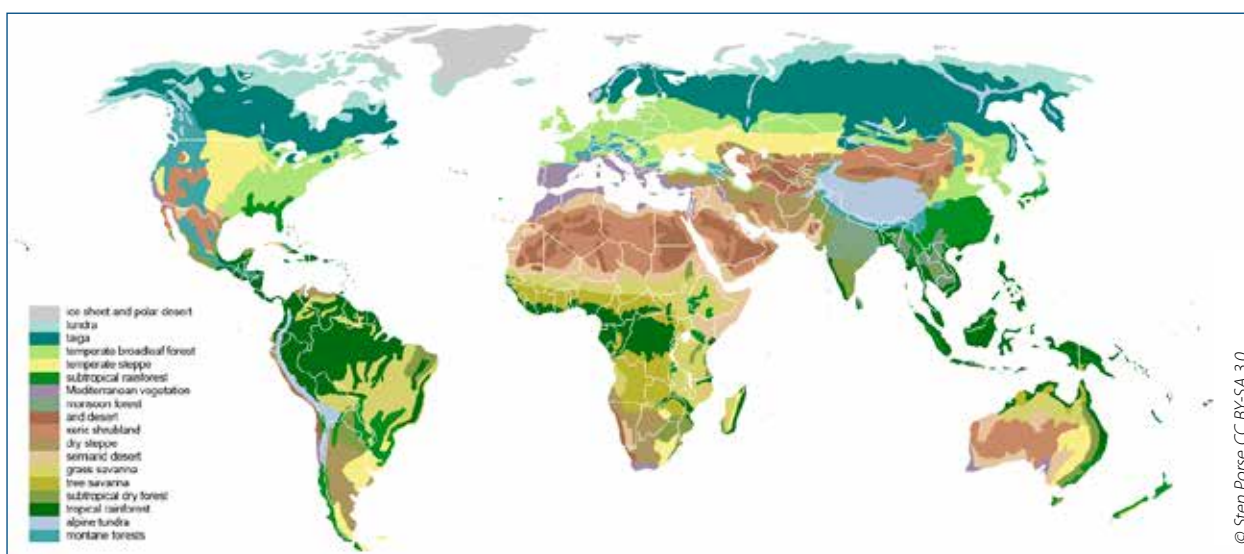
Healthy functioning mountain ecosystems also **regulate climate**, air quality, and water flow and contribute to protection against natural hazards and the impacts of extreme events.

Mountains are among the **most sensitive regions** to **climate change**. Their glaciers and ecosystems provide some of the clearest indicators of this global phenomenon.

All of these values can be addressed using the conceptual framework of **ecosystem services**: a standardised approach to classifying and quantifying natural resources in ways that are meaningful in both ecological and socio-economic terms.

**Ecosystem-based adaptation** provides opportunities to decrease this vulnerability –with has significant consequences not only for mountain people, but for billions of people depending on water from mountains or other ecosystem services they provide.

Ecosystem-based adaptation identifies and assesses potential risks and increases the ability of mountain ecosystems and people to adapt to climate change. One approach involves 'payment for ecosystem services': payments to mountain communities to support them in maintaining ecosystems to provide services in the long term, with widespread benefits.



**Figure 1** – Classification of terrestrial habitat to provide 15 ecosystem services at 1 km<sup>2</sup> grid resolution. Mountains (highlighted by the bounding line) provide the most numerous ecosystem services (Grêt-Regamey *et al.* 2012)

**Source:** Grêt-Regamey A, Brunner SH, and Kienast F (2012) Mountain Ecosystem Services: Who Cares? Mountain Research and Development 32(Supplement): S23-S34.



## Actions for governments and organisations

Following the call for sustainable mountain development in Chapter 13 of 'Agenda 21', the action plan endorsed by the 'Earth Summit' in 1992, and 'The Future We Want', the outcome document of the Rio+20 summit, governments and international, regional and national organisations should undertake the following actions to maintain the provision of ecosystem services from mountain areas and thus provide long-term benefits to the world's population:

- strengthen research on the ecosystem services provided by mountain areas, recognising that, despite the unprecedented abundance of ecosystem services they provide, **mountains are along the poorest documented ecosystems in this regard;**
- support the education, training and knowledge exchange necessary to **develop the human capacity** to collect, compile, and analyse data regarding ecosystem services provided by mountain areas and the likely impacts of climate change;
- ensure that data of sufficient quality, coverage and resolution are available to map and assess ecosystem services provided by mountain areas, and **monitor the impacts of climate change;**
- further develop the concept of payment for ecosystem services (PES), including evaluating the potential economic benefits that can be offered to mountain communities to **ensure their long-term provision of ecosystem services** and considering both synergies and trade-offs at appropriate scales;
- implement the concept of PES, ensuring that mountain communities are included at all stages and **recognising the value of their traditional knowledge** in adapting and responding to climatic and other environmental hazards;
- enhance regional and international collaboration, particularly to establish a common standardized methodology to undertake vulnerability assessments of mountain areas in order to facilitate **ecosystem-based adaptation (EBA)**;
- further develop EBA approaches, and formulate policies and legislation that take into account traditional mechanisms to adapt to environmental change;
- include PES and EBA approaches in **mountain-specific policies** that contribute to national sustainable development strategies, *inter alia*, contributing to poverty reduction plans and programmes for mountain areas, particularly in developing countries;
- include specific consideration of the characteristics of mountain regions, and their critical linkages with downstream areas, in **national adaptation programmes** under the United Nations Framework Convention on Climate Change;
- continually evaluate and monitor **policies and legislation** to ensure that they support the long-term provision of ecosystem services from mountain regions.



## Mountain Ecosystem Services

The conceptual framework of ecosystem services has been developed to recognise the multitude of ways in which people benefit from ecosystems through the direct and indirect goods and services they provide. The concept was popularized and brought into the policy domain by the Millennium Ecosystem Assessment, published in 2005. It offers a standardised approach to classifying and quantifying natural resources in ways that are meaningful in both ecological and socio-economic terms. Four main types of ecosystem services are recognised:



**Provisioning services:** such as **water**, food, raw materials, medicines, energy.



**Regulating services:** such as **climate regulation**, carbon sequestration, purification of water and air, pest and disease control.



**Cultural services:** such as cultural heritage, aesthetics, spiritual value, recreational experiences, opportunities for research and education.



**Supporting services** which are necessary for the production of other ecosystem services.

Use of the framework has helped provide a large-scale view of the unique multifunctionality of mountains in comparison to other terrestrial habitats.

### ◀ Provisioning Services

**Water** is the most critical ecosystem service that mountains provide. Because rates of precipitation are higher in mountains and they store both ice and snow, mountain areas contribute disproportionate amounts of runoff, are the sources of the world's major rivers' and are also origins of groundwater. Downstream lowlands rely heavily on mountain water not only for **domestic** use, but for **irrigation**, various **industrial** sectors, and the generation of **hydroelectricity** in dams and power stations both in mountains and downstream.

Mountains are global centres of **biodiversity**, much of which is utilized by people in provisioning ecosystem services such as **food, fibre, timber** and other **forest products**, and **medicines**. Mountains are the original

source of many of the world's major **crops**, and continue to function as vital **gene pools** (e.g. for agricultural and pharmaceutically important plants, wild crop relatives, and horticulturally valuable ornamentals). However, the prospect for exploitation of genetic resources as sustainable mountain ecosystem services remains poorly known and underdeveloped.

### ◀ Regulating Services

Mountain ecosystems regulate **climate, air quality**, and **water flow**. Healthy functioning mountain ecosystems contribute to protection against **natural hazards** and the impacts of **extreme events**, such as floods, droughts, and major storms. These services are especially critical to downstream areas, where the effects of such events are often most intensively experienced, sometimes several hundreds of kilometres away. Comparatively less is known about the biological importance of mountains in regulating services such as **pollination, seed dispersal**, and **pest and disease control**.

### ◀ Cultural Services

A remarkably high proportion of the world's **cultural and ethno-linguistic diversity** is found in mountain areas, representing the legacy of human habitation and adaptation in these challenging environments over many centuries, and often millennia. Mountain regions possess immense significance in terms of intangible services, such as **cultural heritage** and **aesthetic values**, which are widely acknowledged and celebrated. Many mountains and mountain ecosystems are **sacred**. **Tourism** and **recreation** form the basis of economies in many mountain areas worldwide, though the extent to which these opportunities are realised varies greatly at all spatial scales, and a general lack of infrastructure often limits greater development in less developed regions.

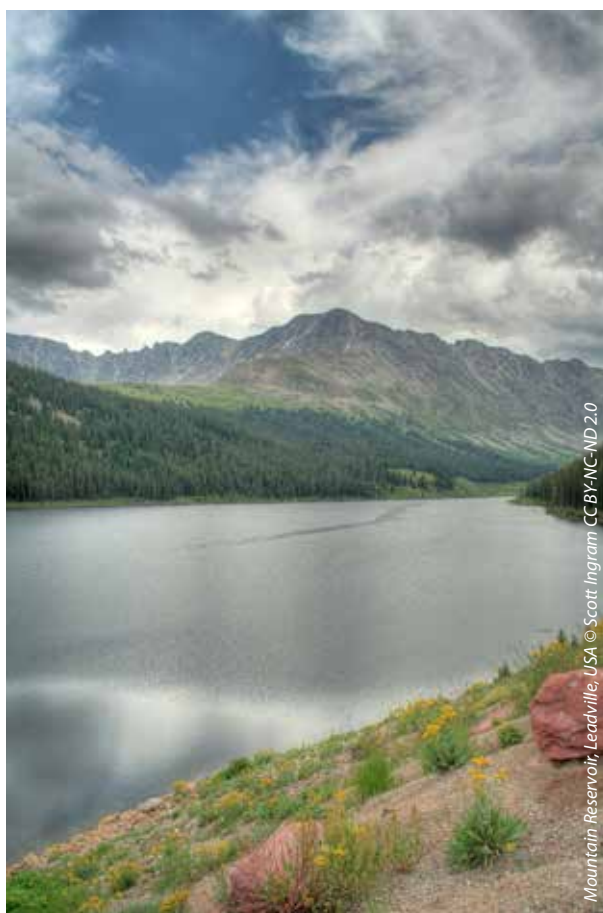
## Addressing Challenges and Uncertainties

Although so many ecosystem services derive from mountain areas, there has been relatively little research with an explicit focus on mountain ecosystem services: far less than for other key ecosystems. While it is useful to generalize with regard to the ecosystem services provided by mountains, the specificities of each mountain area must be recognised in actions that are specific to the location and services provided. In addition, careful evaluation is needed of the potential of payment for ecosystem services, avoiding overemphasis on identification of synergies – and the extent to which multiple services can be provided – and ensuring that potential trade-offs are recognised. Decision-making tools and modelling platforms can be utilized to gain a holistic picture of potential synergies and trade-offs among ecosystem services in mountain areas at the landscape or regional scale.

A further major challenge underpinning vulnerability assessment and ecosystem-based adaptation is the need to reduce scientific uncertainty associated with climate change and its likely impacts at the local scale. This will necessitate greater compilation and distribution of baseline data and increased monitoring, especially in high-elevation areas.

While climate change will degrade the provision of some mountain ecosystem services, others – such as food production, carbon sequestration, watershed services, and recreation – may be enhanced; their development may help ensure future resilience. Linking payment for ecosystem services to climate change adaptation has not yet progressed greatly in mountain

areas, and greater policy-based action is required to mainstream such initiatives. Monitoring and evaluation of ecosystem-based adaptation projects and payment for ecosystem services initiatives will be essential, in order to set best practice and inform future policy development and implementation.



## Adapting to Climate Change Threats

Mountains are among the most **sensitive regions** to climate change and provide some of the clearest indicators of global warming. In the 20<sup>th</sup> century, they experienced **above-average warming**, in comparison to the global mean. As the world's **glaciers** are shrinking and becoming thinner, they may be regarded as a global early warning system. Mountain systems are highly vulnerable to climate change, whether related to biophysical fragility and natural hazards, social vulnerability and human livelihoods, or mountain biodiversity.

Predicting and responding to the effects of climate change in order to ensure the capacity of mountains to supply ecosystem services is therefore essential, both for vulnerable mountain communities and for dependent lowland regions. Identification and anticipation of these changes are the first elements of the formulation of local to regional-level **adaptation strategies**, as a component of much-needed mountain-specific planning and policy. A key element of this must be to strengthen the political recognition and relevance of the ecosystem services concept.

Enhancing the **resilience** of mountain communities most at risk from climate change is of high priority as the impacts of climate change become increasingly evident. A key step towards this goal is to use vulnerability assessment to identify the areas and communities most at risk. Sensitive management of ecosystems can help promote climate change adaptation. A key approach is **ecosystem-based adaptation**, which is increasingly being applied in mountain areas and emphasises the sustainable use of biodiversity and other ecosystem services as a means to foster the adaptive capacity of mountain socio-ecological systems to respond to anticipated climate change. This can be supported through **payment for ecosystem services**: incentives offered to communities or land managers to manage their land to provide specific services.





**FOR MORE INFORMATION:**

Division of Water Sciences  
International Hydrological Programme (IHP)  
UNESCO  
<http://www.unesco.org/new/en/ihp>

**Climate Change Impacts in Major Mountainous Regions of the World: Multidisciplinary Network for Adaptation Strategies (Africa, Asia, Latin America and Europe)**

[http://www.unesco.org/new/en/media-services/single-view/news/climate\\_change\\_impacts\\_in\\_major\\_mountainous\\_regions\\_of\\_the\\_world/#.VC0advmsyvA](http://www.unesco.org/new/en/media-services/single-view/news/climate_change_impacts_in_major_mountainous_regions_of_the_world/#.VC0advmsyvA)

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