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Achieving Multidisciplinary Regional Cooperation for Integrated Assessment of Climate Change

Climate change aggravates the challenges of sustainable development in mountain regions and calls for deeper insights into impacts on the vulnerability of mountain people and their options for adapting to changing conditions. Peru is considered highly vulnerable to climate change. Therefore, its government has initiated a program to strengthen the capacity for transdisciplinary research in order to propose adaptation measures and reduce the negative impacts of climate change. The present article describes the strategy for selecting the study area and for achieving collaboration between natural and social scientists, stakeholders, decision-makers, and other societal groups, in order to carry out an integrated assessment of climate change in the mountainous ecosystems region of central Peru, with an emphasis on vulnerability and adaptation.

Background

There is evidence that the planet Earth is warming due to the increased effect of greenhouse gasses in the atmosphere. As a response to this warming, the global climate will change. It is anticipated that patterns of atmospheric circulation and the precipitation regime will change, and the frequency and intensity of extreme climate events such as floods, droughts, frosty weather, and El Niño will intensify. There will be alterations in ecosystems, and poor people living in mountain regions whose livelihoods depend heavily on agriculture will be economically affected by crop loss due to intensification of extreme weather and climate events. Estimated losses related to climate disasters run into billions of dollars.

The United Nations Framework Convention on Climate Change, signed by 191 parties by 2005, contains a set of integrated strategies and detailed programs to halt and reverse the effects of environmental degradation and promote appropriate and sustainable development in all countries. The target is to establish cooperation between member countries to reach agreements on laws and principles that will promote sustainable development.

In accordance with this Convention, the countries will execute a set of actions and commitments, such as:

1. Implement national programs containing measures that will mitigate the effects of climate change and measures to facilitate appropriate adaptation;
2. Cooperate in preparing for adaptation to the impacts of climate change;
3. Promote and support scientific, technological, socioeconomic, and other forms of research cooperation.

Peru's approach to climate change

In the implementation of national programs related to climate change, the National Environmental Council (CONAM)—Peru's focal point of climate change—launched an initiative in 2003, with funds provided by the government of the Netherlands, to carry out activities that would strengthen local institutional research capacity related to **issues of** climate change, **and seek research institutions that would carry out** research on **vulnerability and adaptation**. The general objective of this initiative is to propose adaptation measures to reduce the negative impacts of climate change in the most vulnerable communities, as Peru is considered highly vulnerable to climate change.

Because of limited funds, 2 regions were selected as priority pilot areas to study the impact of climate change. The first was the Piura River basin, located on the northern coast of Peru, a region with high vulnerability to the impacts of El Niño events. The second region was the Mantaro River basin, located in the central Peruvian Andes.

In 2004 the Geophysical Institute of Peru (IGP) undertook the charge of developing a 2-year program in this basin. The objective of the multidisciplinary study was to detect climate change signals in the Peruvian Andes, evaluate the vulnerability of the social system and environment, and propose adaptation measures to reduce the impacts of climate change as well as the vulnerability of communities and regions to climate change. Formula-

tion of research and application proposals, to fund new activities that will emerge at the end of this 2-year program, was also included in the agenda.

The Mantaro River basin: an ideal area for climate change research

Considering that mountains are an important source of water, agricultural products, and biological diversity, and that rapid changes in mountain ecosystems have been recently observed, the Mantaro River basin, located in the central Peruvian Andes, was chosen as a pilot area. The basin is a unique area from the point of view of biodiversity, natural reserves, and the presence of glaciers. It has the best hydrometeorological observational network in the region, where 35% of the electricity consumed in the country is generated hydroelectrically. The region is also a major source of food supplied to Peru's capital (Figure 1). Elevation rises from 500 to 5768 m; the total area is 34,550 km^2. The population of the basin is about 1.2 million. The region plays an important role in the Peruvian economy.

The freshwater that supplies the city of Huancayo and the Mantaro Valley originates in the Huaytapallana Glacier, the most important glacier in the basin. The ice caps of the glacier have been melting rapidly, particularly since the 1980s. It is estimated from a sequence of pictures taken on land and by satellites that about 22% of the surface area of the glacier has been lost. This implies reduced supplies of water for human consumption, agricultural activities, and generation of hydroelectric energy.

Institutional arrangements for collaborative research

To gain an overview of the institutional setup in the region, all institutions and organizations concerned with social and economic sustainable development in the region, and those dealing with environmental issues as well, were identified. Most of the 55 identified institutions are located in cities and urban communities. The institutions are dedicated to several activities, eg environmental education, health, agricultural support, regional management, monitoring and management of soil, water and air quality, and observation of climate variations. A further classification was made, taking into account their level of intervention—local, regional, or national.

Classification of institutions was made in order to identify collaborative institutions for carrying out the proposed research project. The criteria for selecting the institutions

FIGURE 1 Weather and climate are critical for crop production in the Mantaro Valley, located at an altitude of 3100 m. (Photo by Pablo Lagos)

FIGURE 2 The IGP geophysical observatory, a facility used for meetings and scientific studies carried out for the project. (Photo by Pablo Lagos)

were that they would be a source of information needed in the study, and that they could validate and become users of the deliverable products of the project.

Of the 55 institutions, about one-third were government organizations, and the rest private institutions. Most of the organizations have a mission to define and decide on environmental issues in the region, whereas most of the private institutions emphasize specific topics related to sustainable development, in support of rural communities. In addition, a third group of institutions was found to exist under the category of community-based organizations such as settlement communities, irrigation committees, and productive committees for individual crops.

FIGURE 3 Workshop participants from the research community and various societal groups. (Photo from IGP archives)

Developing climate change scenarios

Two groups of natural and social scientists were set up to accomplish the objective of the project through an end-to-end information flow concept, from data acquisition through delivery of integrated research products. The first group was made up of IGP scientists, with the task of rescuing historical meteorological data, performing an objective analysis to provide understanding of climatological characteristics, using statistical tools to identify and understand the causes of seasonal and inter-annual variability, and generating future climate scenarios for the Mantaro River basin (Figure 2).

To understand seasonal and inter-annual variations in temperature and precipitation, linear correlation analysis and teleconnection mechanisms were applied. Generation of future climate scenarios was performed using the output of the global National Center for Atmospheric Research (NCAR) Climate Model for one scenario, which was downscaled to the Mantaro River basin with a Regional Climate Model (Reg CM). The scenario was generated for 2045–2055. Future climate scenarios were also generated by applying statistical downscaling techniques for the same period, using the output of several global models for other climate scenarios; these are related to global emission scenarios. One scenario considers a future world with economic growth based on both intensive fossil fuels and predominantly non-fossil fuels. Another describes a future world with balanced energy sources. Further scenarios describe a very heterogeneous world, and a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. The results of both methods indicate an average of 1.3°C warming in the basin by 2050.

Assessing vulnerability

The second group was set up with 30 local social scientists from the university community, government and non-government research institutions, and local and

regional government organizations. The group had the task of developing a procedure for assessing the social risk and vulnerability to impacts of climate variability and climate change, and identifying viable options for adaptation in the selected agricultural and hydroelectric sectors. Risk and vulnerability are crucial elements in reducing the potential adverse impacts of weather and climate events. It was anticipated that adaptation measures would be included in local and regional governmental socioeconomic planning.

The establishment of working groups that included participants from most institutions was critical to the success of the project. Multidisciplinary collaborative research among natural and social scientists, stakeholders and decision-makers, as well as individuals representing different societal groups, was achieved through open discussions in a sequence of participatory workshops (Figure 3).

Transdisciplinary discussions took place in 24 workshops, approximately one every month (Box 1). The research community and societal groups were brought together to express their opinions and share their experience on the nature of climate and human behavior. This type of participation made it possible to obtain valuable information from the region. All members of the second group were invited to participate in the training activities to strengthen their research capacity, and encouraged to be part of the team that would formulate proposals to implement project recommendations. Challenges determined by participants included the ability of society to distinguish between climate change due to anthropogenic causes and climate variability due to natural causes, and the incorporation of issues of vulnerability and adaptation to climate change in the development agenda of each participating institution.

Main results

The project emphasized detecting signals of global warming, understanding regional climate variability, identifying extreme climate events and natural hazards, assessing impacts and vulnerability to climate change, understanding how the relationship between natural systems and human behavior is affected by climate change, and proposing measures to adapt to the impacts of climate change. The management of water resources in the basin was considered as the main issue, as reported in IGP reports in 2005.

The strategy for multidisciplinary collaborative research among natural and social scientists, stakeholders, and decision-makers that was used successfully in this study seems to be the most appropriate. The criteria for selecting the study area could serve as guidelines for selecting other areas.

Further important findings were: open discussions in a sequence of participatory workshops made it possible to strengthen institutional research capacity for a comprehensive assessment of climate change in high mountain regions. Considering that natural disasters in the central Peruvian Andes are mainly due to extreme weather and climate events (inundations, landslides, frosts and drought), the proposed adaptation measures took these events into account. The authorities responsible for social and economic development in local and regional governments have benefited from the availability of adaptation measures proposed by the study, which are currently being included in their development plans.

Topics of the workshops

- Rescuing meteorological data and building a database on research quality
- Statistical tools for data analysis
- Diagnosis of current climate characteristics
- Climate variability and climate change
- Societal perceptions of climate change
- Diagnosis of vulnerability to impacts of climate change
- Strategy for selecting economic sectors
- Developing vulnerability indices
- Development of conceptual models for vulnerability assessment
- GIS applications for vulnerability assessment
- Vulnerability and adaptation to climate change
- Future climate scenarios
- Integration of physical and societal findings

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FURTHER READING

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