The Ev-K2-CNR contribution to mountain ecosystem conservation and the study of climate change

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Executive summary

Ev-K2-CNR is a 20-year old institution of multidisciplinary high altitude scientific and technological research built upon a tradition of Italian exploration in the Karakorum and Himalaya. Ev-K2-CNR mission is to provide specialized scientific support for sustainable development in high altitude areas, promoting environmental conservation and a better quality of life for local populations.

Recent years have seen Ev-K2-CNR focusing more on the tangible outputs of its research efforts, moving beyond the generation of knowledge to the application of that knowledge on a management and decision-making level. Thus, contributions can be made to the resolution of major global or local problems, such as the impact of climate change on fragile mountain ecosystems and the urgent need for sustainable management of the world's precious resources like water, energy and food.

Ev-K2-CNR is promoting these integrated research projects:

- Stations at High Altitude for Research on the Environment (SHARE) which generates unique information for helping face the challenges posed by climate change. Interdisciplinary environmental monitoring is carried out in high altitude areas in the fields of Environmental and Earth Sciences (atmosphere and climate changes, glaciology, hydrology and limnology in high altitude areas, geophysics and natural hazards).
- Karakorum Trust (KT) which comprises a multi-sectoral intervention to contribute to sustainable economic development and environmental protection in the Northern Areas of Pakistan. Key focus is placed on implementation of the Central Karakoram National Park as a major opportunity for improving the standards of living of the local populations while safeguarding the precious resources of Pakistan's vulnerable Karakorum range.
- The Hindu Kush - Karakorum - Himalaya (HKKH) Partnership project, carried out together with IUCN, ICIMOD and CESVI. This project aims to facilitate local, national and regional systemic planning and management, focusing on poverty reduction and biodiversity conservation in the HKKH region. Ev-K2-CNR is particularly proud of the ground being broken in the promotion of management-oriented research and the local institutional capacity being built in this framework.

Introduction

Ev-K2-CNR is a 20-year old institution of multidisciplinary high altitude scientific and technological research built upon a tradition of Italian exploration in the Karakorum and Himalaya. It was one of the past century's most renowned scientists and explorers, Prof. Ardito Desio, who founded the organization and who, at the age of 90, personally inaugurated the famous International Pyramid Laboratory-Observatory located in Nepal near Mt. Everest (5,050 m a.s.l.) run by Ev-K2-CNR and the Nepal Academy of Science and Technology.

The Ev-K2-CNR specialization lies in its capacity to work systemically using knowledge generated within a multidisciplinary framework while promoting the dissemination of science. Ev-K2-CNR combines lessons learned through science with innovation to promote sustainable strategies for safeguarding the environment and improving the quality of life with a special focus on one of the world's most vulnerable and most valuable resources: mountains.

The main objective of Ev-K2-CNR is to improve understanding of high altitude ecosystems, their processes and interactions with the human component and the effects of global changes on a local level, so as to contribute to sustainable development and enhanced management of natural resources. Specific objectives include:

- Improve and expand its monitoring network in order to develop an integrated system of scientific measurements for improving knowledge in the fields of environmental and Earth sciences.
- Contribute to the mitigation of the impacts of climate change and promote sustainable adaptation strategies with particular regards to the water resources, biodiversity, ecosystem conservation and food security.
- Create electronic information systems and databases that are accessible to governments and scientific research institutes to facilitate the dissemination of knowledge, helping improve understanding of climate change phenomena.
- Help build institutional capacity for systematic planning and management of fragile high altitude ecosystems.
- Promote the preservation and valorisation of the environmental, cultural and architectonical heritage of the HKKH region.

Background and Context

The HKKH region comprises extraordinarily high mountain chains, spanning over thousands of kilometres and encompassing an extensive diversity of flora and fauna, unparalleled natural beauty and many varied cultures. These mountains feed most of the major river systems in the region which are a lifeline for approximately 10% of the world's population. Despite their importance, mountain regions are some of the least monitored regions in the world, primarily due to difficult accessibility and limited local scientific capacities.

According to the *IPCC 4th Assessment report*, climate change will have major impacts on glaciers and ecosystem services, with long term implications on food and water security, and on the livelihoods of local communities. Mountain areas are thus particularly vulnerable in this sense, especially with regards to their role in hydro-climatic systems and the fact that they provide essential freshwater for downstream populations, especially in the world's arid and semiarid zones. Furthermore, mountain areas have been recognized as sensitive early indicators of the effects of climate change. Recently, the United Nations General Assembly (*resolution n. 62/196 2008*) called for an enhancement of research efforts in mountain areas in order to understand how climate change influences hydrology, cryosphere, geomorphology, ecosystems, human livelihoods, etc., given that they are ideal and vastly representative locations for the study of climate change. Meeting this objective will require collection of high quality, long-term environmental data to support modelling and long-term prediction.

So far, the majority of mountain regions lack such datasets, primarily because of the extreme topography, harsh climate, lack of appropriate technical equipment and a general under-appreciation of the data's scientific benefit. Nonetheless, fragile mountain ecosystems which provide essential natural resources such as water, energy, wood, food, etc., are at stake. Furthermore, the role of high elevations in influencing global climatic processes is also not understood, but it is clear that there are significant effects on monsoons and pollution transport that need to be clarified within the efforts to understand global climate change.

Other critical issues in the HKKH mountain area arise from the lack of baseline information on biodiversity, resource use and availability, and the need for sustainable management programs and infrastructures in fragile areas. One such example is the Central Karakorum National Park (CKNP) in Pakistan's Northern Areas. This 10,000 km^2 landscape, endowed with rich floral and faunal biodiversities, natural beauty and key resources such as forest products and freshwater was declared as a protected area in 1993, yet it does not have a sustainable management plan since in place. Such a plan requires a wide range of reliable scientific information on all aspects of environment, development and socio-economic spectra which are not yet available.

Ev-K2-CNR Projects Dedicated to Mountain Ecosystem Conservation and the Study of Climate Change

SHARE (Stations at High Altitude for Research and Environment): Ev-K2-CNR is responsible for implementation of the SHARE project, in collaboration with UNEP and with the participation of several Italian and international research institutions. This program aims to facilitate study of the effects of climate change on mountain ecosystems and improve our understand of ongoing climate processes and phenomena, using an integrated approach based on long-term observations and appropriate climate modelling. The scientific research performed within the SHARE framework includes topics such as:

- analysis of the influence of regional anthropogenic and natural processes
- study of the interaction between mountain ranges and global atmospheric circulation
- characterization of physical, chemical, optical properties of aerosol and their variations
- study of seasonal variability of atmospheric pollutants and climate-altering compounds
- characterization of wet deposition chemistry
- evaluation of glacier energy and mass balance and consequent risks (Glacier Lake Outburst Floods - GLOF) and study of debris-covered glaciers and the role of debris in ablative processes
- monitoring of surface variations of glaciers, rock glaciers and moraines
- creation of hydro-geological models for analysis of risk factors
- study of lacustrine trophic chains and biomass accumulation in response to natural or disturbance factors
- identification of areas at risk of natural hazards through geodetic environmental monitoring

Given the high standards and distinctiveness of the data collected through the SHARE network (*Table 1*), the SHARE project has become an international point of reference. Contributions are made through SHARE to other monitoring networks which collect climate, atmospheric and terrestrial data, such as:

- Project Atmospheric Brown Clouds (ABC) - UNEP
- AErosol RObotic NETwork (AERONET) - NASA
- Coordinated Energy and Water Cycle Observation Project (CEOP) -WMO
- Global Atmosphere Watch (GAW) - WMO
- International Long-term Ecological Research Network (ILTER)

Table 1: Sites currently included in the SHARE network					
Installation site	**Nation/Continent**		**Station**	**Characteristics**	**Altitude (m a.s.l.)**
Mt. Cimone	Italy	Europe	"Ottavio Vittori" Research Station:	Atmospheric monitoring station	2,165
Forni glacier	Italy	Europe	-	Automatic weather station	2,669
Pyramid Laboratory Observatory (Lobuche)	Nepal	Asia	Nepal Climate Observatory-Pyramid (ABC-Pyramid)	Atmospheric monitoring station	5,079
			GPS Master	GPS station	5,050
			AWS 0, AWS 1; AWS CEOP	Automatic weather stations	5,050
			DORIS	Orbitographic station	5,050
Pheriche (Khumbu Valley)	Nepal	Asia	AWS 2	Automatic weather station	4,258
Namche Bazar (Sagarmatha National Park Head Quarter, Khumbu Valley)	Nepal	Asia	AWS NP	Automatic weather station	3,560
Lukla (Khumbu Valley)	Nepal	Asia	AWS 3	Automatic weather station	2,660
Kala Patthar	Nepal	Asia	AWS-KP	Automatic weather station	5,600
Mt Everest South Col	Nepal	Asia	AWS-CS	Automatic weather station	8,000
Urdukas (Baltoro glacier, Baltistan)	Pakistan	Asia	AWS PK1	Automatic weather station	3,926
Askole (Baltistan, Pakistan)	Pakistan	Asia	AWS PK2	Automatic weather station	3,015
Mt. Rwenzori (Elena Glacier)	Uganda	Africa	-	Automatic weather station	4,700

Preliminary scientific results of SHARE regarding the HKKH region were presented in 2005 at the Rome conference: "Mountains Witnesses of Global Changes. Research in the Himalaya and Karakoram: SHARE-Asia Project". The proceedings of the conference were published in a book edited by Springer (*Baudo et al. 2007*).

Taking advantage of the SHARE network, a new component of "regional focus" dedicated to High Elevations (HE) was recently implemented by Ev-K2-CNR within the Coordinated Energy and water cycle Observation Project (CEOP) of GEWEX (Global Energy and Water Cycle Experiment). HE aims to identify a worldwide network of high elevation climatic stations, including but not limited to CEOP reference stations, and to help facilitate dialogue amongst researchers concerned with these stations. Scientific priorities of the HE initiative include detection of the main factors affecting the water, energy and material cycles at high elevations in diverse climates and locations, studying the effects of such factors on glacial areas, and understanding the hydrological regime in surrounding lower altitude areas.

In order to help overcome the objective difficulties of carrying out continuous high altitude measurements in remote mountain areas, SHARE also intends to produce a sophisticated technological system called “Nano-SHARE” to facilitate installation and maintenance of monitoring stations in such regions. Nano-SHARE will be innovative in that it will be the world’s only modular and adaptable, high-tech, integrated environmental and geophysical monitoring system. Important measurements will thus be make possible where installation of a permanent laboratory or standard station would otherwise be too difficult or expensive. The system will be developed to run exclusively on renewable energy and will ensure a low environmental impact.

SHARE furthermore intends to generate an electronic information system dedicated to mountain environments. Data collected will be organized within a synergic and integrated framework allowing researchers to optimize their investments, harmonize databases and improve collaboration. The system will also be made accessible to concerned stakeholders concerned with the environment and sustainable development, such as governments, institutions, policy-makers and protected area managers.

Finally, SHARE also intends to continue supporting sustainable development of mountain regions and improving local environmental management systems by promoting institutional capacity building and transferring technology and know-how in the fields of environmental and geophysical sciences.

HKKH Partnership Project: Recent years have seen Ev-K2-CNR increasingly focused on the tangible outputs of its research efforts, moving beyond the mere generation of knowledge to the application of that knowledge on a management and decision-making level. The best example of such management-oriented research is manifested within the HKKH Partnership, being executed in collaboration with IUCN, ICIMOD and CESVI. This program builds on cutting-edge approaches and experiences in contemporary ecosystem management practice, successfully bridging the gap between research and management. Within this framework Ev-K2-CNR is coordinating execution of research on important, management relevant, environmental issues in the Nepal, Pakistan and China, such as: forest conditions, solid waste management, water pollution, biodiversity, energy, wildlife and climate change. All research is guided by the identification of crucial knowledge gaps for adaptive socio-ecosystem management, as identified during a modelling process which forms the basis for a Decision Support Toolkit being produced for local stakeholder institutions.

A few examples of the management-oriented research being carried out within the HKKH Partnership include:

Study on the impact of climate change and anthropogenic activities on high altitude forests and biodiversity in Sagarmatha National Park (SNP), Nepal. A dendrochronology laboratory is being installed at the Nepal Academy of Science and Technology as an output of this study. Researchers of several Nepali scientific organizations will be trained in dendrochronology techniques which are key to monitoring the effects of climate change on forests in Nepal, thus allowing Nepal to contribute to and share data with regional networks and initiatives concerned with climate change, biodiversity and forest condition issues and to monitor changes in the condition of essential resources of its various national parks.

Sustainable Forest Management (SFM) in the CKNP, Pakistan. Training courses have been organized in Pakistan aimed at promoting sustainable forest management in the CKNP. Key local stakeholders involved include: the Bagrot Community, NAs Forest Department, WWF-P, AKRSP, IUCN and KIU. Through such training, collaboration among concerned organizations is promoted at various level to develop the awareness about the importance of SFM and to develop the local capacity to implement an SFM plan. This will ultimately ensure the sustainable use of natural resources in the CKNP and increase the skills of the Pakistani forest managers to perform a sound inventory of their forest resources.

Biodiversity Research. Studies particularly focused on the large and small fauna in SNP and CKNP are ongoing. Ev-K2-CNR is carrying out a project aimed at assessing the effects of the return of the snow leopard to Nepal's Sagarmatha National Park. The project is concerned with understanding the numbers, movements, habitat use and prey of the snow leopard, while developing initiatives to improve co-existence with the local human community (i.e., management measures to prevent/discourage predation on livestock and steps to reduce poaching). In CKNP, research has been aimed at increasing baseline knowledge of local biodiversity. Researchers have been particularly concerned with distribution of large mammals, herpetofauna and invertebrates, to catalogue the existing species and use such data to identify the conservation priorities for the CKNP.

Karakorum Trust: After an initial implementation phase of coordinated activities aimed at laying the groundwork for the implementation of the CKNP, Ev-K2-CNR and UNEP have jointly developed a new Karakorum Trust proposal which comprises a multi-sectoral intervention contributing to sustainable economic development and environmental protection in the Northern Areas of Pakistan. Key focus is placed on implementation of the Central Karakoram National Park as a major opportunity for improving the standards of living of the local populations while safeguarding the precious resources of Pakistan's vulnerable Karakorum range.

A knowledge base on natural resources and the cultural heritage of the Central Karakorum region will be developed, to the benefit of the local administration, communities, development cooperation organizations, and local and international research institutions. The project will be particularly concerned with carrying out an assessment on the impacts of climate change on the Central Karakorum ecosystem, including glaciers, water and biodiversity. Based on these findings, capacity building support will be provided to the local communities and institutions regarding possible adaptation measures to adopt. The project will also undertake pilot projects in order to demonstrate the adaptation measures at the local level, showcasing particular successful strategies to decision makers and managers.

Conclusions and Way Forward

As can be seen from this rich framework of multidisciplinary, sustainable development-based projects, Ev-K2-CNR is dedicated to optimizing its expertise in high altitude scientific research, ensuring its outputs are increasingly management-oriented. To summarize, Ev-K2-CNR's future priorities include:

- helping understand global climate processes and the effects of climate changes on fragile mountain ecosystems, paying particular attention to water resources, biodiversity and ecosystem conservation and food security;
- promoting sustainable management of mountain environments, promoting the conservation of biodiversity and promotion of unique the cultural heritages of mountain regions;
- building capacity of local institutions to study, monitor and sustainably administrate mountain resources and protected areas.

Unable to meet such objectives alone, Ev-K2-CNR will continue to expanded its national and international collaborative network. Expertise is drawn from numerous institutes of the Italian National Research Council (CNR) and Italian universities, international organizations, NGOs and INGOs. With regards to ICIMOD, Ev-K2-CNR and ICIMOD signed an MoU in 2007 for the promotion and coordination of research and cooperation initiatives in the HKKH. This collaboration, although already manifest through participation in numerous joint initiatives will be consolidated through the participation of ICIMOD in the new phase of the "Karakorum Trust" project supported by UNEP.

Ev-K2-CNR also intends to contribute to the work of GEO (Group on Earth Observation), a voluntary partnership of governments and international organizations arising out of the G8. GEO is principally concerned with creation of a Global Earth Observation System of Systems (GEOSS), in which Ev-K2-CNR hopes to participate with the SHARE high elevation environmental monitoring network and through the data collected within the CEOP-HE initiative. A proposal in this sense has been submitted to GEO.

Considering its presence in Uganda with a SHARE station on Mt. Ruwenzori, Ev-K2-CNR is also exploring the possibility to participate in an MRI-led project aimed at the establishment of High Altitude Global Change (Climate) Observatories in African Mountains.

Ev-K2-CNR intends to promote its commitment to management-oriented research in mountain areas in institutional and political arenas, as well as scientific contexts. To this end, Ev-K2-CNR is planning to closely collaborate with the Milan Expo 2015 “Feeding the Planet, Energy for Life” given key themes of the event are in line with Ev-K2-CNR’s main objectives: preservation of biodiversity, environmental protection, fresh water, sustainable development, food security and renewable energies. In this context, a conference on the contributions of the SHARE project to understanding the impacts of climate change on mountain resources such as energy, water and food is being planned for 2009 in collaboration with the Scientific Committee of Expo 2015. The goal of this event will be to promote awareness regarding the effects of climate change on the environment, economy and society.

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Links

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