Stations at **H**igh **A**ltitude for **R**esearch on the **E**nvironment

SHARE

monitoring global climate change

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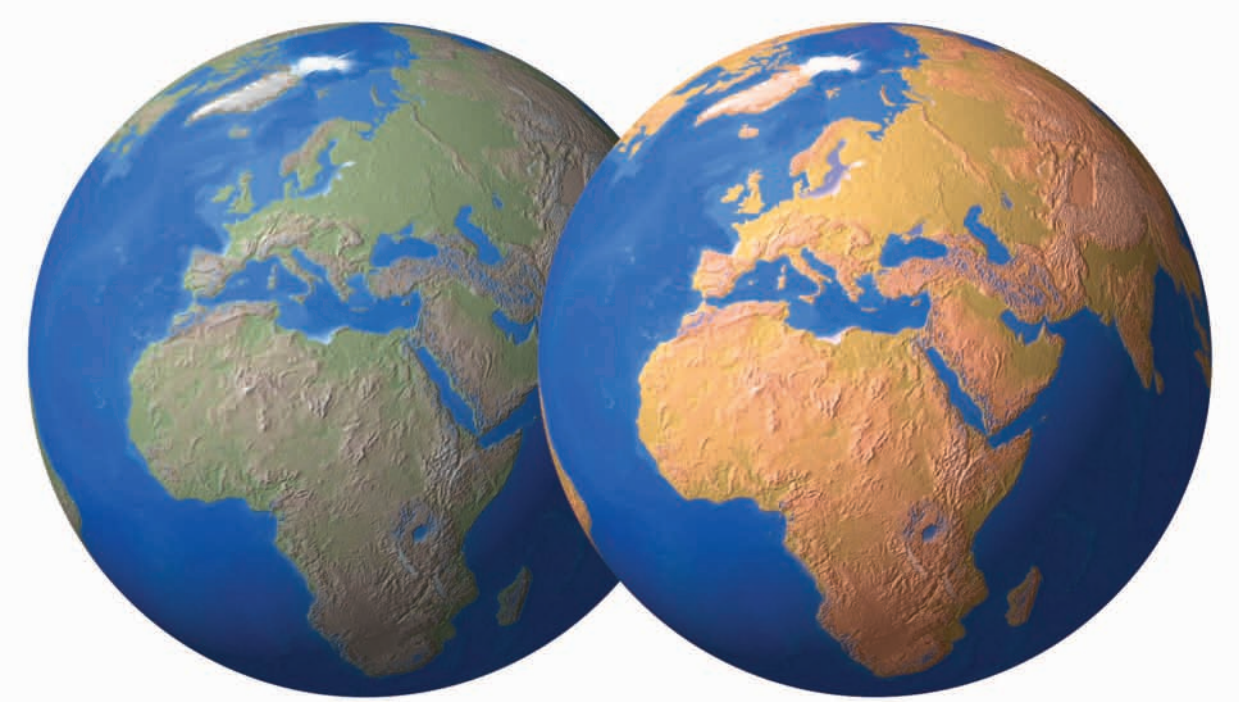


The Earth's average surface temperature has risen by 0.74°C since 1850.

Most of the warming that has occurred over the last 50 years is very likely to have been caused by human activities. Without further action to reduce greenhouse gas emissions, the global average surface temperature is likely to rise by a further 1.8 - 4.0°C this century.

climate change scenario

Human activities that contribute to climate change include in particular the **burning of fossil fuels, agriculture and land-use changes like deforestation**.
These cause emissions of carbon dioxide (CO2), the main gas responsible for climate change, as well as of other **greenhouse gases that in atmosphere cause climate alteration**. The continuous trend of increasing temperatures could also lead to **extinction** phenomena.
Pollution has already produced habitat loss and as a consequence made numerous animal and plant species vulnerable. These species will probably not survive for more than 100 years.

Humans must now deal with an increase in a variety of extreme phenomena related to climate changes, such as **violent storms and drought**. High temperatures have caused an increase in sea levels and should this trend continue, the often densely populated coastal areas (like that of Bangladesh) will be flooded or risk disappearing all together, in the case of countries like the Maldives. Seawater intrusions will also decrease the availability of fresh water, a serious problem affecting many populations with already limited access to drinking water.

Another imminent consequence regards agricultural production, which will decrease in tropical, subtropical and temperate regions, while desertification phenomena will occur in places such as Central Asia, Africa Sahel and the great plains of America. These changes in land use will lead to a decrease in food supplies and an increased incidence of epidemics like malaria.

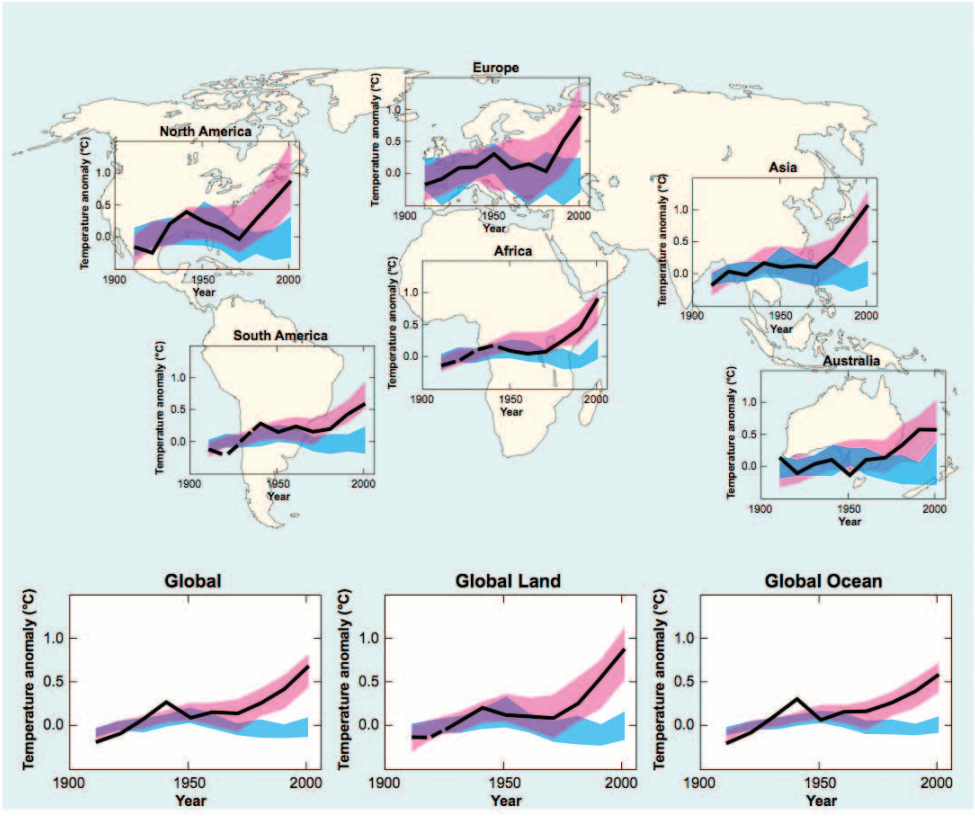
Researchers have observed several changes produced by climate variations in over 420 processes, biological species and communities. For example, some plants and insects are now found living at higher altitudes, where previously cold conditions did not allow them to survive.

Climate changes have complex interactions with health including for example direct impacts like **diseases and death** due to temperature modifications, extreme environmental events, pollution and radiation, and the scarcity of food and water.

Global warming effects the entire world and has strong implications regarding poverty, economic development and population growth. Industrialized countries in North America, Western Europe and Japan are responsible for the past and present greenhouse gases emissions although **the greatest victims of climate change will be developing countries**.
Their limited resources will make it harder for them to protect themselves from disasters, disease and food scarcity, thus hindering their already tenuous economic development.

the greatest victims of climate change will be developing countries.

Global and Continental Temperature Change



models using only natural forcings

models using both natural and anthropogenic forcings

mitigation actions

Over the past ten years, mitigation actions to contrast climate change phenomenon have been undertaken. In 1998, the **I**ntergovernmental **P**anel on **C**limate **C**hange (**IPCC**) was established to coordinate scientific research aimed at providing information for climate programs. The program interacts closely with several other initiatives, particularly with the **U**nited **N**ations **F**ramework **C**onvention on **C**limate **C**hange (**UNFCCC**) which promotes reduction of global warming according to the Kyoto Protocol.
As indicated in the last Conference of the Parties (COP) report, COP 12, attention needs to focus on: implementation of efficient energy systems; renewable energy sources; low greenhouse gas emissions; development of environmentally sound agriculture techniques such as traditional reforestation methods; solid and liquid waste management systems for methane recovery. Capacity building is also seen as a priority in economically disadvantaged areas to promote efficient energy usage, provide technical support in the application of low greenhouse gas emission systems and distribute advanced, environmentally friendly technologies for fossil fuel and energy consumption.
Other important steps toward mitigation are being made through:

- The **European Climate Change Programme**, which deals with carbon dioxide emissions and efficient energy production systems.

- The **G**lobal **C**limate **O**bserving **S**ystem (**GCOS**) Project, which coordinates ongoing climate research on a global level, studies the physical, chemical and biological properties of climate, as well as the Earth's atmosphere, oceans, hydrology, chryosphere and environmental processes. The information collected supports the evaluation of climate change impacts and provides predictive climate models for research projects.

- The **UNEP-G**lobal **E**nvironmental **O**utlook (**GEO**) supports environmental policy management through an integrated analysis of environmental conditions and studies of ecosystem trends, current policies and emerging problems.

- The **G**lobal **E**arth **O**bservation **S**ystem of **S**ystems (**GEOSS**), approved in 2003 during the G8 in Evian. The aim of this program is to facilitate information dissemination and provide elaboration models through creation of a vast data collection system using the latest hardware and software technologies. The benefits and consequences of a global information system will have repercussions on different levels: disease reduction, integrated management of hydrological resources, monitoring and management of ocean and marine resources, monitoring of meteorology and air quality, biodiversity conservation, sustainable land use management, comprehension of environmental factors with human health consequences, improved energy resource development and adaptation to climate change variability.

- The **UNEP-G**lobal **E**nvironmental **F**acility (**GEF**), which promotes environmental projects regarding biodiversity, climate change, international waters, soil degradation, persistent organic pollutants and the hole in ozone layer.

- The **U**nited **N**ations **C**ommission on **S**ustainable **D**evelopment (**UNCSD**), which according to its latest report "Trends in sustainable development" deals with themes like: energy, sustainable development, industrial development, atmosphere and climate change. Particular attention is paid to energy consumption and increases in the emissions of sulphur dioxide.
Consequently, one of the Commission's main priorities regards atmospheric protection, as similarly highlighted in international agreements like the **Convention for the Protection of the Ozone Layer** (1985) and the **Montreal Protocol on Substances that Deplete the Ozone Layer** (1987).

- The **Agenda 21**, which calls for coordination of environmental activities with economic development and poverty reduction. Four main program areas include: increase scientific knowledge to reduce uncertainty, prevent ozone depletion in the stratosphere, reduce air pollution, promote sustainable energy development in terms of efficiency, consumption, transport, industrial development, marine, resource exploitation and land use.

Particular emphasis has been given at national and international levels to cooperation mechanisms promoting capacity building in developing countries. Definition of needs and priorities to ensure sustainable development in developing countries through improved involvement, stronger human resources and institutional capacities is a clear priority. Capacity building is one of the focal points of the **J**ohannesburg **P**lan **O**f **I**mplementation (**JPOI**) that supports introduction of developing countries in multilateral and global research programs. The seven objectives of the **Millennium Development Goals** concern the need for environmental sustainability in management programs and policies, contrasting the loss of environmental resources. The **W**orld **H**ealth **O**rganization (**WHO**) analyzes the impacts of global environmental risks on human health, included climate change, ozone depletion, biodiversity loss, hydrological system changes, freshwater resource use, soil degradation and food production. Evaluation of the level of climate change's influence on human health needs to concentrate on ecosystems and demonstrate awareness of the fact that long term good health is related to the stability and functioning of support systems for a healthy biosphere. The **I**nternational **S**trategy for **D**isaster **R**eduction (**ISDR**) promotes prevention and reduction of diseases as an integral component of sustainable development, with the aim of decreasing human, social, economic and environmental loss due to natural and environmental and technological disasters. Industrial powers too have recognized the priority issue of climate change.
During the last **W**orld **E**conomic **F**orum (**WEF** - Davos, 2007) statements were issued confirming that climate change concerns not only developed countries who are responsible for high level emissions, but also developing countries, since for example China will surpass the USA in greenhouse gas emissions by 2009. The WEF has called for creation of an international partnership, the Climate Disclosure Standards Board, to provide a unique network through which industries can discuss climate risks. Given difficulties in reaching international consensus on these issues, however, actions taken by single nations to mitigate the effects of climate change are strongly encouraged.
The participants in WEF 2007 also recalled the importance of technology for providing sustainable solutions. Some delegates sustained that even if responsibility for prevention remains at a political level, the real solutions will come from the market.

the importance of mountains

Mountain sustainable development is one of the main themes of the UNCSD – Agenda 21 that describes mountains as **a fundamental source of water, energy, biodiversity, minerals, forests, agricultural production and tourism**. Mountain environments are one of the most important **ecosystems, essential for Earth's survival yet fragile and subject to rapid modifications**. Many mountain areas also suffer from environmental degradation. 10% of the world's population depends directly on mountain resources, while an even higher percentage uses precious mountain resources like water.

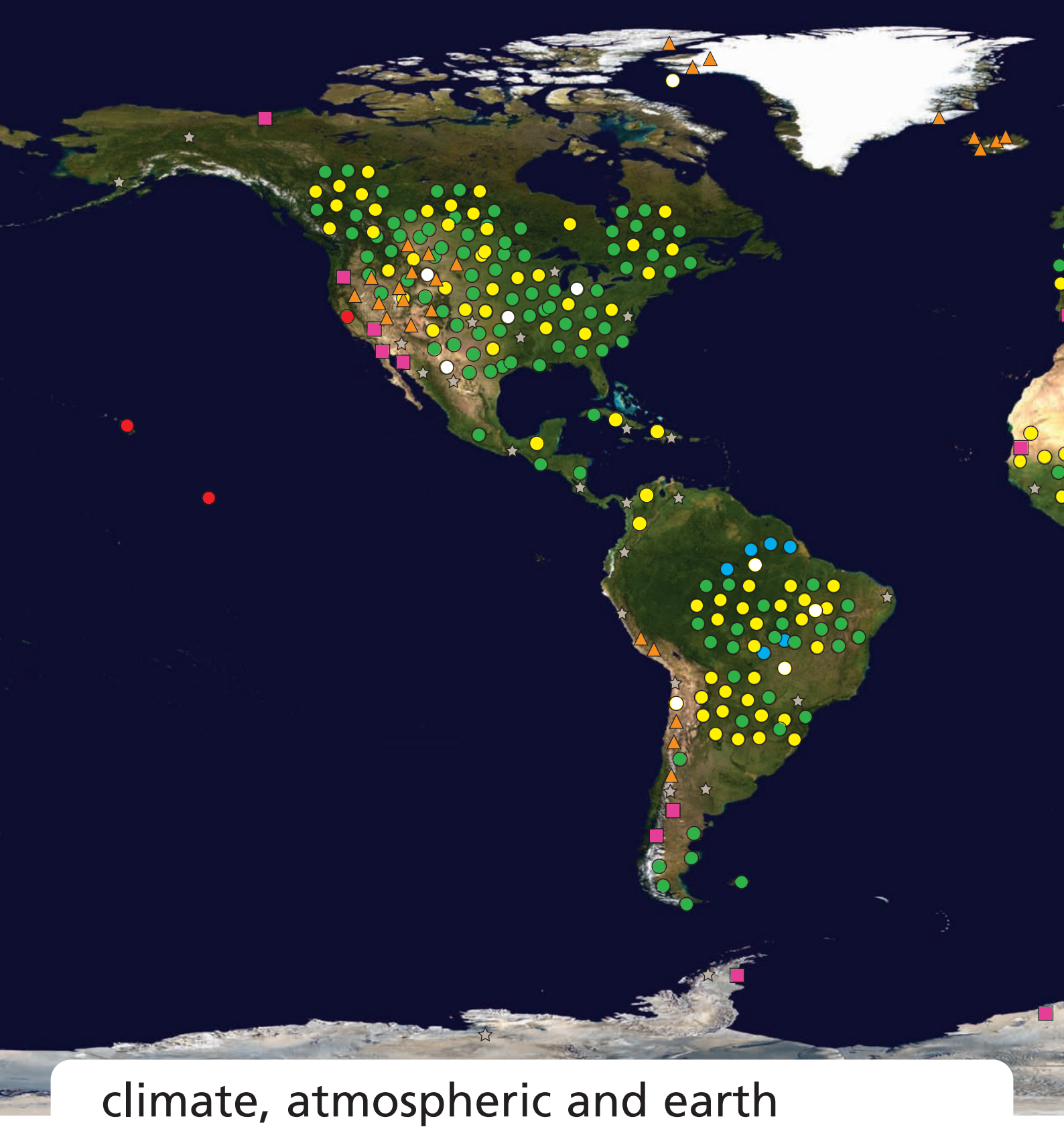
On November 10, 1998 the General Assembly proclaimed 2002 the International Year of Mountains. The objectives of the year were to guarantee present and future welfare of mountain communities through the promotion of conservation and development of mountain areas; to increase sensitization actions and **ecosystem** knowledge (ecosystem dynamics and functioning, their importance as a source of goods and services, particularly **water** and food security, fundamental for the welfare of the planet's populations), to promote and preserve **cultural heritage** of mountain communities, to carefully follow the frequent conflicts in mountain regions and promote **peace** initiatives in these areas.

These concepts were confirmed in 2002 at the World Summit on Sustainable Development (WSSD) in Johannesburg.
The JPOI highlighted the following concepts in particular:

- Mobilize a **national and international support** system of applied **research**
- Strengthen **capacity building**
- Provide technical and financial assistance for the effective implementation of **sustainable development** of mountain ecosystems in developing countries as well as those with economies in transition;
- Deal urgently with **poverty in mountain regions** by planning activities and implementing projects.

A Johannesburg Type II Outcome partnership initiative, the International Partnership for Sustainable Development of Mountain Regions aims to contribute to reach these objectives for mountains development. Within the framework of this umbrella program, the Ev-K2-CNR Committee became the main promoters of another partnership initiative dedicated to the creation of Decision Support Systems in the Hindu Kush-Karakorum-Himalaya region (HKKH Partnership for Ecosystem Management).

Finally, other international initiatives like the collaborative research on global change and mountains regions under the **International Geosphere-Biosphere Programme** (IGBP) point out the importance of an integrated approach to observation, modelling and investigation of phenomena and processes (impacts on ecosystems and on socioeconomic systems) in mountain regions.
Such initiatives demonstrate that **mountain regions provide optimal conditions for the analysis of processes and phenomena connected with global changes**.

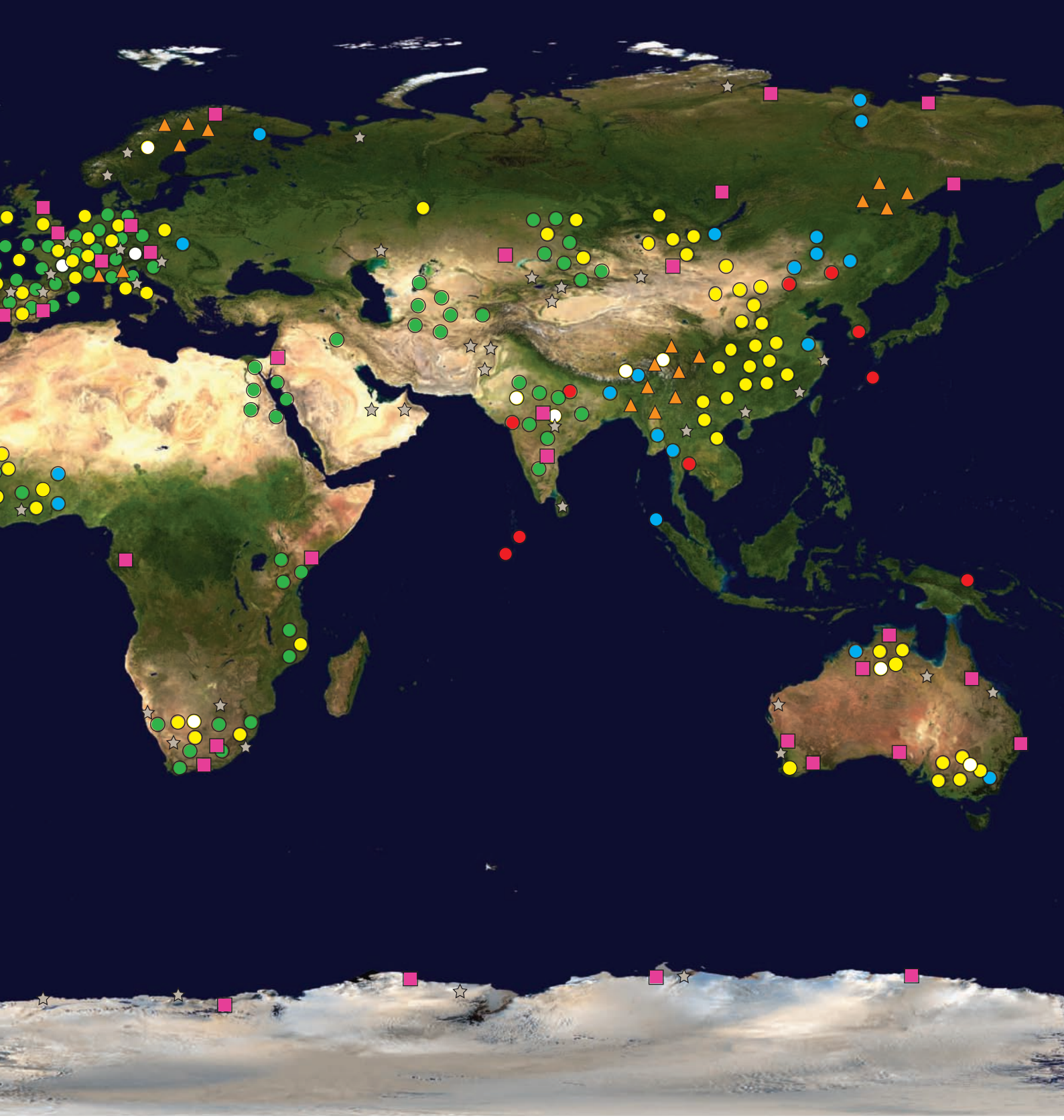


climate, atmospheric and earth monitoring networks and high altitudes

Global monitoring responds to the needs for increasing time-space knowledge on the whole environmental system. The development of a monitoring network for the detection of climate change must consider the complex interactions which exist between ecosphere components, necessarily applying an approach which considers the entire planet. **Many networks which study climate changes do not include strategic high altitude locations around the world**.

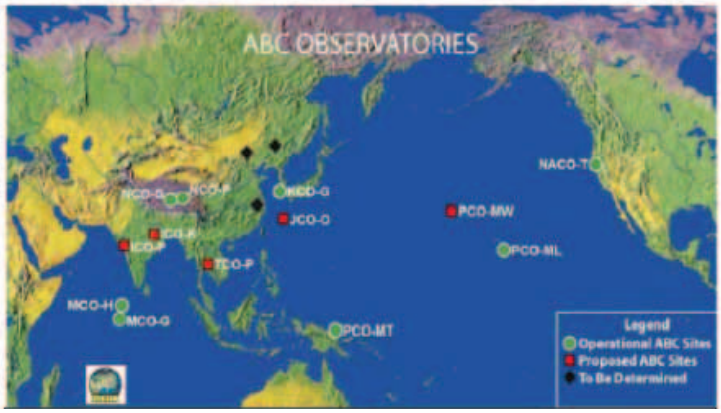
This is because of the great challenges regarding management of such sites and the only recent understanding of the scientific importance of these locations. Networks for the study of Earth sciences must in fact increase investigations in mountain areas in order to be effective.

The most important monitoring networks which collect climate, atmospheric and terrestrial data are:



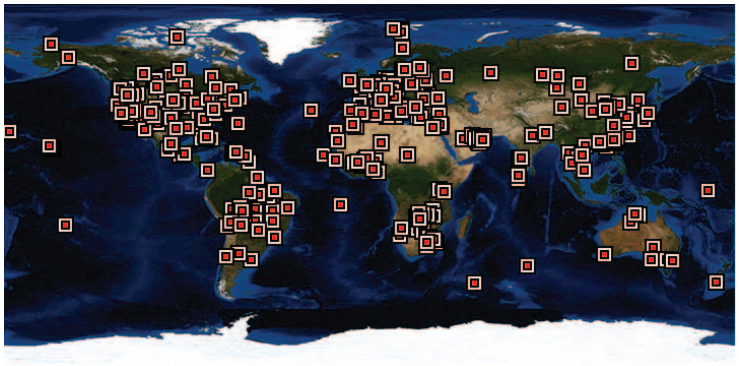
- Project Atmospheric Brown Clouds (ABC)
- AErosol RObotic NETwork (AERONET)
- Coordinated Enhanced Observing Period (CEOP)
- Global Atmosphere Watch (GAW)
- International Long-term Ecological Research Network (ILTER)
- Global Land Ice Measurement from Space (GLIMS)
- Global Seismographic Network (GSN)
- International GNSS (Global Navigation Satellite Systems) Service (IGS)

Project Atmospheric Brown Clouds (ABC)



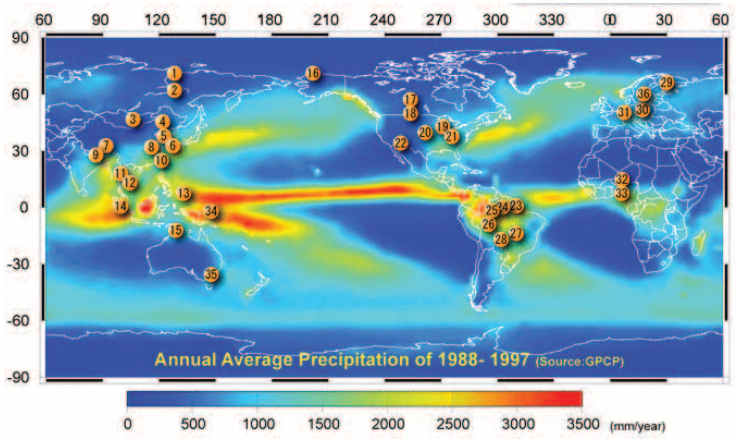
This monitoring program promoted by UNEP was undertaken to study the impacts of "brown clouds", masses of pollutant substances initially detected in the Indo-Asian Pacific region. To do so, an aerosol observatory network is being implemented and the first stations have been installed (see figure), but with the extension of this phenomenon, the monitoring area will need to be extended in order to better comprehend causes and effects. UNEP thus accepted the Ev-K2-CNR Committee's proposal to install observatories in the Himalaya-Karakorum area. **The first high altitude station of the ABC network is in fact the ABC-Pyramid station** (named in the framework of ABC Project: **NCO-P**, **N**epal **C**limate **O**bservatory–**P**yramid) **installed near the Pyramid Laboratory-Observatory, at 5,079 m a.s.l. in the Khumbu Valley, Nepal, near Mt. Everest**.

AErosol RObotic NETwork (AERONET)



The AERONET program is a federation of ground-based remote sensing aerosol networks established by NASA and LOA-PHOTONS (CNRS) and is greatly expanded through collaboration with national agencies, institutes, universities, individual scientists and partners. The program provides a long-term, continuous and readily accessible public domain database of optical, mircrophysical and radiative properties of aerosol for aerosol research and characterization, validation of satellite retrievals, and synergism with other databases. The network imposes standardization of instruments, calibration, processing and distribution. AERONET collaboration provides globally distributed observations of spectral aerosol optical properties and precipitable water in diverse aerosol regimes. The NASA monitoring network is made up of over 100 photometers across the Earth, both at sea level and in mountain regions. **At the ABC-Pyramid Laboratory (NCO-P), a sunphotometer has been installed and included in the AERONET network.**

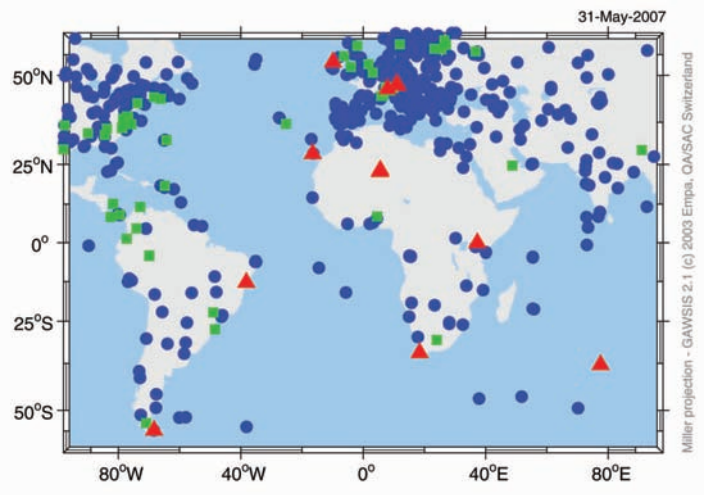
Coordinated Enhanced Observing Period (CEOP)



CEOP aims at carrying out a global integrated system of observations to study the water cycle, a fundamental resource for science and society. The advanced scientific objectives that CEOP aims to pursue concern the comprehension and definition of extreme event mechanisms and the obtainment of thorough knowledge on interactions between aerosols and water cycles. Presently, the CEOP network is made up of 36 reference sites covering large areas characterized by different climatic regimes, from artic to tropical. Stations are located at various altitudes, from sea level to above 5,000 m a.s.l. **A CEOP monitoring network reaching from 2,600 to 5,050 m a.s.l. in Nepal's Khumbu Valley has been installed and is managed by the Ev-K2-CNR Committee. The Ev-K2-CNR stations in Pakistan will also be soon included in the CEOP project**.

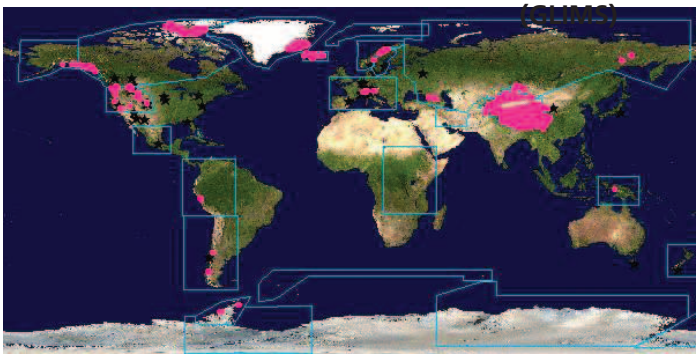
Global Atmosphere Watch (GAW)

The GAW program has implemented a global network of observatories and monitoring stations for the study of atmospheric background conditions. The project provides data to the scientific community for the study of changes in chemical and physical properties of the atmosphere which can produce effects on the environment. The main substances monitored are greenhouse gases, ozone and UV radiation, as related to recent climate changes producing effects on the biological community, as well as reactive gas and precipitation chemistry which plays a fundamental role in the study of atmospheric pollution. **Given the uniqueness of the data collected at the Pyramid Laboratory in Nepal and its relevance to GAW activities, a request has been made for the inclusion of the station in the GAW program.**



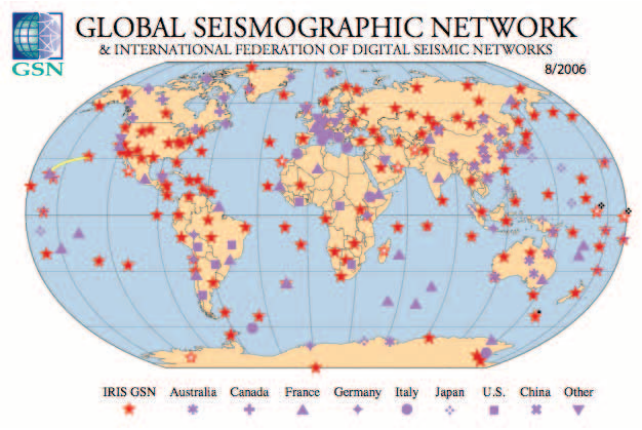
Global Land Ice Measurement from Space (GLIMS)

GLIMS is a project designed to monitor the world's glaciers primarily using data from the ASTER (Advanced Spaceborne Thermal Emission and reflection Radiometer) satellites. The project foresees implementation of a set of software tools to track glaciers and determine glacier area, location of the post-melt season snow line, velocity field and location of the terminus. GLIMS also includes a network of centers around the world that will monitor the glaciers in their regions and the implementation of a global glacier database of derived glaciological parameters. All information and glaciological parameters will be collected and stored in a single archive. **Even if not directly involved in GLIMS, Ev-K2-CNR researchers have been collaborating with delegates of this project, exchanging information on Himalaya and Karakorum glaciers, for over a decade**.

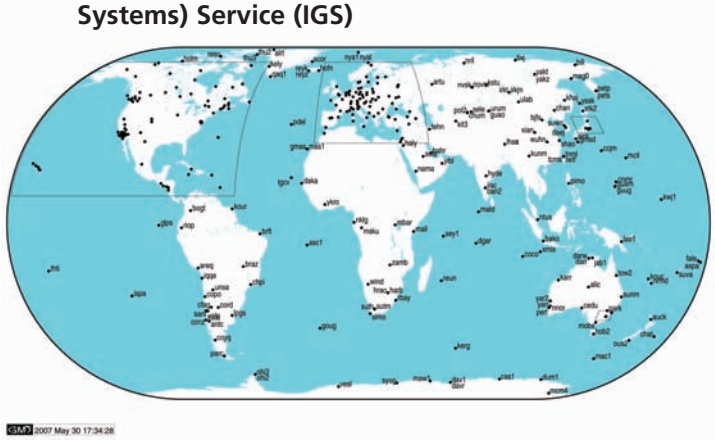


Global Seismographic Network (GSN)

GSN is one of the four programs of the Incorporated Research Institutions for Seismology (IRIS), a consortium of research universities dedicated to the monitoring of the Earth by sharing seismographic data. The GSN manages the information collected by 128 seismographic stations located around the globe. The aims of the program are: provide digital registration of Earth's movements, from free oscillations to teleseism; provide enough bandwidth to all stations to register local earthquakes; and provide real-time data for event monitoring. **The Ev-K2-CNR Committee intends to activate collaboration with the GSN, following installation of some seismic stations in the Himalayan-Karakorum area**.

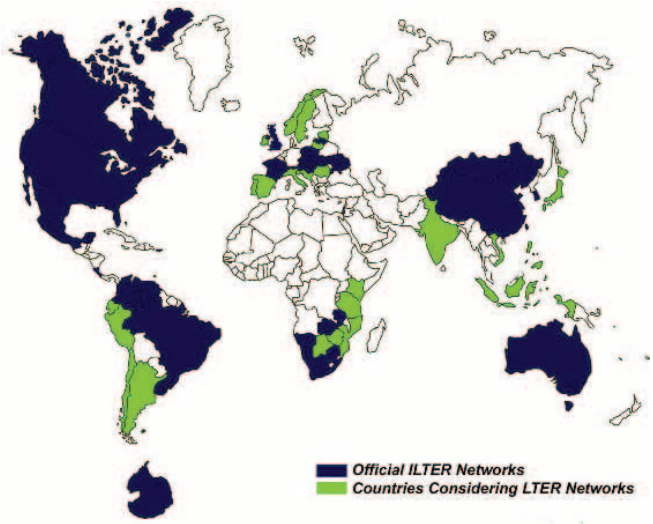


International GNSS (Global Navigation Satellite Systems) Service (IGS)



The IGS system, made up of global monitoring stations and data collection and elaboration centers, is committed to provide high quality real time data and GPS station products and elaborations on line to contribute to a multitude of studies and scientific and engineering projects. In the field of Earth sciences, data are the foundation for the International Terrestrial Reference Frame (ITRF), a system which monitors terrestrial surface deformations, Earth rotation movements, sea level and ocean variations and glacier variations, using techniques like satellite orbit determination and ionosphere monitoring. **Since GPS survey is one of main scientific parameters for the Ev-K2-CNR Committee research, inclusion of their GPS master stations in the IGS network will be an important recognition**.

International Long-term Ecological Research Network (ILTER)



Long term ecological research programs have rapidly expanded, reflecting the importance of studies which address complex environmental problems. In this context, groups of scientists have promoted the creation of international networks, like ILTER. Currently, ILTER is made up of 26 sites representing different ecosystems like deserts, estuaries, oceans, coral reefs, grasslands, alpine and artic tundra, urban and agriculture areas located in North America, the Caribbean, Asia Pacific and Antarctica. In Italy a consortium of promoter institutes with the participation of the National Research Council (CNR), Italian Universities, and the Ministry of Forests implemented the sub-network, LTER-Italy. **In addition to several sites in Italy, this sub-network includes the Pyramid lakes in Nepal, where Ev-K2CNR researchers have been performing ecological research for over a decade**.

GAW-WMO stations distribution.
The high altitude stations are indicated in red

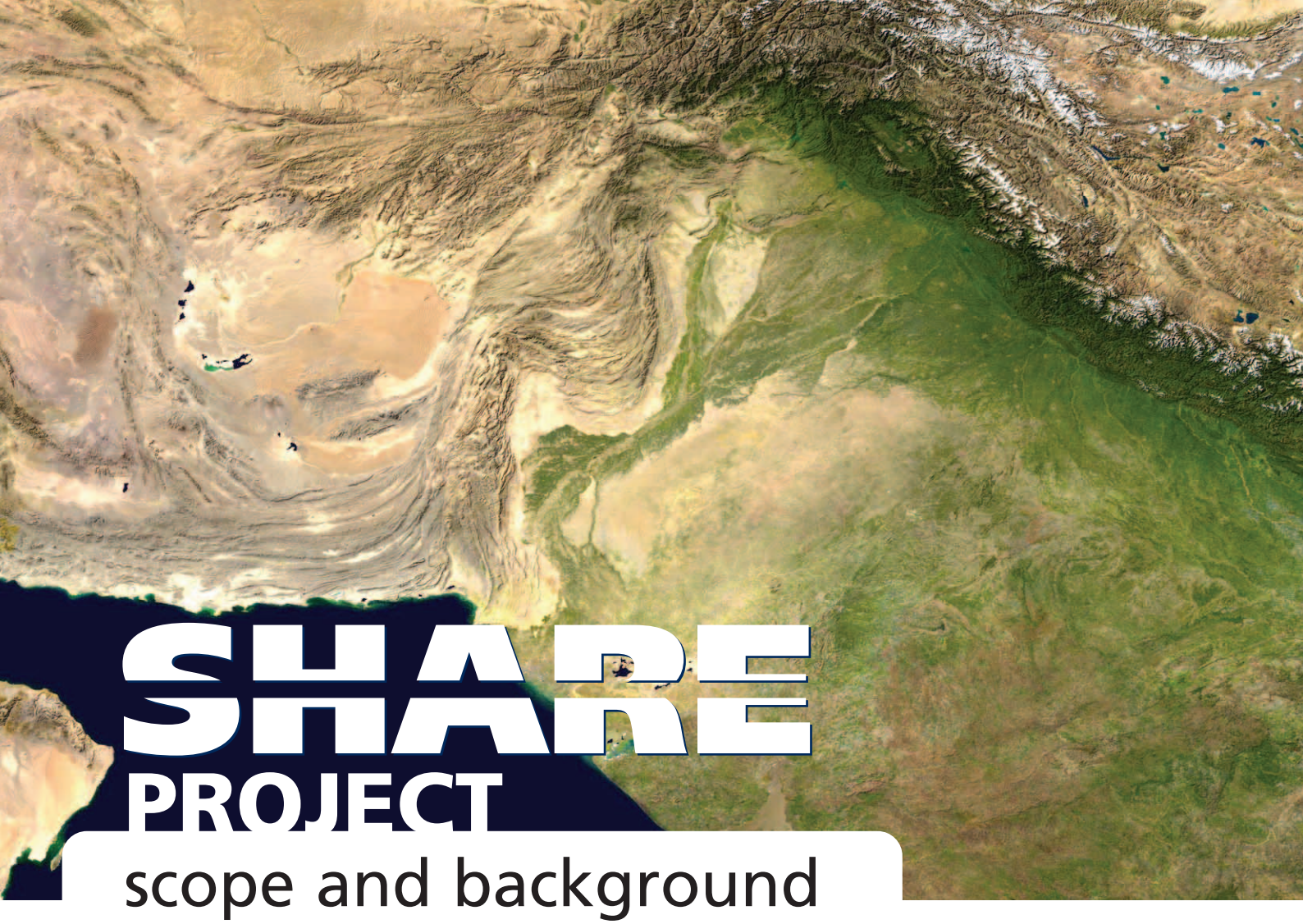
(a) Haze over the lower Himalayas,
(b) Haze over the Arabian Sea,
(c) Haze over the Indian Ocean,
(d) Haze over Los Angeles
(e) Haze over the Alps, Geneva
(f) Haze over the South China Sea

summary of high altitude monitoring activities

There are several networks of research stations around the world, many of which monitor the characteristics and composition of the atmosphere. The World Meteorological Organization (WMO) **Global Atmosphere Watch** (GAW) network, established in 1989 and comprising 22 global stations (generally located in remote sites and representative of large geographic areas characterized by the absence or low levels of local pollutants) and over 300 regional stations, can be considered one of the main networks. However, **only 5 observatories in the GAW network are installed at high altitude**.
This survey of the main international monitoring programs demonstrates that generally **few measurement sites are located in high altitude regions. Amongst these, the observatories located in some of the remotest areas have been installed by the Ev-K2-CNR Committee**.

Ev-K2-CNR has in fact accepted the challenge to fill the scarcity of data collected in mountain regions, in spite of factors like extreme topography and harsh climate conditions that are at the root of this data gap.
Thanks to collaboration with researchers involved in monitoring activities in other mountain ranges in Europe and in North and South America, Ev-K2-CNR is already performing continuous environmental monitoring in mountain areas of Africa and Asia, where measurements were otherwise limited or absent.

Another limitation of current international studies is their tendency to deal specifically with one environmental sector. It is thus nearly impossible to find a global environmental monitoring network for the multidisciplinary study of diverse components and their interactions, especially in remote ecosystems.



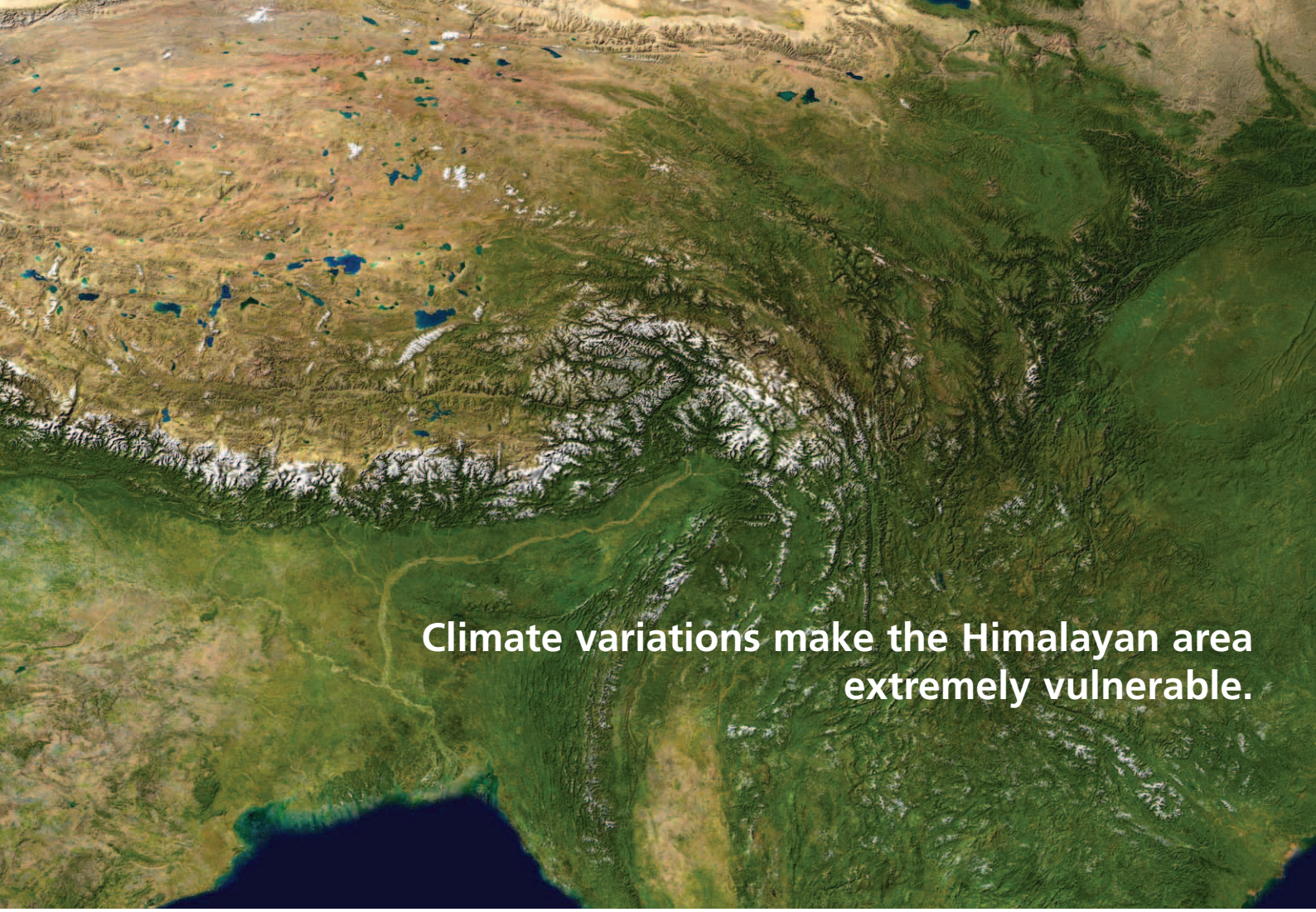
SHARE PROJECT

scope and background

The goal of this program for implementing an environmental monitoring network in the Himalaya-Karakorum region is to **significantly contribute to the improvement of knowledge in the fields of environmental and Earth sciences** by developing an integrated system of measurements for determining meteorological/climate parameters, performing atmospheric chemical measurements, carrying out limnological and paleolimnological analyses on high altitude lakes, monitoring glaciological activity and establishing the precise measurement of Earth surface coordinates. Simultaneously, the program aims to facilitate technology transfer and promote capacity building activities in the fields of environmental and geophysical monitoring by directly involvement of local communities, thus increasing the responsibility of local populations for land use and resource management.

The execution of research activities in Central Asia around the world's highest peaks, **Everest** and **K2**, has proven the importance and strategic scientific role these areas play in our comprehension of environmental phenomena on a local, regional and global level. Project research on atmosphere, climate changes and natural hazards in the Himalayan-Karkorum region has shown, for example, an increasing annual mean temperature trend. Seasonal temperature trends and their spatial distribution also influence the monsoon circulation, revealing a negative precipitation tendency evident in the western region (UNEP – MOPE, 2004). In the Himalaya and Karakorum, furthermore, the seasonality of the monsoons influences soil erosion, and certain episodes can impoverish lands which are already subject to a growing unbalance between demands for arable land, wood, agricultural products and the scarcity of suitable terrain.

Climate variations make the Himalayan area extremely vulnerable. In the last ten years temperature increases have produced a retreat of glaciers and snow cover, reducing water resources in the dry season. This aspect makes an already precarious hydroelectric energy system less reliable and influences irrigation and drinking water supply. Glacier melting causes the collection of water in lakes that can burst their terminal moraines, provoking disastrous floods called **Glacial Lake Outburst Floods (GLOFs)**. These events show the importance of a continuous topographic survey of glaciers' planimetric and altimetric deformations and of glacial-moraine barriers in high altitude regions like those where Ev-K2-CNR is already active. Multiple annual surveys have for example been performed on the Changri Nup glacier and on the intersection of the Lhotse Shar, Ambulapcha and Imja glaciers, where there is a lake feeding the Dudh Koshi, a tributary of the Ganges.

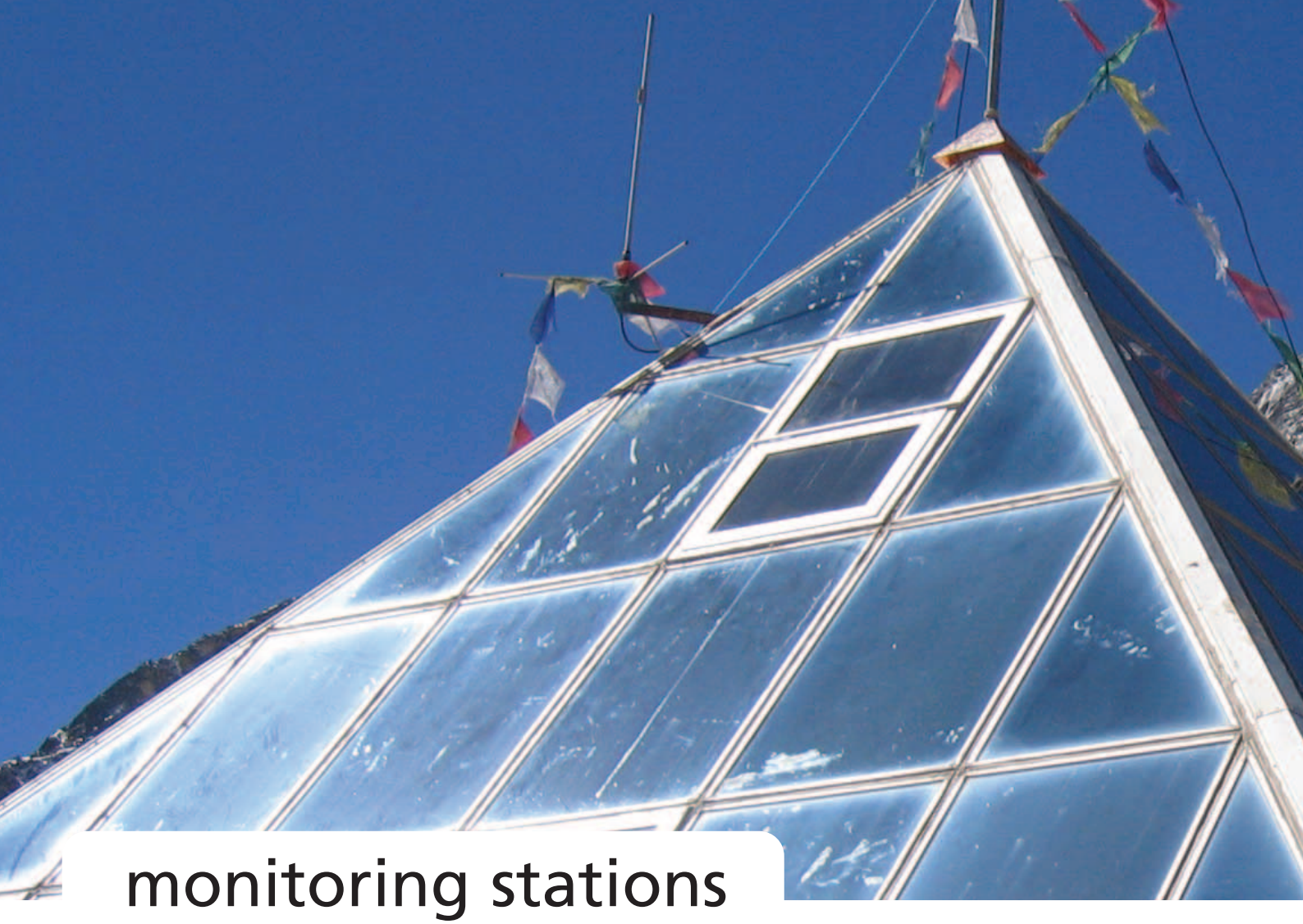


Climate variations make the Himalayan area extremely vulnerable.

The intrinsic fragility of ecosystems and mountain ranges, caused by climate variations and degradation from improper resource management, is **the critical element to assess in planning and management of sustainable development**. This is even more important when the tourism potential of these regions is considered.

Global climate change influences monsoon circulation and precipitation trends in South Asia, where pollution emissions are extremely high. These pollutant species which form a thick gray-brown cloud in the atmosphere can considerably reduce the amount of solar radiation reaching the Earth's surface (up to 15%), potentially causing soil cooling and atmospheric heating. This pollutant cloud, first identified in South Asia, was dubbed the Asian Brown Cloud (ABC) within **a dedicated UNEP study and observation project**. Identification of these such phenomena around the world led to a renaming of the project as "Atmospheric Brown Clouds".
ABCs influence human health, agriculture and biodiversity, especially in mountain regions. Many countries, particularly in Asia, have already undertaken air quality monitoring activities in urban areas but information on spatial distribution of pollution on a regional scale and its seasonal trends are still insufficient. The monitoring of atmospheric compounds in mountain areas is extremely limited. Control of meteorological parameters and atmospheric compounds in high altitude regions plays an essential role in the **quantification of actual pollution levels but is also important for the study of pollution composition, time variations, transport phenomena and deposition processes** (on glaciers for example).

Given the importance of the scientific information it has collected thus far, Ev-K2-CNR is making it available within **the Ev-K2-CNR Committee led international partnership initiative** (ICCIM-Ev-K2-CNR, 2003).
This project, funded by the Italian Government, aims to implement mechanisms supporting mountain development, focusing on poverty reduction and environmental conservation, in the Hindu Kush-Karakorum-Himalaya region, using a database of biophysical and socioeconomic data.
The system foresees use of software applications based on data and predictive models to establish a **Decision Support System (DSS)** that will contribute to fulfillment of the Millennium Development Goals. This initiative was formally presented by the Italian Government and approved by the United Nations Secretariat as a WSSD Type II outcome partnership initiative in Johannesburg (2002).

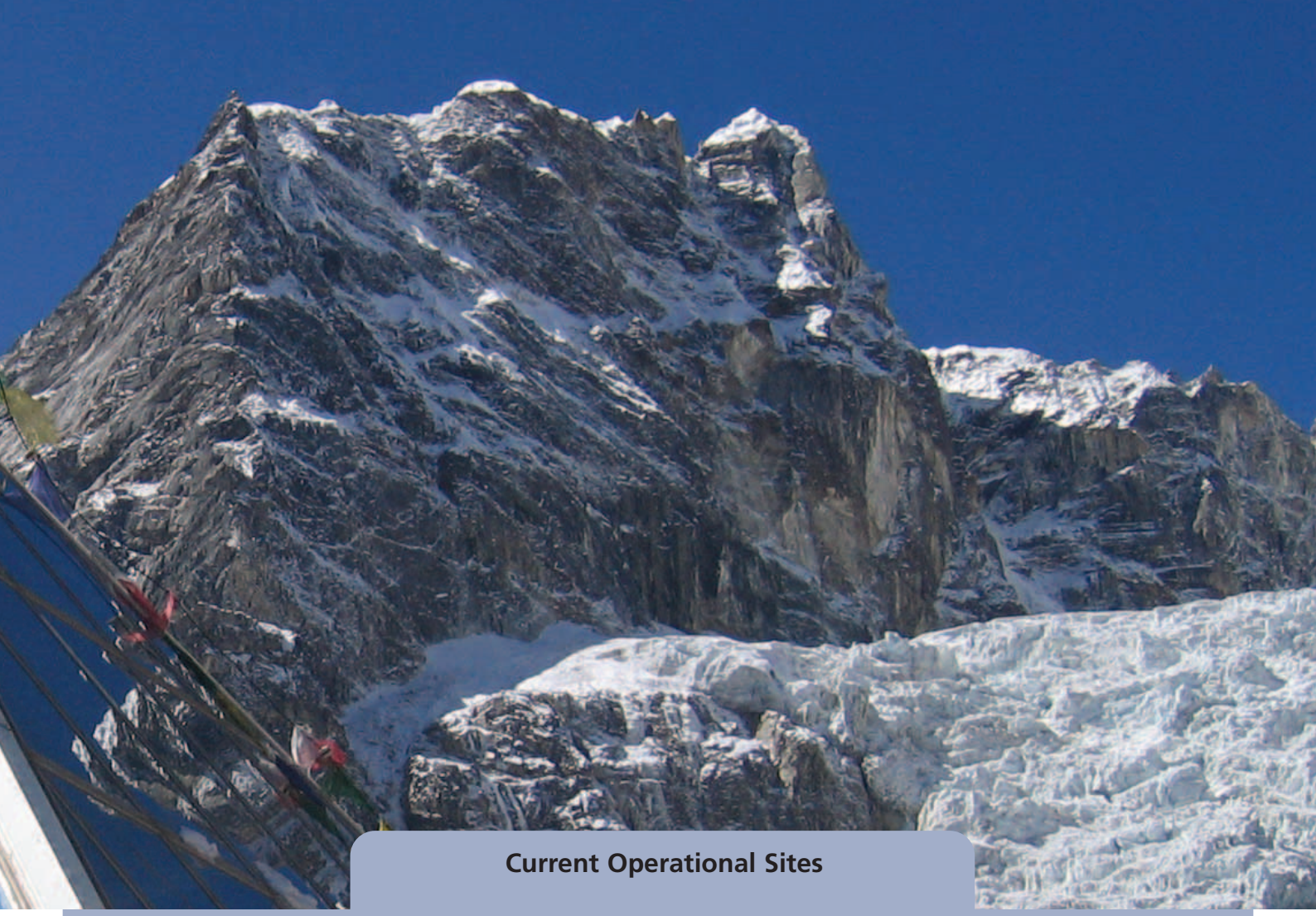


monitoring stations

The implementation of laboratories like the ABC-Pyramid (**NCO-P**) atmospheric monitoring station has been possible thanks to the long-term experience of CNR researchers participating in the Ev-K2-CNR Project.
In **European mountains** in fact a decade of research and monitoring has been carried out at the "Ottavio Vittori" Research station on **Mt. Cimone** (Italy).
This laboratory, managed by the Institute of Atmospheric Sciences and Climate of the Italian National Research Council (ISAC-CNR), is located on the highest peak of the northern Apennines (44°11'N, 10°42'E; 2,165 m a.s.l.), and is hosted at an important meteorological observatory of the Italian Air Force Meteorological Service.

Given the environmental and climate peculiarity of the Himalayan-Karakorum area, Ev-K2-CNR has promoted and supported studies requiring specific research activities carried out in these high altitude regions.
Within and in support of these studies, several stations have been installed: an atmospheric monitoring observatory, a GPS station, six meteorological stations and a Doris sensor.

The "Ottavio Vittori" Research Station is a **GAW-WMO regional station** performing research and measurements of greenhouse gases, trace gases, natural radioactivity, aerosol, bioaerosol (spores and pollens), total NO2 and O3, NO2, vertical profile solar photometry, cosmic radiation, meteorological parameters.
The **Himalaya-Karakorum environmental monitoring network** is carrying out continuous measurements. The ABC-Pyramid (**NCO-P**) laboratory transmits real time data to Italy via satellite. The importance and relevance of the data collected there have made inclusion of these stations in major international programs possible, particularly in the **CEOP Project** (Coordinated Energy and Water Cycle Observation Project, previously Coordinated Enhanced Observing Period) for meteorological data collected in Nepal and Pakistan and **Project ABC** (Atmospheric Brown Clouds) for the atmospheric monitoring station ABC-Pyramid (**NCO-P**). Glaciers and lakes have been annually monitored for over a decade and the "upper" and "lower" lakes near the Pyramid laboratory are part of the **ILTER** (International Long Term Ecological Research) Network



Current Operational Sites

Installation site	*Nation / Continent*	*Station*	*Characteristics*	*Altitude (m a.s.l.)*
Mt. Cimone	Italy - Europe	"Ottavio Vittori" Research Station	Atmospheric monitoring station	*2,165*
Pyramid Laboratory Observatory (Lobuche,)	Nepal - Asia	ABC-Pyramid (NCO-P)	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 stations	*4,258*
Namche Bazar (Sagarmatha National Park Head Quarter, Khumbu Valley)	Nepal - Asia	AWS NP	Automatic weather stations	*3,560*
Lukla (Khumbu Valley)	Nepal - Asia	AWS 3	Automatic weather stations	*2,660*
Urdukas (Baltoro glacier, Baltistan)	Pakistan - Asia	AWS PK1	Automatic weather stations	*3,926*
Askole (Baltistan, Pakistan)	Pakistan - Asia	AWS PK2	Automatic weather stations	*3,015*

project development

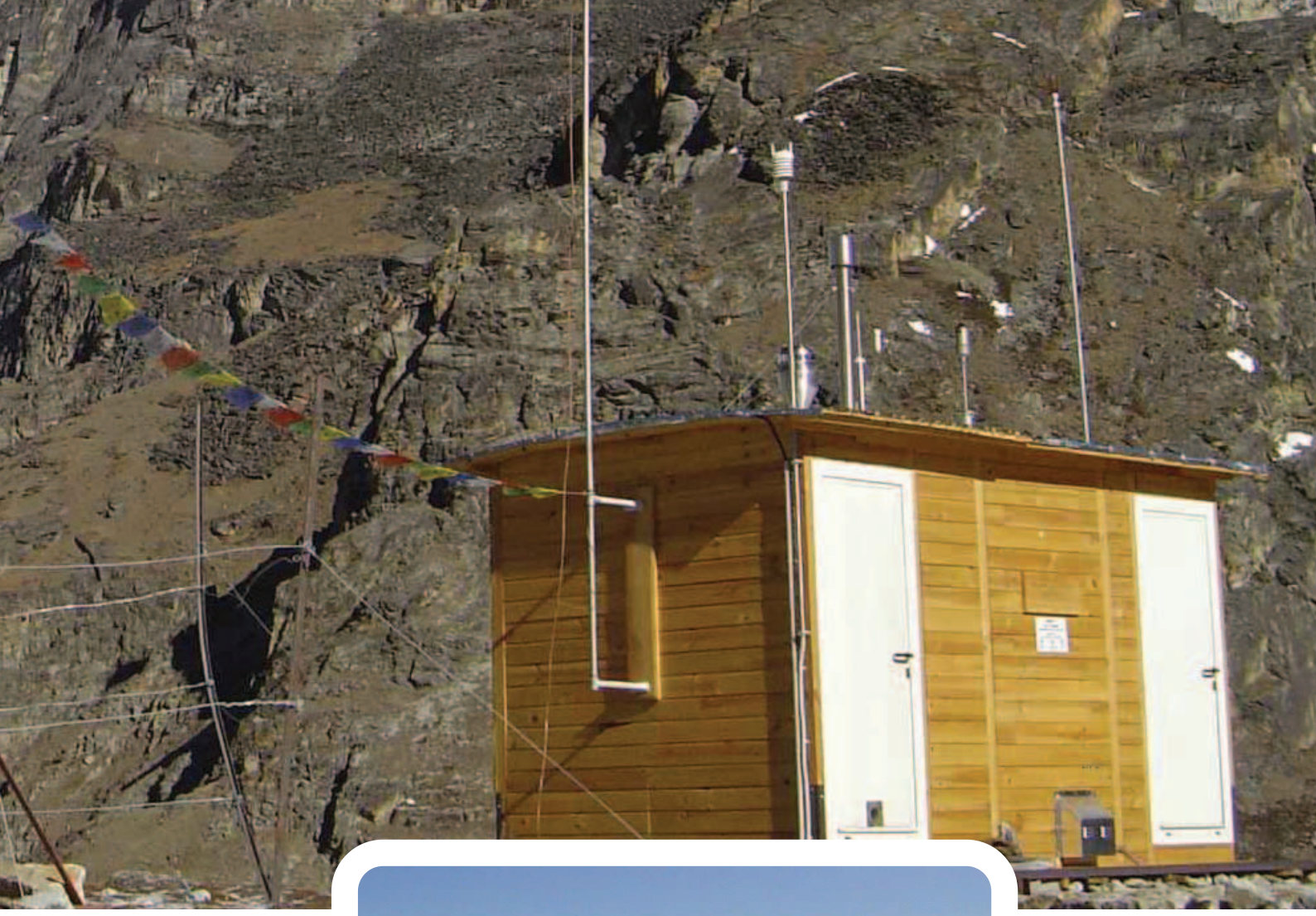
It eventually became clear that SHARE would need to extend its area of study beyond Asia in order to help solve major global issues in the fields of environmental and Earth sciences and improve knowledge regarding the mechanisms and processes which influence or cause global problems. While developing its activities in Asia and Europe, Ev-K2-CNR aims to promote research in mountain environments on a global level, thus contributing to an improvement of environmental conditions. The data collected in these important and fragile ecosystems influencing global processes is therefore unique. **Ev-K2-CNR's consolidated experience in mountain environments has led to a growing international demand for expansion of their research activities beyond the Himalaya**.

The first activities of the new phase of SHARE are:

- **Improve** the monitoring network in the Himalaya and Karakorum with additional installations
- **Expand** the area of measurement to other mountain ranges where there are no ongoing research activities

In the Himalayan area the installation of five seismic stations is planned to measure tectonic movements in the region, along with hydrometers to analyze catchment inflow in the Sagarmatha National Park area. An atmospheric monitoring station will also be installed in the Karakorum, in the Baltoro region.
The first measurements in Africa got underway in June, 2006. A weather station was installed in Uganda, on Mt. Rwenzori near Elena Glacier, at 4,700 m a.s.l. to obtain information on one of the main glacial systems of this country. The glaciers in this area represent 50% of Africa's glaciers, but an evident reduction has been demonstrated between 1955 and1990, an estimated 40% loss of glacial mass. Consequently, glacier reduction principally due to global warming phenomena severely influences water supply for southern and central-west Africa. Information on these ecosystems along with that on local meteo-climatic conditions and their variations thus becomes essential. The area's lakes, including Lake Victoria, will also be monitored in upcoming field campaigns.

With the expansion of research activities, the data collected could contribute even more to international projects aimed at analyzing global change issues.



SHARE objectives

General Aim: The SHARE Project aims to provide important information in the environmental and earth sciences with particular emphasis on mountain regions to support planning and decision-making processes on local, regional and global levels.

Specific objectives:

- Contribute to the enhancement and dissemination of scientific knowledge on the environment by developing and applying analytical and prediction models. These authoritative and scientifically rigorous outputs, based on the SHARE network dataset, will be made available for use by decision makers, stakeholders, public and scientific community.

- Promote institutional capacity building and technological transfer mechanisms, by directly involving local decision makers and research institutes in continuous monitoring and research activities in developing or transitioning countries. As requested in **Agenda 21**, on the job training will be provided for local researchers and technicians to build their scientific knowledge.

- Create a **network of high altitude monitoring stations**, comprising both existing observatories and implementing new monitoring sites so as to make up the first, comprehensive high altitude environmental network. The first step in this direction will be to collect information on stations operating in the field of atmospheric monitoring and create an **electronic archive** of remote stations, describing the sites, location, and parameters measured. The importance of information collected in these areas was recently confirmed in Washington DC by the scientific committee of the international project Global Energy and Water Cycle Experiment (**GEWEX**) - Coordinated and Water Cycle Observation Project (**CEOP**) during their March 12-17, 2007 meeting. The scientific committee decided to introduce for the first time a **Working Group** dedicated to **High Elevations**, which **Ev-K2-CNR** was asked to coordinate.

SHARE scientific themes

SHARE will develop three main themes:

(I) Atmosphere and climate changes
(II) Glaciology, hydrology and limnology in high altitude areas
(III) Geophysics and natural risks

(I) Atmosphere and climate changes: Climate is the driving force behind global change. Aside from its natural variability, over the past two centuries an anthropogenic component has been introduced, regarding the production of pollutant and/or climate-altering substances that have favored the temperature increases on Earth (IPCC, 2001). These climate variations cause significant consequences in mountain areas, thus these ecosystems have become an important subject of study. Mountain sites are also important for monitoring of atmospheric conditions and climate, as they are representative of a large spatial scale. Variations recorded are frequently due to long distance transport phenomena and information detected there are often representative on a global level.

(II) Glaciology, hydrology and limnology in high altitude areas: Water and terrestrial ecosystems of mountain regions, lakes and glaciers, are highly sensitive to climate change. Monitoring of these ecosystems is necessary to identify main risk factors, making it possible to formulate policies for the protection of such fragile ecosystems as high altitude lakes, rich in biodiversity, and glaciers, a vital freshwater source for all life forms. These ecosystems, deeply influenced by climate variations to which they have a very short response time, are in fact becoming sensitive indicators. Clear examples are volumetric variations of glaciers and changes in lacustrine biology.

(III) Geophysics and natural risks: Natural risk in mountain environments refers to several phenomena and processes, not just physical risks (earthquakes, erosion, slope stability,…) or hydrogeological risks, but also to anthropogenic impact due to growing changes in land use. These aspects determine variations that could influence local population life, causing biodiversity loss, disappearance of forests and water ecosystems, etc. The development of georeferenced information systems (Geographic Information System – GIS) and the use of GPS technology are important not only to better understand the landscape but also to support environmental sustainability policy actions. Monitoring the Earth's crust in these regions is useful for soil conservation as well as for scientific research, but also to improve cartography in mountain regions.

scientific activities

The data collected within the project's three themes will make it possible to:

- Study mechanism and process interactions between the Himalayan range and Asian monsoon circulation

- Characterize physical, optical and chemical aerosol properties and their variations

- Study seasonal variability of ozone and climate altering gases

- Characterize chemical composition of snow and rain

- Evaluate energy and mass balance of glacial environments and consequent human risks

- Study debris-cover glaciers and the role of debris in ablation processes

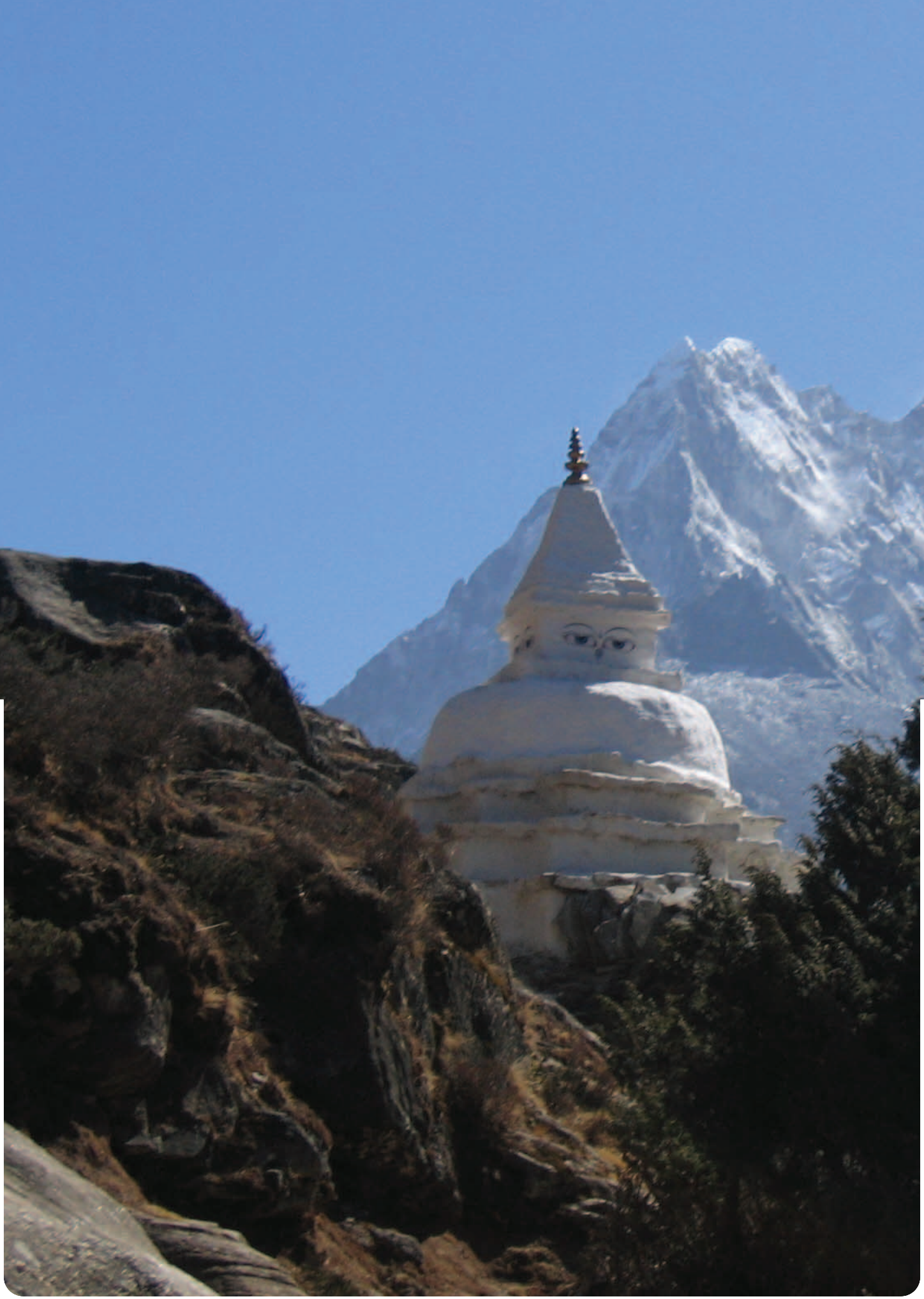
- Monitor variations in glaciers, rock glaciers and moraines

- Model energy and hydrological cycles

- Study lacustrine trophic chains and sediment biomass accumulation in response to natural or disturbance factors

- Perform environmental geodetic monitoring to identify risk areas (landslide, tectonic and seismic movement)

- Forecast geological risk using remote sensing techniques.



SHARE and sustainable development policy

SHARE is a multidisciplinary project crossing many environmental research fields and making use of national and international collaborations. Its execution and management requires an organization capable of managing the research activities and complex relationships which have developed over time in response to important international environmental problems related to global change.

The Ev-K2-CNR Committee was established at the and of the 1980s as an independent, non-profit association for the promotion and development of scientific and technological research in mountain regions, with a particular interest in the Hindu Kush – Karakorum – Himalaya, in Nepal, Pakistan, China (Autonomous Region of Tibet), India and Bhutan. The objective of Ev-K2-CNR has always been **provide specialized scientific support aimed at the sustainable development of high altitude remote areas to ensure environmental conservation and quality of life for local populations by furthering scientific knowledge, transferring scientific results applied to sustainable management of mountain regions, pursuing capacity building activities, and promoting cooperation in the respect of local cultures and traditions**.

Their next goal will be to support the SHARE Project with a system capable of finding solutions to complex global problems concerning the environment, health and socioeconomic development. Ev-K2-CNR **intends to organize knowledge within a multidisciplinary model**, supporting the dissemination of scientific results and consequently reinforcing Italy's contributions on an international level. Understanding current environmental problems that years of research have confirmed means working for practical solutions, applying the lessons that research has taught us. Problems will be dealt with, offering innovative and sustainable solutions in specific strategic themes around which research projects will be oriented:

1. environment
2. health
3. socioeconomic development
4. ecosystems management
5. resources management
6. territory planning

Achievement of these objectives will be possible thanks to the many national and international collaborators of the Ev-K2-CNR Committee: institutions, universities, Italian research institutes, public and private partners, local beneficiaries and stakeholders.

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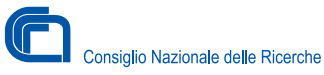
Unità di Ricerca
EvK2CNR



want to **SHARE**?

If you are interested in participating
in the SHARE Project

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