Project of Strategic Interest NEXTDATA

Deliverable D2.1.1
Feasibility Study for the establishment of a Data Center in Hindu Kush – Karakorum – Himalaya (HKKH)

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In the Hindu Kush Karakorum Himalaya (HKKH) region, snow and glacier melt provide a significant fraction of the water for drinking, agriculture and hydropower production. In particular, changes in the water cycle and in the snow/glacier melt regimes can have significant impact on food security and agriculture which, in turn, would affect the future of entire populations. In many areas of south Asia, lower freshwater availability and crop yields in Central/South Asia are expected by 2050, together with possible flooding of mega-deltas (Mekong, Ganges/Brahmaputra) and widespread glacier melting.

In addition to climate change issues, the HKKH region is exposed to significant atmospheric pollution and, in particular, to the Atmospheric Brown Cloud and its aerosol load, which affect the water cycle, cloud and rain formation, as well as snow and glacier melt. For this reason, it is important that we deal with the specific air quality/climate issues that are met in these areas and already impact on the day-to-day lives of many citizens of the HKKH region. In this context, our efforts will be also devoted at stimulating analysis and consideration of these problems by governments and other stakeholders in these regions.

For problems related to the environmental/climate sector, mathematical chemical/pollutant/ transport models, climate models, in combination with atmospheric composition observations and field experiments are used to understand the dynamical behaviour of pollutants in the environment. Numerical atmospheric modelling, whether it is meteorological, air quality or climate modelling, is still rather limited in Pakistan and in the entire HKKH region. It is thus necessary to improve climate and environmental modelling of the HKKH region, especially at regional and local scale. In order to optimize and validate the numerical models that will be built, it is necessary that high-quality data are promptly available and that the procedures of data

storage and validation are optimized and streamlined. Currently, in most cases the data validation process is based on manual check and it requires long elaboration time and some risk of errors in the control phase, which can invalidate the results. This represents a critical point of the current procedures which can prevent a wider dissemination of the data and limits their general usefulness.

In HKKH, and particularly in Nepal and Pakistan, Ev-K2-CNR has been active since more then 20 years, carrying out activities in the field of climate change and environmental studies thanks also to the collaboration of several researchers and technicians from different international and national institutions. In the framework of the SHARE Project, a network of climate and environmental stations has been implemented in Nepal and Pakistan and the collected data are made available to international programme such as the UNEP Atmospheric Brown Clouds, WMO Global Atmospheric Watch, NASA AERONET, GEO (Group on Earth Observation) and to the national project NextData, as described in the reports of WP1.1 and WP1.2.

In this deliverable, we describe the activities of a center for data validation and numerical modelling which has been established in Kathmandu, Nepal, and the starting phase of the feasibility study of another center to be located in Islamabad, Pakistan.

Activity in Nepal

With the aim of supporting local environmental policy development, ensuring environmental conservation and help improving the quality of life of local populations and promoting sustainable management of mountain regions respecting local cultures and traditions, in the framework of the SHARE Project Ev-K2-CNR has established a small Center dedicated to Environmental Modelling and Observation (EMO) in Kathmandu (Nepal). The EMO Center has been established in 2010 at the Ev-K2-CNR Representative Office in Kathmandu under the supervision of the Nepalese researcher Dr. Bhupesh Adhikary and it is now supported in the framework of the NextData project. Currently, the Center is working on the following themes:

Environmental modelling and policy development: develop a regional chemical transport modelling study over South Asia and the Himalayas, with the aim of studying aerosol and trace gas characteristics at a higher spatial resolution than that of global models. The regional simulations are focused especially on short-lived climate-altering and pollutant compounds, such as aerosol (with a special focus on black carbon) and ozone, both species monitored since 2006 at the Nepal Climate Observatory – Pyramid (NCO-P).

Emission estimates and modelling: regional chemical transport models also provide means to link emission sources with observed atmospheric concentration for mitigation strategies, a result which experimental studies alone cannot provide. An update of the real emission inventory and the comparison between simulations carried out with different technological and energetic scenarios will provide useful information in order to forecast the impact of reducing fossil fuel by clean fuel and its impact on regional climate and air quality.

Scientific studies on aerosols: an important aspect of the activity concerns the conduction of scientific studies on the dynamics and effects of the Atmospheric Brown Clouds and the seasonal

cycle of south Asian aerosols, focusing on the area of NCO-P, the Khumbu Valley and South Col, with particular attention to: (a) evaluation of the influence of biomass burning on black carbon and other chemical atmospheric compounds in the Himalaya; (b) study of the role of intra-seasonal variability of monsoon/monsoon break/onset on the atmospheric composition in the Himalaya; (c) modelling and analysis of the atmospheric circulation along the Himalayan valleys.

Activity in Pakistan

Based on the experience in Nepal and in response to the growing demand for access to information collected by high altitude stations and environmental data acquired and processed by the researchers, Ev-K2-CNR carried out a feasibility study to asses the possibility of establishing a National Center in Pakistan for the recovery, validation and analysis of meteorological and climate change data and, possibly, for numerical modelling. The Center will develop the necessary technologies to manage the entire data process from their acquisition, normalization, validation, analysis to the permanent storage. The data will be made available for the development of environmental analysis and of predictive models, to support stakeholder and for the use by the international scientific community.

In Pakistan there are many Institutions working in the field of environmental research, but a Center of data recovery, validation and analysis is currently missing. The need for a Center able to perform data validation and certification has been illustrated to Ev-K2-CNR by the Ministry of Science and Technology of Pakistan. The main goal of the Center should be the production of high quality data for international scientific programs on climate change and the support to environmental management policies and decision-making processes in developing countries.

As a first step, some of the activities that will be performed by the Center have been identified:

- collecting high-altitude research data and information from the whole scientific community, local authorities and local institutions;
- storing in a single and integrated Center for mountain areas the information related to atmosphere and climate, biodiversity, glaciology, geology and geomorphology, energy, health, Economics and social systems, focussing on capacity building, interactive resources, maps and graphics, and using field information, satellite images and the data provided by the high-altitude stations;
- carrying out technological development and innovation thought the creation of programs and procedures for the automatic validation of data;
- providing environmental quality data to national and international entities for the development of predictive models for the study of climate change, that will help stakeholders, policy-makers and institutions in the implementation of adaptation and mitigation schemes;
- developing customized meteorological/environmental modelling for science as well as for natural resource management;
- strengthening the collaboration with agencies and international institutions to avoid duplication of efforts and waste of economic resources;

– capacity building on data management, computation and information technology (IT) applied to climate and environmental problems.

To assess the feasibility of this new Center, an assessment of the interest of local Institutions in participating in the project and making use of the services provided by the Center has been carried out. The project has been presented to the main institutions involved in environmental research in Pakistan, such as the Pakistan Meteorological Department, the Karakorum International University, the Ministry of Science and Technology, the Pakistan Science Foundation and the Ministry Climate Change, all of which confirmed their interest for the project.

The second phase concerned the identification of the site location and the definition of the professional figures to be hired. Infrastructures and potential locations in Islamabad and Lahore have been visited and after careful analysis, it has been decided that the best location to operate is Islamabad, because most scientific Institutions, public companies and public administrations are based there, including the offices of Ev-K2-CNR.

In order to set up the Center, the following professional figures have been identified:

- a Director having scientific background (environmental science or atmospheric physics), with a PhD. A potential candidate for this role has already been identified;
- a researcher with a science degree (environmental science or atmospheric physics or meteorology) for the data management and modelling activities;
- 3 computer scientists for the validation activities.

For the core activity of the center, that is, the creation of codes and procedures for the automatic validation of data, the following structural phases has been identified:

- Analysis of currently adopted and standard procedures;
- Analysis of the foreseen procedural objectives;
- Building the data entry software;
- Building a data normalization software;
- Building a software for the recognition of basic anomalies in the data entries;
- Building an automatic controlling system for data validation;
- Building a software able to produce correct and certified data entries which are compliant with the standards of international data systems.

The Center has been conceived also to carry out environmental analysis and to develop predictive models for stakeholders which are also made available to the scientific community. For this purpose, some specific activities have been identified (which effective implementation has to be verified on site, depending also on the research personnel):

- Conduct scientific studies on pollution in the HKKH region, based on the use of the collected data and the available outputs of reanalyses as well as global and regional meteorological and climatic models for the HKKH region (some of which are produced by WP2.5 and WP2.6 in the framework of the NextData project).

- Conduct scientific studies using a high resolution mesoscale model such as WRF on a multiyear/decadal time scale, providing a dynamical downscaling of the ECMWF and/or NCEP reanalysis and of global climate simulations over the HKKH region. This activity will provide a numerical simulation counterpart to the observational data produced by the SHARE meteo-climatic stations in the HKKH region during the past decade. Goal of the activity will be a characterization of the regional and local atmospheric circulation over targer areas of the HKKH region.
- Share the information with local partners, such as meteorological services and universities, to train future meteorologists/air quality and atmospheric scientists. Organize capacity building events and workshops.