



Proceedings of the
International Symposium

Benefiting from Earth Observation

Bridging the data gap for adaptation to climate
change in the Hindu Kush-Himalayan region

4 – 6 October 2010, Kathmandu, Nepal

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Foreword

On behalf of ICIMOD, I would like to express my sincere appreciation to the distinguished delegates and participants for their invaluable contribution to making the International Symposium on 'Benefiting from Earth Observation: Bridging the Data Gap for Adaptation to Climate Change in the Hindu Kush-Himalayas' a very successful event. The symposium was held in Kathmandu, Nepal from 4 to 6 October 2010. It was a special honour and pleasure for ICIMOD to welcome so many important dignitaries to this symposium, including the Honourable Shri Jairam Ramesh, Minister of State for Environment and Forests, Government of India; Charles F. Bolden Jr, NASA Administrator; Michael Yates, Senior Deputy Assistant Administrator of the United States Agency for International Development (USAID); José Achache, Director, Group on Earth Observation (GEO) Secretariat, Switzerland; together with many high-level delegates from ICIMOD's regional member countries.

We at ICIMOD consider it an important task to organise and provide space for regional exchange. I believe this platform helped build synergies among national, regional, and international initiatives for the sharing of Earth observation data and brought us a step closer to bridging the data gap for climate change adaptation. The symposium was also useful in strengthening regional and international networking. The different sessions of the symposium and my interactions with participants reaffirmed that the Himalayan region can benefit immensely from the emerging potentials of Earth observation in gaining insights about regional status and trends in relation to climatic and broader environmental changes of a transboundary nature, and their implications at the global level.

The symposium, attended by all space agencies from the Himalayan region, and supported by the US National Aeronautics and Space Administration (NASA) and other international partners, has paved the way for the fostering of regional cooperation. Among ICIMOD's regional member countries, China and India are emerging as leading nations on Earth observation. As a participating organisation in the Group on Earth Observation, ICIMOD is happy to further the principles of the Global Earth Observation System of Systems vision and bring Earth observation closer to the societal benefit of mountain communities and their environment. This symposium also offered new opportunities for programming and collaboration with regional and international partners, and strengthened the work of ICIMOD, through its Mountain Environment Natural Resources' Information Systems (MENRIS) Division.

At ICIMOD, we are continually striving to strengthen our programme for improved access to and use of Earth observation and to develop meaningful applications for integrated mountain

development. This bears special significance at a time when international communities are paying increasing attention to the Himalayan region as one of the world's most vulnerable ecosystems in terms of climate change. Indeed, the impact of climate change in these mountains is of great concern, both to vulnerable mountain communities and to those in the downstream river basins and plains whose livelihoods will be affected. ICIMOD, with its overarching goal of promoting resilient mountain communities and strengthening ecosystem services for the downstream population through the emerging regional and international partnerships will further enhance regional capacity and develop a relevant knowledge base by using the best of Earth observation science and technology.

I would like to take this opportunity to thank the ICIMOD staff, in particular Basanta Shrestha and his team at MENRIS, for their initiative and leadership in promoting geo-information and Earth observation in the region, and for organising this symposium and other events. I am also pleased that the symposium brought together many eminent people in the field of Earth observation, both from the region and beyond, as well as key regional and international organisations. Finally, on behalf of the organisers, I would like to express my sincere thanks and appreciation to the various sponsors, especially USAID and NASA, for supporting the symposium, as well as to Swedish International Development Cooperation Agency (SIDA), United Nations Environment Programme (UNEP), and the German Government through German Technical Cooperation (GTZ, now GIZ) and the collaborating organisations for their support. I look forward to fruitful collaboration in the future.

Andreas Schild
Director General, ICIMOD

Preface

The International Symposium 'Bridging the Data Gap for Adaptation to Climate Change in the Hindu Kush-Himalayan Region' was organised by ICIMOD in cooperation with GEO, supported by USAID, NASA, GTZ (now GIZ), and SIDA. The event was organised in collaboration with the Government of Nepal, UNEP, World Meteorological Organization (WMO), and regional space agencies – the Bangladesh Space Research and Remote Sensing Organization (SPARSSO), Chinese Metrological Administration (CMA), Indian Space Research Organisation (ISRO), and Pakistan Space and Upper Atmosphere Research Commission (SUPARCO).

More than 250 participants from 24 countries focused on applications and use of space-based information in seven thematic sessions. An exhibition and poster session allowed participants to interact further. On 5 October, special guests Charles F. Bolden Jr, NASA Administrator, Michael Yates, Senior Deputy Assistant Administrator of USAID, and Andreas Schild, Director General of ICIMOD launched SERVIR-Himalaya, the third regional SERVIR node, to complement initiatives already operational in Mesoamerica and East Africa.

There were three linked pre and post symposium events: a Youth Forum, a Workshop on Space-based Information for Disaster Preparedness and Risk Management, and the Inception Workshop for the Regional SERVIR-Himalaya. All contributed in valuable ways to the overall success of the Symposium. The momentum gained from the Youth Forum will be continued in a youth programme for climate action being developed by ICIMOD. A Japan Aerospace Exploration Agency (JAXA) WINDS receiving station (Wide-band Internetworking Engineering Test and Demonstration Satellites 'KIZUNA') was inaugurated on 3 October at ICIMOD during the Pre-symposium Workshop by José Achache, Executive Director, Group on Earth Observations; Shinichi Mizumoto, Japan Aerospace Exploration Agency (JAXA); and Andreas Schild, Director General of ICIMOD. Finally, the regional SERVIR Inception Workshop was used to determine priority application areas for SERVIR-Himalaya.

The Symposium was the first of its kind in the region and an important milestone in promoting regional and international cooperation to bring the benefits of Earth observation to mountain communities in the Himalayan region. I would like to express my sincere thanks and appreciation to all the delegates for their support and contributions, and to the team members for their untiring efforts and support which ensured the success of the Symposium and side events.

Basanta Shrestha
Division Head MENRIS, ICIMOD

Acknowledgements

We would like to extend our deepest gratitude and appreciation to the many important dignitaries who gave generously of their time to participate in the Symposium, including the Right Honourable Subash Chandra Nemwang, Chairman of the Constituent Assembly, Nepal; Honourable Thakur Prasad Sharma, Minister of Environment, Government of Nepal; Honourable Shri Jairam Ramesh, Minister of State for Environment and Forests, Government of India; Charles F. Bolden Jr., NASA Administrator; Michael Yates, Senior Deputy Assistant Administrator of USAID; and Professor José Achache, Director, Group on Earth Observation (GEO) Secretariat, Switzerland; and the many other high-level delegates from ICIMOD's regional member countries and beyond.

We would like to express our deep gratitude and sincere appreciation to all the collaborating partners of our regional member countries representing all the regional space agencies and others: SPARSSO, Bangladesh; CMA, China; ISRO, India; MoST, GoN; SUPARCO, Pakistan; and Jaxa-Japan. We would also like to this opportunity to express our deep appreciation and thanks to the overwhelming contributions from participants in the form of papers and posters. We would like to acknowledge with thanks the presence of many young people and their enthusiasm and overwhelming response, which was a major highlight of the symposium.

Last but not least, we would like to thank the entire team at ICIMOD, and especially MENRIS colleagues, theme coordinators, rapporteurs, and all others, for their untiring efforts and continuous support in making the symposium and associated events a success.

Earth Observation for the Hindu Kush-Himalayan Region

The Hindu Kush-Himalayan (HKH) region is the youngest, highest, and one of the most fragile mountain systems in the world. Known as the 'water tower' of Asia, the region boasts the largest concentration of snow and glaciers outside the polar regions, and contains the headwaters of ten large Asian rivers. The HKH region is a reservoir of biodiversity and includes all or part of four Global Biodiversity Hotspots. Climate change has placed the Himalayan region at the centre of international attention as one of the most vulnerable ecosystems in the world, and is leading to severe impacts on mountain and downstream communities and their environments. The dynamics of the life support systems that rely on the HKH ecosystems are threatened, and the traditional adaptation and coping mechanisms of the local people are losing their effectiveness. ICIMOD and its national and international partners are working to build regional capacity and develop relevant knowledge bases in relation to key strategies and policies for improving adaptation to climate change for mountain communities at risk.

Systematic collection of data and information about the HKH mountain system is critical for improved understanding of climate change, and its trends and impacts, and for predicting future scenarios. Data and information derived from Earth observation are proving increasingly vital for gaining insight into the regional status and trends, especially in relation to climatic and broader

The symposium in progress



environmental changes of a transboundary nature, and their implications at the global level. ICIMOD is promoting geo-information and Earth observation technology and applications for sustainable mountain development in the HKH region through its specialised GIS/RS Division MENRIS. Together with partners, ICIMOD is pursuing its goal through innovations in technology, capacity building, and scaling up of the development of mountain-specific applications and decision support systems, and by acting as a clearing-house mechanism for geo-information within ICIMOD and for agencies involved in sustainable mountain development. To this effect, ICIMOD is actively partnering with Global Earth Observation (GEO) and relevant international agencies, space agencies, research institutes, and universities, as well as the private sector.

ICIMOD organised the International Symposium 'Benefiting from Earth Observation: Bridging the Data Gap for Adaptation to Climate Change in the Hindu Kush-Himalayas' from 4 to 6 October 2010 with the primary objective of fostering regional and international cooperation to promote the use of, and access to, Earth observation for improved scientific knowledge and understanding to support adaptation to climate change in the HKH region.

More specifically, the symposium aimed at

1. building synergies with national, regional, and international initiatives for the sharing of Earth observation data in order to develop a regional database and relevant information products;
2. promoting regional cooperation among ICIMOD's regional member countries (Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan) to foster development of a Himalayan spatial data infrastructure (H-SDI) to support climate change adaptation;
3. promoting a common approach and methodology to develop key Earth observation applications in the areas of climate change adaptation for improved scientific knowledge and understanding; and
4. providing a regional platform for the strengthening of international networking through mutual sharing and learning.

The symposium was attended by all the regional space agencies and marked an important milestone in promoting access to Earth observation through regional and international cooperation. The large-scale event was organised in partnership with GEO and GIS Development, and was supported by the United States Agency for International Development (USAID), US National Aeronautics and Space Administration (NASA), German Technical Cooperation (GTZ, now GIZ), and Swedish International Development Cooperation Agency (SIDA). The event was organised in collaboration with the Government of Nepal, United Nations Environment Programme (UNEP), World Meteorological Organization (WMO), and the regional space and remote sensing agencies – the Bangladesh Space Research and Remote Sensing Organization (SPARSSO), Chinese Metrological Administration (CMA), Indian Space Research Organization (ISRO), and Pakistan Space and Upper Atmosphere Research Commission (SUPARCO).

The symposium had more than 250 participants from 24 countries, comprising government officials, scientists, researchers, development practitioners, policy-makers, media representatives,

and young people. In addition to the inaugural and keynote sessions, 68 papers were presented in seven thematic sessions: 1) Space-based information for disaster management; 2) Remote sensing of cryosphere (snow cover mapping and modelling); 3) Remote sensing of cryosphere (glacier mapping and monitoring); 4) Spatial decision support system for ecosystem management; 5) Land cover change and carbon stocks; 6) Spatial data Infrastructure for climate change adaptation; and 7) Transboundary air pollution monitoring and modelling. Further contributions were displayed in more than 60 posters exhibited in a special poster session. The technical sessions disseminated the latest scientific knowledge and promoted an understanding of the various applications of Earth observation. The Symposium expanded its audience by sharing the presentations, posters, and discussions online via a symposium blog, Facebook, and Twitter.

Three related pre-and-post symposium events were organised to coincide with the symposium:

- a Youth Forum – Empowering Youth with Earth Observation Information for Climate Actions, from 1–6 October 2010, which brought together some 40 young people from the Hindu Kush-Himalayan (HKH) region to familiarise them with the potential benefits of the information derived from Earth observation and to demonstrate practical action to address climate change related issues;
- a Pre-symposium Workshop on Space-based Information for Disaster Preparedness and Risk Management, from 2–3 October 2010, which brought together more than 30 participants from disaster management related organisations in the region, and relevant international partners, and proved extremely useful in synergising efforts to use space-based information for disaster preparedness and risk management in the region; and
- a SERVIR-Himalaya Regional Inception Workshop, on 7 October 2010, organised after the symposium to determine priority application areas for SERVIR-Himalaya.

This publication provides a summary of the proceedings and recommendations of the main symposium and the related events. Detailed information on the individual events, abstracts, full papers, presentations, posters, video clips of individual sections, photos, and others are include on a DVD in the back pocket of the publication.

International Symposium Benefiting from Earth Observation: Bridging the Data Gap for Adaptation to Climate Change in the Hindu Kush-Himalayas

Inaugural Session

The inaugural session brought together high-level dignitaries from the governments of Nepal and India, GEO, and USAID, as well as policy makers, researchers, and scientists from the region and abroad.

The session was chaired by Thakur Prasad Sharma, Minister of Environment, Government of Nepal. Subash Chandra Nembang, Chairman of the Constituent Assembly of Nepal was the Chief Guest, and Shri Jairam Ramesh, Minister of State for Environment and Forests, Government of India, was the Guest of Honour.

Subash Chandra Nembang, Chairman of the Constituent Assembly of Nepal lighting the traditional lamp to mark the start of the Symposium



Andreas Schild, Director General of ICIMOD, briefly outlined ICIMOD's mandate in his introduction. He emphasised ICIMOD's contribution through its focus on the mountain perspective and by catering to needs largely ignored by other players in the Hindu Kush-Himalayan region. The inaugural address was delivered by the Right Honourable Subash Chandra Nembang, Chairman of the Constituent Assembly of Nepal. Mr Nembang emphasised the importance of climate issues and said that the Government of Nepal has been making a conscious effort to reduce greenhouse gas emissions by cooperating at regional and international levels. Nepal is extremely vulnerable to both natural and human-induced climate change, and as a developing country is highly affected by changes in monsoon patterns, glaciers, and biodiversity. Mr Nembang expressed the hope that ICIMOD's promotion of regional cooperation and its international connections would help improve Nepal's ability to take sound environmental decisions.

Kevin Rushing, USAID, Nepal, emphasised the importance of space information. He highlighted the importance of data and locational information in addressing problems of poverty, disease, conflict, biodiversity, food security, access to natural resources, and education.

Michel Jarraud of the World Meteorological Organization addressed the assembly through a video message and expressed his wish for increased cooperation with ICIMOD. The keynote speaker, José Achache, Director of GEO Secretariat, gave an overview of international cooperation on geospatial data, which has been successful ever since the inception of the Global Earth Observation System of Systems (GEOSS) in 2007, and advocated for adherence to GEO data sharing principles. For him, the current challenges are all interconnected with the problems of population growth, biodiversity loss, and the destruction of ecosystems. He said that there are two kinds of solutions – one technical, through new energy sources, better crops, more efficient buildings, vaccines, and treatments; and the other through environmental management. Both, however, will involve Earth observation data to understand and manage the magnitude of the environmental challenges. The launch of SERVIR, and the implied further cooperation, marked an important step in this direction.

Shri Jairam Ramesh, Minister of State for Environment and Forests, Government of India, conveyed his enthusiasm for the building of closer partnerships with Nepal and institutions like ICIMOD. In this rare event of a State Minister's visit to Nepal, his plea for cooperation was well received by the audience. Shri Ramesh announced the Indian Government's plan to start new satellites to observe climatic changes and forest cover changes, and to set up a new national institute of glaciology. He emphasised the fundamental difference between Himalayan glaciers and those of Europe and the polar

Shri Jairam Ramesh, Minister of State for Environment and Forests, India, addressing participants



regions, which have been much better researched. The new institute is intended to help fill the gap in Himalayan-specific glacier research. He alluded to future problems of reduced water and natural resources in forest areas. He also reported that India will launch its first own satellite for measuring greenhouse gas emissions in 2012, and one to monitor forest changes in 2013.

The Chair, Thakur Prasad Sharma, Minister of Environment, Nepal, closed the session by extending his congratulations for the timely symposium, which was an important milestone in synergising international benefits.

Basanta Shrestha, Head of ICIMOD's MENRIS Division, delivered the vote of thanks and reminded the audience of their common goals, which brought them together on that day "to bring the benefits of Earth Observation to the mountain communities of the Hindu Kush-Himalayan region". He further welcomed the presence of representatives from the space agencies of the regional member countries and closed the session with



Visitors at the poster pavilion



Inauguration of the exhibition and poster pavilion by Subash Chandra Nembang

a special round of applause for the young people attending the conference, who were taking part in a special week-long workshop.

The Exhibition and Poster Pavilion were then inaugurated, with exhibits and posters displaying information on Earth observation products and applications in relation to different themes.

A special session was devoted to the Youth Forum. Carrie Stokes, USAID, Dan Irwin, NASA, and Climate Ambassador Dawa

Steven Sherpa, delivered inspiring speeches sharing their personal experiences ranging from the Tour de France to climbing Everest, encouraging the participants of the Youth Forum and symposium delegates to actively take part in climate actions in their own communities.

Keynote Session

The Keynote Session was chaired by José Achache, Director of the Group on Earth Observation Secretariat. Charles F. Bolden Jr, NASA Administrator, and Michael Yates, Senior Deputy Assistant Administrator of USAID, were among the speakers.

Andreas Schild, Director General of ICIMOD, in his opening words, communicated a message from his meeting with the Indian Minister of Environment and Forests on the previous day, that India was considering ICIMOD as an anchor for regional cooperation. The Minister had emphasised that full cooperation between all regional countries and stakeholders was an attainable goal and that the window of opportunity is widening. He confirmed India's strong support in this regard. He acknowledged the serious obligation that the launch of SERVIR place on ICIMOD in serving the stakeholders of the region.

NASA Administrator, Charles F. Bolden Jr, opened by sharing an experience from his first space expedition. When looking down from 600 km above the Earth, he realised that the world was one big body of water, which was only periodically interrupted by pieces of land. He explained that human-induced changes in the world have to be measured using all available knowledge sources. This meant combining space-based satellites with in-situ observations to make Earth observation a predictive science. This is why NASA has reinvigorated its applied sciences programme – to address immediate needs, nine of which have been identified by GEOSS. He welcomed national cooperation between NASA and USAID and the international body of GEO, to bring together the world's Earth observation agencies. Bolden closed his speech with the words "from space this is a world without borders – we all have a responsibility to cooperate to make our village, our country, our region, and this planet a better place".

In his keynote address, Michael Yates, Senior Deputy Assistant Administrator, USAID, spoke about the present trend within the US administration. USAID is looking for scientific collaboration as a true game-changer, and SERVIR is a step in this direction. SERVIR combines NASA's research and technology experience with USAID's comprehensive development expertise from working with many partners around the world. No single government ministry or organisation can handle all the available information offered in the different areas, and SERVIR-Himalaya is the newest node in the vision of a truly global network.

Charles F. Bolden Jr., NASA Administrator, delivering his keynote speech





Launch of SERVIR-Himalaya

Basanta Shrestha, Division Head of MENRIS, ICIMOD, gave a presentation on 'Bridging the data gap for climate change adaptation in the Hindu Kush-Himalayan (HKH) region'. He related the SERVIR launch to the overall theme of the International Symposium. He outlined the major drivers of climate change, and explained how it was creating a particular strain on mountain ecosystems and downstream areas. In the context of the rapidly changing climate, the traditional adaptation mechanisms of mountain communities appear to be losing their effectiveness, which is why ICIMOD's focus and mission has been to increase adaptive capacity and resilience. Our understanding of the complexity of the interlinking issues is still at a very early stage, and the problem is compounded by the fact that the HKH is a 'data gap' region. ICIMOD is directing its various programmes to addressing different aspects of the knowledge gap, for example in regional snow monitoring, mapping and inventory of glaciers, biodiversity, land cover mapping, disaster rapid response mapping, satellite-based forest fire detection and monitoring, and transboundary air pollution. He concluded that the way forward is through regional and international cooperation, which will help to build synergies between different initiatives and promote the complementary development of a regional database to attain a Himalayan spatial data infrastructure (H-SDI).

The session ended with the official launch of SERVIR-Himalaya by various dignitaries.

Technical Sessions

Thematic session 1 – Space-based information for disaster management

The impacts of climate change are already becoming evident in the HKH region in the form of a higher incidence and intensity of natural disasters. It is increasingly clear that the lives and livelihoods of the people of this region are at risk. The HKH region is among the most vulnerable regions in the world to natural hazards, particularly those induced by weather and climate, and these often lead to disasters, impeding socioeconomic development and poverty reduction efforts. Earth observation has proven to be an invaluable source of information; it enables the disaster management community to make critical decisions for better preparedness and to improve initial assessments of the nature and magnitude of damage and destruction. Data access, timeliness, appropriateness, data sharing, training, and transnational cooperation are the key elements of an appropriate disaster management framework for international and national communities.

This session had eleven presenters on the use of Earth observation data for making effective decisions and executing smart responses to disasters. After the presentations, discussions were focused on 'How best to improve our coordination among the member countries to use space-based information for disaster management and communities?' The presenters emphasised that data and information from Earth observation are already available, but there is a need for increased awareness and assistance in developing the capacity of end-users to make them aware of how the information can be used during major disasters and emergency response. It was suggested that we need to enhance our knowledge by using space charters to have access to the current situation and address the needs of disaster management authorities and communities. The group recommended setting up of an in-situ measurement network for major disasters in the region to allow for real time integration with forecasting models. They advocated for the use of distributed computing systems, sensor web, and interoperable systems for seamless analysis and modelling, which will help early warning systems. Furthermore, they suggested capacity building measures and research incorporating Earth observation systems, socioeconomic and in-situ measurements for early warning, and vulnerability and risk analysis. Non-spatial variables must be integrated into assessments of vulnerability to provide improved understanding of the region for decision-making processes.

Fostering regional cooperation among ICIMOD's regional member countries and others would help improve understanding of the different phases of the disaster management cycle. It was stressed a number of times that while the focus was on setting up national databases, it is important to promote a culture of information sharing among the research communities so that decision-making processes can collectively address disaster risk reduction, as the majority of natural disasters are transboundary. Data sharing mechanisms among regional space agencies should be further developed through cooperation and strengthening of the existing mechanisms. In order to maximise the benefits from Earth observation technologies, it was suggested that ICIMOD's regional member countries activate charters and transfer the information accessed to communities at times of disaster. SERVIR-Himalaya was welcomed as major initiative to provide information on the key issues of mountain development and disaster risk reduction. Models and tools like SERVIR could play a marked role in helping decision makers to obtain a better understanding during cycles of disasters.

Thematic session 2 – Remote sensing of the cryosphere: Snow cover mapping and monitoring

The cryosphere, which encapsulates water in solid form (ice/snow/permafrost) is a key natural resource for socioeconomic development, and is in a state of rapid depletion under the influence of global temperature rise, which is particularly pronounced in the HKH region. The absence of regular monitoring mechanisms have resulted in gaps in our understanding of cryogenic processes and the magnitude of changes, and have led to a poor understanding of future scenarios for water resources and related hazards.

Nine papers were presented focusing on issues of snow cover mapping, monitoring, and modelling. Many of the presentations focused on improvement of the accuracy of the predominant MODIS (Moderate Resolution Imaging Spectroradiometer) snow cover algorithm. Several factors, such as mountain shadows, clouds, and snow albedo effects, in particular at higher altitudes, reduce the accuracy of conventional algorithms. Several presentations dealt with impurities such as dust, which change the energy balance enormously, causing earlier snowmelt runoff than for clean snow. A case study was presented on the application of snowmelt runoff forecasts in the Sutlej basin of India. As timely forecasting is useful for planning and adaptive management of multi-purpose projects downstream, this good practice has the potential for replication and scaling up in the other major river basins of the region. In snow cover mapping and modelling, the issue of the period of time covered is crucial, as there is high interannual variability. It was suggested that longer-period data of up to 30 years should be used. A suggestion was also put forward to consider historical data such as AVHRR snow products.

Participants suggested complementing the data obtained from optical remote sensing with microwave remote sensing, as the latter has the capability to penetrate cloud cover and can be used at night. However, there are limitations associated with it due to mountain topography, spatial resolution, and cost. It was felt that the culture of data sharing has quite a long way to go in the HKH region. It was suggested that access to data should be provided to all in the region, and beyond, in order to accelerate the progress of science for the benefit of humanity. For example, ICIMOD makes data available through its GeoPortal, and the GLIMS (Global Land Ice Measurements from Space) database is fully accessible to anyone. The countries of the region should have a clear and more generous policy toward the provision of satellite images to aid in disaster preparedness (not just in post-disaster situations), as well as in climate change adaptation.

There was a call for the communication of (cryospheric) research findings to the world at large in layman's terms, including the implications for the livelihoods of mountain people and those living downstream, especially in the context of climate change adaptation.

Presentation on snow cover mapping



Thematic session 3 – Remote sensing of the cryosphere: Glacier mapping and monitoring

The 10 papers presented in this thematic session highlighted the fact that glacier response patterns and the behaviour of individual glaciers are exceedingly complex in the HKH. There is a difference in the behaviour of Hindu Kush-Himalayan glaciers across the mountain range from east to west as a result of regional variations in the trends of precipitation and temperature. In the east, sustained warming is leading to the formation of glacial lakes, with the potential to cause floods. In the west, a number of glaciers are advancing, resulting in different glacial hazards. Lack of mass balance data is hampering the precise assessment of actual glacier changes in the HKH.

Great efforts have been made in the mapping and monitoring of the cryosphere in the region by the global community, as well as by regional and national scientists. The GLIMS database is being used in both regional and global studies, and the analysis of glacier surface area and distribution over elevation ranges has provided new insight into crucial aspects of the changes happening in the cryosphere. A second generation glacier inventory of the HKH is being prepared using remotely sensed, single source data (multi-spectral Landsat satellite) with a narrow temporal range (2005–2009). Multi-temporal digital terrain models can enable determination of glacier mass changes using the geodetic method, e.g., using stereo optical data. A case study of major glaciers in the Ladakh mountains showed that changes in the geometry and morphology of glaciers can result from various micro-climatic factors, terrain morphology, and neo-tectonics. Similarly, comparison of glacial retreat in the Warwan and Bhut basins of the Chenab river in the western Indian Himalayas has shown that there are many factors that influence glacier retreat or advance, such as the altitude of the glacier, its depth, and debris cover, as well as changes in moraine cover. Also, in climate change scenarios, it has been shown that the Karakorum Range in Pakistan is undergoing variable cycles of surge and retreat. An analysis of the surge cycle of the Panmah Glacier through remote sensing techniques, undertaken to understand the dynamic behaviour of the glacier, has demonstrated its connection with changing climatic scenarios. The physical basis of the complexity of glaciers is mainly being explored by scientists considering one mechanism at a time. The scientific community is still far from having an integrated perspective of the Earth climate system in the HKH. There is a great need for an empirical and theoretical understanding of glacier dynamics in the HKH to help with, and plan for, some serious pragmatic issues, including water resource management, hydropower management, and the assessment of alpine hazards.

One of the most important issues raised during the session was the lack of coordinated efforts in the study of glacier dynamics. There is a lack of mechanisms for coordinated work by the scientific community from different parts of the world working in the region. Scientists, whether from the region or beyond, were requested to provide information on any field-based glacier mapping and monitoring research so that the information can be disseminated. This would help reduce data duplication as well as save precious time and resources. It was proposed that ICIMOD, as a regional knowledge centre, play the role of information hub. Data sharing should be a priority, but the uncertainty associated with the remote sensing data generated by scientists in the region should be addressed by field validation. In the present context of global climate change, detailed

permafrost mapping using remote sensing technologies and modelling is necessary to understand the impact of temperature rise on permafrost in the Himalayas. A recommendation was made that a broad observational and investigative programme be developed that would involve deployment of advanced observational/monitoring technologies on land, air, water, and space; advanced methods of data analysis; and advanced theoretical modelling of key glaciers and alpine processes of concern. In the final summary, the presenters recommended the use of automatic to semi-automatic mapping of glaciers coupled with an improvement in methodology and accuracy, supplemented by field verification. High resolution data would be beneficial in the study of glacier dynamics.

Thematic session 4 – Spatial decision support systems for ecosystem management

This session highlighted the use of spatial decision support systems using integrated GIS tools in the management of ecosystems and protected areas in different parts of the Hindu Kush-Himalayan region. A presentation on the Teknaf landscape, Bangladesh, showed the use of geospatial mapping for developing sustainable eco-restoration of protected areas by considering climate change and land use/land cover monitoring scenarios. The Decision Support Toolbox presented by ICIMOD provided tools for integrating spatial components into system dynamics modelling for the systematic planning and management of ecosystems. Another presentation showed how spatial decision support systems are applied in the planning of forest village relocation, habitat suitability analysis, and vegetation carbon calculation. The data portal developed by the Pakistan Wetlands Geographic Information System (GIS) programme allowed the sharing of information on climatic data and species sightings with provision for a data query builder to explore specific questions on wetland biodiversity, thus enhancing planning and management capacity for wetland conservation. The automated generation and dissemination of fire and burnt area products, and analysis of forest fire watchtower visibility analysis, was another area for decision support systems (DSS). A case from India showed how mountain farmers had noticed climate change indicators and replaced their traditional cropping patterns with new systems and crops. However, their success in replacing crops depended on their level of access to institutional support services and marketing opportunities for new produce, and spatial information played a very important role in policy making and development planning for this. Other presentations dealt with flood monitoring systems and estimation of the population affected by floods and the impact on crops; models for the exploration of plant resources; and boundary delineation of national parks and other protected areas based on geographic information systems and remote sensing (GIS/RS) for the improvement of legal notification, which is a step towards the better management of ecosystems in protected areas.

During the discussion, the Pakistan flood maps prepared by ICIMOD were commended, and participants asked whether it is possible to prepare indicative maps of potential floods. Another question raised was how GIS and RS tools can be used in developing mitigation and adaptation strategies to combat the impacts of climate change in the HKH region.

One of the issues raised during the session was the lack of exchange of generated data with other organisations and, in particular, with the general public. Another issue was the lack of accuracy

in models. Most often, social issues and people's perceptions are not considered during the development of management plans for protected areas.

The session came up with the recommendation that DSS should be used at the landscape level for the conservation and management of protected areas and specific ecosystems, and issues like forest fires, landslides, and climate change should also be considered. DSS should also be used for developing adaptation strategies for conservation and management of mountain agro-ecosystems by taking into account the issues of farmers and local conditions. It was suggested that ICIMOD organise another international symposium to share and exchange their research on different topics with the wider regional and international community.

Thematic session 5 – Land cover change and carbon stocks

In situ and satellite-based land observation efforts, and disciplines such as geography, ecology, geology, and forestry, use and refer to land cover as one of the most obvious and easily detectable indicators of land surface features. Satellite remote sensing is an essential data source providing regular data that contributes to the estimation of status and trends, including historical trends, of land use/land cover and carbon density in landscapes. Progress in remote sensing science and operations needs to be clarified and linked to opportunities, applicability, and limitations to establish robust national monitoring systems. It is important to provide stakeholders involved in reducing emissions from deforestation and forest degradation activities (REDD) with clear and widely accepted knowledge on the performance of satellite remote sensing for investment decisions related to monitoring.

Presentation on remote sensing of REDD



The presenters of the session highlighted the use of recent RS technologies in assessing land use change, documenting the change patterns, and consequent lobbying for carbon credits in developing nations in the HKH region. It was emphasised that RS is of great importance in supporting field inventory, and the combination of the two will greatly assist policy makers to make accurate decisions. The applications of advanced RS will help the countries of the HKH region to upgrade to Tier III of the Intergovernmental Panel on Climate Change (IPCC) guidelines, and the need for continuous upgrading was realised. A number of technical issues were discussed, such as LiDAR (Light Detection And Ranging), which has proven to be the best method for validating data from field sampling, especially in Nepal's diverse terrain. Discussions included the accuracy of using LiDAR, considering the varied terrain and accessibility issues, the compilation of data as near to IPCC Tier I-III as possible, and lobbying for carbon credits between community users and governments. It was emphasised that the process should be based on reliable and transparent agencies that follow proper monitoring, reporting, and verification systems.

All presenters emphasised the need to use RS data with ground truthing, and to integrate airborne data with satellite imagery and field measurements, to obtain more reliable statistics. The crown projection area (CPA) method is being developed for carbon stock estimation. Variations exist in methodology and there is a need for standardisation in different studies. Land cover mapping in different regions indicates changes with climate change in land use area, agricultural crop patterns, and forest species composition and cover density. However, land cover maps have mostly been prepared as pilots and on smaller areas, and country-wise land cover mapping has yet to be done for many countries. Land cover mapping methodologies are still at an experimental stage and need early finalisation for broad-scale application. It was agreed that regional cooperation is required to reinforce the efforts and create synergy. The session also recommended that ICIMOD and other international/regional agencies play a central role in the coordination and promotion of projects on land cover mapping and carbon stock estimation.

Thematic session 6 – Spatial data infrastructure for climate change adaptation

The problem of insufficient data and information in the HKH region in relation to understanding and addressing the issues of climate change is further aggravated by difficulties in finding and using the information that does exist. There is a need at all levels to be able to access, integrate, and use spatial data from disparate sources to guide decision making. The concept of spatial data infrastructure (SDI) has emerged to address this need, and includes the collection of technologies, policies, and institutional arrangements that facilitate the availability of, and access to, spatial data. SDI provides a basis for spatial data discovery, evaluation, and application for users and providers, thus increasing the ability to make sound decisions collectively at the local, regional, and global levels.

All of the eight presentations in this session emphasised the need for an SDI for the acquisition, sharing, and dissemination of information and knowledge related to climate change adaptation. Some presentations noted the lack of availability of both real time data and archived data for the region. It was pointed out that ICIMOD, as a regional organisation, can help in setting an



Attentive audience

example and providing leadership towards development of a regional SDI. Climate change adaptation needs to be addressed at local, national, regional, and global levels. Fostering regional cooperation among the regional countries of the HKH and others would facilitate a better understanding of climate change and disaster events.

Bridging the data gap and promoting a culture of sharing of information and

knowledge among research communities and the general public is important to create awareness, and capacity development needs to be carried out in support of this. Technical innovations (Open Geospatial Consortium [OGC] compliant infrastructure, interoperable solutions, distributed computing systems) will help in the development of harmonised data across the region. There is a need for a regional SDI to facilitate data and information exchange between national institutions in the region through a common dissemination platform. The participants underscored the need for a regional organisation like ICIMOD to take a lead role with an institutional approach. A two-fold approach was suggested to help countries to work together: one through technical innovation, such as interoperable solutions, distributed computing systems, and open standards; and the second employing an institutional approach, which includes extensive needs assessment of the gaps in data and capacities involving all stakeholders. The session provided guidelines for a regional SDI to develop a unique approach for information dissemination ensuring the involvement of all stakeholders and drivers, and for sustainable capacity building of stakeholders.

Thematic session 7 – Transboundary air pollution monitoring and modelling

Aerosols play an important role in all problems connected with air pollution, ranging from very local effects, to regional problems such as acid deposition, stratospheric ozone loss, and climatic change. Aerosols also have an impact on human health and agricultural productivity. Earth observation has been a valuable tool in monitoring, assessing, and mapping atmospheric pollution and providing time series data at various spatial scales.

This session included a key presentation on the long range transport of Asian dust and aerosols. The case presentation on rapid urban assessment of air in Kathmandu city highlighted the results of modelling and monitoring, and showed that high resolution data are needed for more accurate results. Another presentation demonstrated the near real time visualisation of atmospheric brown cloud (ABC) data, highlighting the potential benefits for applications related to disaster, agriculture, and the environment. Other presentations dealt with black carbon transport to the Himalayas, acid rain, forest fires, and the development of air quality indicators. It was shown that satellite-based indicators can be developed for use by global, regional, and country level decision makers to develop policies and programmes to reduce human exposure to air pollution.

The major concern raised during the discussion was that the haze/aerosol problem is particularly marked in this heavily populated region, and has significant impacts on human health, the water cycle, agricultural production, and regional climate change. Recommendations were made for the coordination and construction of ground-based observational networks accompanied by Earth observation systems; the generation of data and an integrated assessment of impacts in the region through the assimilation of observation, modelling, emissions, and other related data to bridge the data and knowledge gaps. Capacity building (both institutional and individual) is needed to make science-based information available to policy and decision makers, and as a basis for outreach to the general public.



Speaker at the air pollution session

Valedictory Session

The Valedictory Session was chaired by Tej Partap, Vice Chancellor, Sher-e-Kashmir University of Agriculture Science and Technology, and co-chaired by Madhav Karki, Deputy Director General, ICIMOD. The Chair introduced the panel of Hiromichi Fukui, Keio University, Japan; Li Jing, Director of Resource Technology and Engineering Institute, Beijing Normal University; Thomas H Painter, Jet Propulsion Laboratory, California Institute of Technology, USA; Soonchang Yoon, Seoul National University, Korea; Yousif Ali Hussin, ITC, The Netherlands; Jeffrey S Kargel, University of Arizona, USA; and Andreas Schild, Director General, ICIMOD. The session was in two parts: (1) a summary and feedback session of all the events and sessions of the week, and (2) a panel discussion of the key take-home messages and way forward.

Starting the feedback session, two representatives of the Youth Forum expressed their concerns with passionate pleas for climate action. The first speaker, Kamran Hussain from Pakistan, thanked ICIMOD, NASA, USAID, and SERVIR-Himalaya on behalf of all the participants for recognising the role of youth as agents of change and effective communicators. Raising awareness among young people and engaging them in action on the ground is an important factor in addressing climate change issues in the HKH. The six-day Youth Forum had exposed them to various Earth observation tools for analysing the impacts of climate change and enhanced their capacity to use the information and products more effectively and to integrate them into advocacy for climate risk management in national policies for sustainable development.

The second speaker, Haripriya Madhavan from India, described her experience at the Youth Forum and the responsibility she felt after being a part of it. She explained how the Youth Forum exposed her and the other participants to GIS and RS applications for identifying landscape change, snow-cover mapping, glacier inventory, and disaster risk management through numerous hands-on

activities and power-packed guest lectures by experts from ICIMOD and supporting organisations within such a short period of time. She expressed her fascination at realising the impact that this learning could have on their communities when they go back home and advocate about the consequences of climate change on the HKH region. She thanked ICIMOD for helping them to feel more attached to mountain ecosystems, especially the Himalayas, their pride and heritage, which they must conserve for future generations. She felt that the Youth Forum had helped her recognise the power of communication and effective sharing as necessary for securing our future.

After the feedback from the youth representatives, Asif Khan, Director, National Centre of Excellence in Geology, Peshawar University, presented a summary of the Pre-symposium Workshop on 'Space-based Information for Disaster Preparedness and Risk Management' which took place from 2 to 3 October and brought together 40 people from ICIMOD's regional member countries and 12 international experts. The workshop identified the need for wider awareness among disaster management communities about the existence, usage, source, and types of space-based information on disasters. Furthermore, the workshop saw restriction-free access to data and space-based information as crucial for rapid response to disasters. As concrete measures to strengthen national institutions, it was suggested that disaster management and geoinformatics applications be included as an elective or compulsory subject in all undergraduate courses, and offered as e-learning and self-learning courses. The following suggestions were made for the way forward:

- Capacity building: National and regional level capacity building programmes need to be launched to train disaster management communities in handling space-based information.
- Geo-informatics centres: Geo-informatics centres need to be established in existing disaster training institutes and such institutes need to be empowered.
- Access: Value-added space-based information needs to be provided to disaster management communities for better and more rapid implementation of disaster management measures.
- Role: Space-based information should play a role in disaster preparedness as well as in emergency response.
- Partnership: An effective contribution to the use of space-based information should be made by building national, regional, and international partnerships.
- Success stories: Situation-based achievements should be highlighted.

Summaries and feedback from Thematic Sessions 1 to 7 were presented by PS Roy, Dean of the Indian Institute of Remote Sensing, Bruce Raup, GLIMS, National Snow and Ice Data Center, Anil Kulkarni, Indian Institute of Sciences, Md Shamsul Alam, Jahangirnagar University, Bangladesh; Syed Said Badshah Bukhari, Director, Pakistan Forest Institute; Giasuddin Ahmed Chowdhury, Director, Center of Excellence for Geospatial Information Science (CEGIS); and Maheswar Rupakheti from UNEP.

Following the summaries of the thematic sessions, Birendra Bajracharya from ICIMOD presented the 'Overall Synthesis and Recommendations', summarising the results of the two-day symposium. In the follow-up, a proceedings document including the suggestions of the participants will be made available to the general public and decision makers in the governments of the HKH countries. Key



Panelists in the Valedictory Session

emphasis was placed on the use of Earth observation in disaster preparedness and management, as well as for updating information in the climate change relevant areas of cryosphere, land cover, spatial data infrastructure, and air pollution. On the policy side, the main theme that emerged was the need for cooperation among stakeholders in the region. This also means the adoption of standards and harmonised approaches in building regional databases. The significant gap between the scientific community, policy makers, and the general public needs to be narrowed through intensive capacity building measures. The role of youth in narrowing the gap and in knowledge dissemination emerged as an overarching theme of the event. Initial stepping stones like the installation of the JAXA receiving station and the inauguration of SERVIR-Himalaya were celebrated as significant successes. The concluding vision of the symposium was summarised as a “future where Earth observation information products and services are extensively used in decisions and actions for the benefit of mountain communities in the Hindu Kush-Himalayan region”.

The session was followed by take-home messages and action points from the panel members. Hiromichi Fukui proposed an integration of the region’s online portal sites, which have so far served the purpose of making data available to end users, in particular on issues of disaster mitigation. He further emphasised the importance of communication between stakeholders, not only in this region, but internationally, and encouraged a review of the symposium outcomes to take this cooperation a step further. Li Jing saw the symposium as a good platform for tapping resources. He suggested to keep in mind that not only data, but information, can be understood by the end user, and are needed, in particular during disasters. This is why the platform could be used to share not only data, but also best practices in production and technology.

Thomas Painter made three points on the importance of face-to-face encounters, the applicability of the data to those implementing, and the role of the youth in asking questions. “Make sure that the answers you get make sense, if not, ask again. And we, as the scientific community, should

do the same.” Soonchang Yoon commented that there is a need for concrete and accurate figures on climate change from Earth observation, as well as sound modelling and the creation of an inventory. Regional cooperation in cost sharing will be key to carrying out Earth observation through ground, satellite, and airborne observation. Along the same lines, Yousif Hussin encouraged regional cooperation in capacity-building and higher education. Jeffrey Kargel was impressed by the solid achievements in the form of SERVIR and the JAXA receiving station, which in his view were “cementing some of the longstanding contributions between the wealthy world and ICIMOD”. Further, he saw people as the key to understanding and supporting mountain systems. There are



Session chairs and Youth Forum representatives at the valedictory session

those living in them, those studying them, and those benefiting from them, and there are those that must solve problems – most notably the young, who will really have to grapple with the successes and failures of this generation.

The Chair, Tej Partap, summed up the discussion. He expressed satisfaction that “everybody seems to have realised the need for cooperation, need for a platform, and the role of institutions like ICIMOD”. The most important way for youth to get involved was to increase the critical mass of expert human resources. He found that one dimension was missing in the discussion, which was that of those communities already affected by climate change, such as farming communities. Finally, he suggested a reinforced focus on the impacts on snow and rainfall. Co-chair, Madhav Karki, underlined the role of the media and the need for it to be more knowledge-based and informed.

In his concluding remarks, Andreas Schild expressed his pleasure with the broad participation in the symposium and the political support given by ministers and agencies. He expressed his special thanks for the support received from JAXA, NASA, and USAID, and for the presence of key personalities including Shri Jairam Ramesh, Charles Bolden Jr, Michael Yates, and José Achache. In his message to the youth, he picked up Bolden's remark: "Don't wait to be invited, take initiative." Dr Schild expressed his gratitude for the many suggestions and the trust placed in ICIMOD. "It is an enormous responsibility. You are expecting our staff not only to be very proficient, they must also be able to respond to the users' needs. It is a noble task, which will need the assistance of international resource centres to make it possible."



Question time in the introductory session

The session closed with a vote of thanks by Basanta Shrestha, Head of ICIMOD's MENRIS Division. He expressed his delight at the extent of collaboration during and after the symposium with national partners in the HKH region, NASA, USAID, GEOSS, JAXA, and all the regional space agencies. His final thanks went to all the delegates and the ICIMOD team, thanking them for their untiring efforts and support. He also expressed thanks and appreciation to the Youth Forum participants for their enthusiasm and interest, saying "they belong to our future and all our programmes should contain a youth component. The kind of vibration I have felt, not only during the sessions, but everywhere in the many events that have taken place over the week, is calling for a new beginning for the GIS/RS programme of ICIMOD."

Overall Synthesis and Recommendations

The International Symposium was successful in providing a regional platform for strengthening regional cooperation and international networking as well as mutual sharing and learning from experiences among the delegates from the region and beyond.

The key messages of the International Symposium were as follows:

- The symposium recognised the importance of the Youth Forum and its immense value in successfully empowering youth from ICIMOD's regional member countries to enable them to use Earth observation information to enhance their understanding, making them aware of the issues and enabling them to take climate decisions and action in their communities.
- The symposium emphasised the use of Earth observation data in making effective decisions for disaster preparedness and risk management, and appreciated the efforts of ICIMOD in the rapid response mapping of the Pakistan floods. The symposium acknowledged the contribution of JAXA in successfully commissioning the WINDS satellite receiving station at ICIMOD in order to support rapid response mapping efforts in the region.

- The delegates reaffirmed the importance of Earth observation and appreciated the coordinated efforts of ICIMOD through this symposium to foster regional and international cooperation to bridge the data gap for climate change adaptation in the Hindu Kush-Himalayan region.
- The symposium recommended that synergies be built among national, regional, and global initiatives for integrated approaches and cross-cutting collaborations for the sharing of Earth observation information and application methodologies to address climate change issues for the benefit of mountain communities.
- The symposium emphasised the need to adopt standards and harmonise approaches in building regional databases in conformity with international efforts to deal effectively with broader climatic and environmental issues of a regional dimension and their implications at the global level.
- Given the emerging dynamics of Earth observation, both at regional and global levels, and recognising the differentiated capacities among ICIMOD's regional member countries, the symposium recommended to continue regional and international support for sustained capacity building efforts in the region.
- The launching of the SERVIR-Himalaya initiative in the presence of distinguished delegates was an important milestone in the promotion of regional cooperation and for the participation of ICIMOD's regional member countries in using Earth observation for regional visualisation and decision support. The presence of the NASA Administrator and USAID Deputy Administrator during the launch was a manifestation of commitment towards, and support for, the initiative.

We look forward to a future where Earth observation information products and services are extensively used in decisions and actions for the benefit of mountain communities in the Hindu Kush-Himalayan region.

The people who made the Symposium a success



Special Event: Youth Forum – Empowering Youth with Earth Observation Information for Climate Action

1–6 October 2010, Kathmandu

Background

Climate change is one of the most critical global concerns of this generation, and the young people of the region will face enormous challenges in the future. Raising awareness among youth and engaging them in action on the ground will be an important factor in addressing climate change in the Himalayas. Although young people are increasingly adding their voices to the global call for action on climate change, awareness in the region is limited. It is important to actively engage them in areas of preparedness, risk reduction, adaptation, and mitigation. Young people have innovative ideas and abundant energy to undertake local action. They can play a role as 'agents of change', act as effective communicators in their communities, and be involved in regional and international arenas.

Earth observation is proving to be a vital tool for improving our understanding of the climate change phenomenon by providing information on the changes to various attributes that are indicators. Educating and exposing young people to such innovative tools and technologies will help them to understand climate change situations better and to use scientific approaches in advocacy. In this context, a Youth Forum, 'Empowering Youth with Earth Observation Information for Climate Actions', was organised as a special event during the International Symposium. The Forum was organised by ICIMOD, together with the Asia-Pacific Mountain Network (APMN), Nepalese Youth for Climate Action (NYCA), and Nepal GIS Society, under the framework of the SERVIR-Himalaya initiative supported by USAID and NASA.

Objectives

The objectives of the Youth Forum were to familiarise young people with the potential benefits of information derived from Earth observation for addressing climate change related issues, and to provide a platform for the sharing of experiences and learning related to climate change issues in the extended Himalayan region.

Selection Process

Information on the Youth Forum was disseminated widely through different youth networks; 750 applications were received from ICIMOD's eight regional member countries – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. The 40 participants were selected based on the applications – which included a written essay, information on fields of study, as well as other general information – to provide a representative cross-sectional sample of voices from across the region. The participants represented various sectors and included climate champions and ambassadors, social workers, environmental science students, media people, and TV journalists, among others. More than 60% of the participants were women.

Highlights of the Youth Programme

Welcoming the youth participants and special guests, Andreas Schild, Director General, ICIMOD, expressed his joy at having 40 energetic young people from 8 different countries in attendance, and hoped that it would be a fruitful experience for the participants as well as for ICIMOD.

In his keynote speech, Anil Chitrakar, an Ashoka Fellow and pioneer of the youth movement in Nepal, inspired all the participants with his short stories linked with the current climate change scenarios and role of youth. He shared that, although we young people have projected ourselves as victims of climate change, we are also the new leaders and have a huge potential to save our climate. With some inspiring examples, he shared how young people are capable of bringing about change in the world.

Jason Kessler from NASA highlighted how NASA technology could be employed in empowering youth, and ultimately our family, society, and country. He said that the participants were lucky to be in the Forum, but also had a huge responsibility to learn, use, and disseminate the information to wider groups. Basanta Shrestha, Head of ICIMOD's MENRIS Division, presented a keynote address on 'Earth Observation and Climate Change'. He shared the importance of mountains and explained the uses and potential of Earth observation tools for climate change studies, both for monitoring and adaptation. Birendra Bajracharya, ICIMOD, gave a vote of thanks to all the participants, supporters, partners, ICIMOD staff, and other contributors for making the Youth Forum possible.

The six-day Forum trained the youth participants in the use of basic RS/GIS tools through practical hands-on sessions and the presentation of case studies related to use of Earth observation in climate actions, online resources, and project work for local action in the community. The forum exposed the participants to a range of Earth observations like satellite images, and applications of GIS/RS tools for analysing impacts on air, land, and water, and for identifying climate change attributes in their communities. An innovative GIS-based platform was used to educate the youth on various issues relating to climate change in the Himalayas, such as the melting of glaciers, forest cover change, and natural disasters. The course provided the participants with an overview of climate change in the Himalayas and ICIMOD related initiatives, as well as familiarising them with the latest multi-media videos. Mutual learning and the sharing of experiences was also facilitated.

The young people were exposed to the practical aspects of using Earth observation derived information for climate change assessment and the use of such information for climate actions on the ground. Various sessions exposed them to Earth observation related tools and methods for generating information supporting climate change scenarios and highlighting the urgency of the situation. The sessions were backed by practical hands-on exercises using desktop computers and the Internet, and participants were oriented with different case studies to enhance their understanding of climate change in the Himalayas. The case studies were derived from ICIMOD studies and covered such topics as the melting of glaciers, snow cover dynamics, rapid mapping of the Pakistan floods, and transboundary air quality monitoring, among others.

The youth participants worked on projects using the knowledge and skills acquired in the training course and presented the results in the form of posters. The posters were displayed in the poster pavilion at the main symposium.

Selected participants gave presentations on the international youth movement on climate change and shared inspiring videos about the youth climate change movement. In order to make the Youth Forum fruitful and produce results, the participants shared individual commitment statements, committing themselves to carrying out follow-up activities, changing their individual behaviour, raising awareness, disseminating knowledge, and others.

The participants wrote their thoughts, inspiring quotes, drawings, and slogans related to youth, mountains, and climate change on two white banners posted throughout the Forum. These banners represent the creativity, knowledge, and diversity of the participants and will be shared in different forums as the voice of the youth from the HKH region.

The importance of social interchange and developing friendships and networks was not forgotten. Participants were welcomed with an ice-breaking session coordinated by NYCA which helped them to get to know each other, and also had an opportunity to join sightseeing programmes to Swoyambhunath, a historical temple in Kathmandu, and to Thamel, the most popular tourist area in Kathmandu.

Special Guest Talk by the NASA Administrator

During the Youth Forum, participants were given the opportunity to interact with key international and regional personalities. A special talk programme was conducted with Charles F Bolden Jr, NASA Administrator, and Michael Yates, Senior Deputy Assistant Administrator, USAID. Around 80 young people, in addition to the Forum participants, attended the talk programme. Andreas Schild, ICIMOD Director General, welcomed the guests and participants to the programme. Addressing the forum, Charles F. Bolden Jr inspired the young people with his energy and experience. He highlighted the power of youth, the vitality of the age group, and its importance. He encouraged them not to be afraid of anything and shared his own success story. Michael Yates, Senior Deputy Assistant Administrator, USAID, also spoke of the importance of young people and how time affects

people's perspectives. He highlighted the support USAID has been giving to youth organisations and programmes. Basanta Shrestha focused on SERVIR-Himalaya and its importance, and Birendra Bajracharya demonstrated the detailed features of the SERVIR platform.

José Achache, Director of the GEO Secretariat addressed the Youth Forum participants and shared GEO's vision and activities. He talked about the global initiatives for using Earth observation for nine areas of benefit to society. Dasho Paljor J Dorji, President of the Bhutan Ecological Society, discussed climate change issues in Bhutan. He encouraged the Youth Forum participants to work actively to preserve nature.

The young people asked many scientific, political, and general questions related to climate change, Earth observation, and youth.

Youth Participants in the Main Symposium

The Youth Forum participants joined the Inaugural Session of the International Symposium. The posters they had prepared were displayed in the exhibition at the symposium venue, and the participants discussed their posters with the visitors. The participants also attended the special talk programme by Carrie Stokes, USAID, Dan Irwin, NASA, and Dawa Steven Sherpa, Climate Ambassador, and the Valedictory Session.

Before the Valedictory Session, Andreas Schild, Director General of ICIMOD congratulated the Youth Forum participants and awarded them with certificates of appreciation. Sushila Pandit from Nepal was awarded Best Poster for her poster 'Ice-cream Party'; and Haripriya Madhavan from India, Ei Pa Pa Khine from Myanmar, Mahesh Shrestha from Nepal, and Proggna Paromita Majumder from Bangladesh, were awarded Special Mentions. Kamran Hussain from Pakistan and Haripriya Madhavan from India delivered a speech in the Valedictory Session on behalf of the Youth Forum participants. They urged everyone to protect the future of the youth and upcoming generation from climate change. They also discussed the potential of youth and the role of youth in tackling global problems.

Conclusion

The participants found the six-day event to have been very fruitful. The Forum was able to introduce new tools and technologies to young minds. This will help to bridge the data gap in understanding climate change and to promote research based climate advocacy and campaigning in the region. Another outcome was the linking of like-minded young people from the eight different countries of the HKH together on the same platform. This facilitated the exchange of knowledge and the building of networks among the young people of the region. Such networks are very important in developing regional cooperation to deal with global issues like climate change. The follow-up activities in the coming days will be very important for the sustainability of such efforts and to achieve long-term goals.

Pre-symposium Workshop on Space-based Information for Disaster Preparedness and Risk Management

2–3 October 2010

Background

The Hindu Kush-Himalayan region contains the youngest and highest mountain range in the world and is considered a major hotspot on the global disaster map. Now, climate change is leading to an increase in the frequency and severity of natural disasters. Recent events – the Sichuan earthquake in China, Cyclone Nargis in Myanmar, the outbreak of the Koshi barrage embankment in India and Nepal, and the Pakistan floods, which displaced more than 21 million people – remind us that natural disasters can have devastating and catastrophic effects on an unimaginable scale. Stakeholders and policy makers require timely and accurate information on rapidly evolving disaster events. Space-based information (Earth observation, communication and meteorological satellites, global navigation satellite systems or GNSS) can provide valuable information in emergencies and disaster situations, as well as for preparedness.

Objectives

The Pre-symposium Regional Workshop was organised to build synergies among national, regional, and international initiatives for the use of space-based information for disaster risk reduction. The workshop brought together national partners from ICIMOD's regional member countries to share experiences and discuss pertinent issues in relation to space-based information for disaster preparedness and risk management in the Hindu Kush-Himalayas. Further, the event helped to develop partnerships to engage the support of regional space agencies and international charters in contributing to capacity building and institutional strengthening related to the use of space-based information.

Highlights of the Programme

The event brought together participants from all of ICIMOD's eight regional member countries and international organisations including UN-Spider (United Nations Platform for Space-based Information for Disaster Management and Emergency Response); Japan Aerospace Exploration Agency (JAXA), Asian Disaster Preparedness Center (ADPC), Bangkok; ITC (Faculty of Geo-Information Science and Earth Observation of the University of Twente), The Netherlands; and Keio University, Japan.

Andreas Schild, Director General of ICIMOD, in his welcome speech emphasised the need to develop a regional framework for using space-based information for disaster management and to engage the support of regional space agencies and international charters in contributing to capacity building and institutional strengthening.

Basanta Shrestha, Head of ICIMOD's MENRIS Division, highlighted ICIMOD's work on space-based information for disaster management and especially its role in the recent Pakistan floods. He emphasised the need to develop cooperation strategies, both with affected communities, and with those countries and organisations that have advanced experience. He concluded that we need to bridge the gap between space technology and disaster management communities, and that if we develop strategies to respond to disasters we can make a difference to the lives of people and future generations.

The First Technical Session

The first technical session on 'Overview of space technology and disaster management' was chaired by Mohammad Asif Khan, National Centre of Excellence in Geology, University of Peshawar, Pakistan, and co-chaired by Sreeja Nair, National Institute of Disaster Management, India.

Shirish Ravan of the United Nations Office for Outer Space Affairs (UNOOSA) and UN-Spider, Austria, presented a paper on 'Spatial data to complement the use of space-based information for disaster management'. He talked about the need to integrate baseline and thematic spatial data, like administrative boundaries, infrastructural details, demography, settlements, and socioeconomic details, with space-based information for planning disaster risk reduction, as well as for effective response during a disaster. He highlighted the challenges faced during an emergency response including the availability of baseline data, data compatibility and data access, and sharing. He mentioned the effectiveness of near real-time satellite data in terms of emergency observation, early recovery planning, and mitigation, and concluded that such data is not only important for emergency response, but can also be beneficial to the scientific community for modelling purposes.

Li Jing, Beijing Normal University, China, presented a paper on 'Space-based technology for disaster management in China'. He highlighted the importance of space-based technologies for disaster management in a country like China, which is prone to almost all kinds of natural hazards, including floods, earthquakes, landslides, dust and wind storms, droughts, and typhoons. He mentioned that China has developed a series of remote sensing systems for disaster risk reduction, monitoring, assessment, and response, and presented a few case studies, including one on the 2008 earthquake, where space technologies were used effectively.

Anisur Rehman, ADPC, Thailand, made a presentation on the 'Application of satellite data and GIS for natural hazard and risk assessment'. He described applications of GIS/RS for seismic hazards

and related damage assessment in three major cities in Bangladesh and demonstrated how RS data coupled with geological and geotechnical information can be used for seismic risk assessment in a GIS environment. Such information can be helpful in identifying vulnerable areas, assessing the level of readiness and preparedness, estimating potential losses, and prioritising mitigation measures.

Amanath Giriraj, ICIMOD, discussed 'Rapid response mapping of Pakistan floods'. He described how ICIMOD received data through Sentinel Asia, the International Charter, and MODIS Rapid Response. A total of 640 pre- and-post flood images were processed and analysed and the final products, in the form of flood inundation maps, were disseminated among regional and international disaster networks, including to the Government of Pakistan.

Hirofumi Fukui, Keio University, Japan, highlighted the applications of geo-informatics for disaster risk reduction with special reference to the monitoring system for glacial lake outburst floods in the Himalayan region. He talked about the use of satellite images for glacial lake inventories and the identification of critical (potentially dangerous) lakes, and mentioned that such lakes can then be monitored and the risk reduced by setting up early warning systems in the risk area, as in a case study from Imja glacial lake in Nepal. At Imja, an early warning system has been established which includes wireless sensors and a transmitter network, which is used for real time monitoring of Imja Lake.

Imran Iqbal, Pakistan Space and Upper Atmosphere Research Commission (SUPARCO), Pakistan, talked about the 2010 Pakistan floods and highlighted the role of SUPARCO in space-based disaster mapping and damage assessment of flood affected areas. As the national space agency, people relied heavily on SUPARCO for damage assessment. SUPARCO collected and created baseline data and provided daily flood extent maps to national agencies to assist them in their relief efforts. SUPARCO was asked by the Government of Pakistan to assist the World Bank, Asian Development Bank, and the Food and Agriculture Organization (FAO) in carrying out analysis related to flood damage to infrastructure and cultivated areas.

During the discussions, Asif Khan raised the issue of data sharing and dissemination at all levels. Shakil Romshoo pointed out that data dissemination should be to the grassroots level and said that academic institutions should also be taken onboard in terms of data sharing. It was pointed out that there is no international charter for sharing radar data, which could be very important during rapid response mapping if the region is under cloud cover. Yusuf Hussain said that it is very unfortunate that people and agencies are reluctant to share data. Basanta Shrestha said that improved communication and cooperation are needed at the international and regional level. He added that we, from the HKH region, which is a hotspot for natural disasters, should act as a pressure group for access to all kinds of data during times of disaster. However, he also mentioned that, within the region, the capacity to absorb such data varies widely.

The Second Technical Session

The second technical session was chaired by Vivek Saxena, Ministry of Environment and Forests, India, and co-chaired by Wu Wei, National Disaster Reduction Center of China (NDRCC).

Yusuf Hussin, ITC, Netherlands, made a presentation on the 'Global perspective on modelling fire risk and spread', which highlighted fire hazards and related issues. He mentioned that natural fire hazards can be minimised by developing a fire spread/growth model, and discussed different fire hazard models in practice, including the weather forecast fire hazard model and real fire hazard model. A model should be based on both spatial (elevation and cover type) and non-spatial (weather) data. He discussed a few case histories around the world and concluded that the accuracy of any model can be validated by using a burnt-area map.

Jianqiang Zhang, Institute of Mountain Hazards and Environment (IMHE), China, presented the application of multi-source and multi-temporal remote sensing for mapping earthquake triggered landslides and related hazards in the Wenchuan earthquake. The Wenchuan earthquake triggered thousands of landslides including rock falls and debris flows. A multi-source approach was used to map more than 30,000 landslides. He concluded that satellites like Landsat, SPOT, and CBERS are suitable for mapping landslides, but for debris flows, data from high resolution satellites like Quickbird and Worldview are more efficient.

Wu Lizong, Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI), China, presented a paper on 'Glacial lakes and their dynamic changes during the past 30 years in Nepal'. Based on three different glacial lake inventories by ICIMOD, he noted an increase in glacial lake area from 1970 to 2005 and attributed it to variations in temperature and precipitation conditions. He mentioned that such studies are very important in identifying potentially dangerous glacial lakes.

Hari Krishna, ICIMOD, highlighted ICIMOD's efforts in establishing a regional flood information system in the HKH region, which is the source of 10 large rivers that support the lives and livelihoods of more than a billion people living downstream. He talked about key issues related to flood mitigation, which include transboundary rivers and transboundary conflicts, the scarcity and lack of relevant data, and lack of data management capabilities. He mentioned that a regional hydrological cycle observing system would not only help to build capacity for water resource assessment and management at both micro and macro levels, but also enhance regional cooperation in data collection, transmission, processing, and archiving across the region. Such a system would help minimise the loss of lives and property by reducing flood vulnerability in the HKH region.

Stefan Keinberger, Salzburg University, Austria, presented a paper on 'The notion of vulnerability – its need in integrated disaster risk management', that highlighted different concepts and perceptions of 'vulnerability'. He stressed the need to think beyond emergencies, and talked about a strong interdisciplinary approach to disaster risk reduction. He mentioned that vulnerability assessments

should be action-oriented, with the overall objective of mitigating the negative impacts of hazards. This entails a complex, integrated analysis and monitoring system based on both spatial and temporal components.

Group Work Session: Space-based Information for Disaster Management in the HKH Region and the Role of ICIMOD

The group work session was intended to assess the capability of national partners in the region to use space-based information in disaster preparedness and risk management; to identify ways to synergise cooperation among regional and global space agencies and international partners; and to discuss ways to benefit from the International Charter 'Space and Major Disasters'. The group discussion focused on promoting regional cooperation on information sharing and exchange for disaster management. Four working groups had the following tasks.

1. Identify strategies to bridge the gap between space technology (information) and the disaster management communities in the regional member countries of ICIMOD
2. Identify ways to improve communication and coordination among regional and international stakeholders regarding access to and use of space-based information during major disasters
3. Identify gaps and needs to strengthen national institutions and capacity building in utilising space-based information for disaster preparedness and risk management
4. Look at the role of regional organisations like ICIMOD in space-based information for disaster preparedness and risk management

The following key issues were identified and suggestions made:

- Wider awareness is needed among disaster management communities, including non-government organisations, about the sources and types of space-based information on disasters. Space-based information must be available to all disaster management communities for rapid and effective response to disasters.
- There is a need to launch national and regional level capacity building programmes to train disaster management communities in handling space-based information. Universities, national institutes, and the private sector should be involved in capacity building in geo-information management .
- There is a need for space agencies to give preference to data acquisition during disaster events.
- Value added space-based information needs to be provided to disaster management communities for better and more rapid implementation of measures.
- This requires more initiatives from space agencies in providing free space-based information for rapid response mapping.
- Effective coordination during a post-disaster crisis requires coordination among governments, space agencies, and international development agencies, which should also be in a position to use and apply space-based information in disaster management.
- It was suggested that a focal node needs to be established in each of ICIMOD's regional member countries for the dissemination of information and products.

- As the processing and analysis of disaster mapping products implies costs, it was suggested that systems and tools be developed using open source GIS and image processing software.
- A spatial data infrastructure should be developed for the HKH region using existing sources of spatial and non-spatial data at different scales for better utilisation of maps in aid assessment.
- A training needs assessment and user needs assessment should be conducted through consultation workshops, preparatory meetings, and so forth.
- Regular short-term courses should be conducted as per regional member countries' user requirements and e-learning courses implemented in disaster management.
- ICIMOD should build upon its strengths and mandate and play a role in both disaster preparedness and emergency response.
- A regional centre like ICIMOD should develop a platform for knowledge sharing and play a role in capacity building with partner organisations.

Launch of WINDS Communication Receiving Station at ICIMOD

A receiving station for JAXA WINDS (Wide-band Internetworking Engineering Test and Demonstration Satellites 'KIZUNA') was successfully inaugurated at ICIMOD on 3 October 2010, by José Achache, Executive Director, Group on Earth Observations, Shinichi Mizumoto, JAXA, Japan, and Andreas Schild, Director General of ICIMOD, along with the participants of the pre-symposium workshop.

WINDS is a super high-speed Internet satellite for emergency response. The purpose of WINDS is to build steady communication during sudden disasters and to improve communication services in underserved areas. The WINDS system can perform high-speed communication at a maximum

Inauguration of WINDS receiving station at ICIMOD



speed of 1.55 megabytes per second. WINDS receiving stations have already been established in Taiwan, the Philippines, Thailand, and India, with a central server in Japan. Data are delivered through the Sentinel Asia consortium, a voluntary initiative led by the Asia-Pacific Regional Space Agency Forum (APSRAF), which supports disaster management activities in the Asia-Pacific region by applying web-GIS technology and space-based technology such as Earth observation satellite data. Five countries – Japan, India, Thailand, Taiwan, and Korea – are providing Earth observation data to Sentinel Asia members during major disasters.

Shinichi Mizumoto described Sentinel Asia's cooperation during the Pakistan floods in providing access to a wide-range of satellite data sets, and the limitation to data transmission to ICIMOD through the Internet. WINDS can fill this gap by providing quick access to satellites from the Sentinel Asia data providers. In addition, flood and wildfire monitoring products for the region will also be made available on a daily basis through WINDS communication so that disaster management can be addressed effectively.

Shinya Tanaka of JAXA gave an 'Overview of regional servers with WINDS ground stations in Sentinel Asia'. He stressed the importance of Sentinel Asia's two-step system for delivering disaster information through Earth observation satellites directly to its member organisations, using not only the Internet but also the WINDS communication satellite. Finally, he demonstrated the Sentinel Asia-ICIMOD website (<http://sentinelnp.icimod.org>) in terms of the availability of data and products.

Conclusions and Recommended Next Steps

To consolidate the outcomes of the workshop, two fundamental priorities were identified: (1) the strengthening of disaster mapping and monitoring in the HKH region using space-based information to support regional member country partners, including both disaster management communities and stakeholders, and (2) the coordination and facilitation of a regional programme, establishment of linkages with regional and global level initiatives (Sentinel Asia, UNOOSA, NASA, SAFER [Services and Applications for Emergency Response], the European Space Agency [ESA]), and establishment of cooperation with national space agencies. These tasks are fundamental to realising the overarching goal of having a rapid response mapping system in the region to support regional member countries during disasters. It was also recommended to develop protocols for rapid response mapping in coordination with other initiatives.

It was agreed that there was a need to strengthen regional and national capacity for using space-based information for disaster management. Different activities – such as workshops, training, infrastructure development, the creation of a disaster information system, and the preparation of a regional framework for strengthening space-based information in disaster management – were identified for building capacity on disaster mapping and monitoring. It was suggested that ICIMOD, as a regional organisation, build upon existing strengths and its mandate to develop a disaster knowledge platform for disaster preparedness and emergency response.

SERVIR-Himalaya Regional Inception Workshop

7 October 2010

Background

USAID, NASA, and ICIMOD are working together to establish SERVIR-Himalaya as the third regional SERVIR operational facility. SERVIR-Himalaya aims to augment the capabilities of ICIMOD, and its network of partners, as an established regional resource centre on geospatial information and Earth observation applications in the Hindu Kush-Himalayan region.

The overarching purpose of SERVIR-Himalaya is to improve environmental decision making in the HKH region through the dissemination and analysis of Earth observation information. The applications and information services will be prioritised and developed based on an assessment of users' needs, which will identify gaps and needs for capacity building of stakeholders in the efficient and effective use of these applications. Potential users of this kind of information range from decision makers addressing transboundary issues at the regional level, through national governments, scientists, students, the general public, and donor agencies, to development practitioners working in the region.

A Regional Inception Workshop was organised on 7 October 2010 to introduce SERVIR-Himalaya to the stakeholders in the HKH region and to engage them in the process of defining the needs for the development of information products and the establishment of a geospatial portal. The workshop was attended by 45 participants, including representatives from ICIMOD, NASA, and USAID.

Highlights of the Workshop

Madhav Karki, Deputy Director General, ICIMOD, welcomed participants and emphasised how SERVIR "helps to bring people and the environment in harmony", and how it will create a "linkage from space to village to meet development challenges". He added that, for this to become a reality, the process of dissemination and discussion has to be initiated through a collaborative effort.

SERVIR-Himalaya Inception Workshop

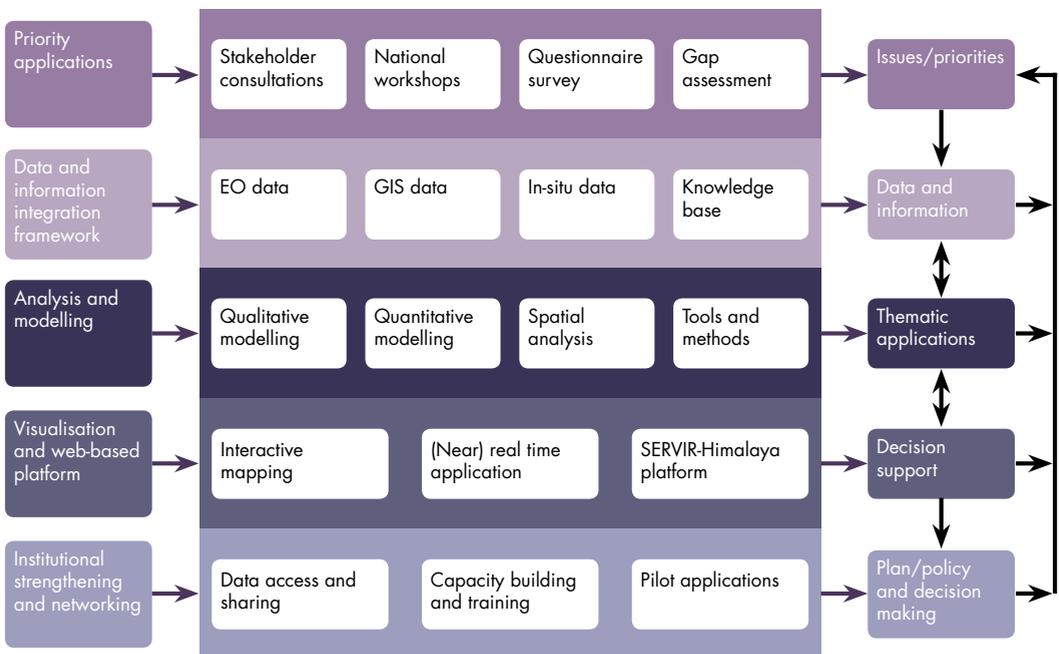


ICIMOD sees itself as playing the role of a regional knowledge sharing and enabling centre. The purpose of this workshop was also to pick some of the ‘low-hanging fruit’ in the use of SERVIR, such as during disaster management, floods, and wildfires.

The technical background to the start of the SERVIR mission was provided by Dan Irwin, SERVIR Project Director at the NASA Marshall Center, who explained that SERVIR has to be adapted to the needs of the people in order to create the ‘space to village link’, which is the true goal of the first non-conventional cooperation between USAID and NASA. He encouraged the new platform to be informed by a spirit of data sharing, and suggested special considerations for the use of cloud computing and the redundancy of geospatial data.

Carrie Stokes, Geo-spatial Technology Advisor, USAID, Washington, remarked that the maps created through the use of SERVIR would not give answers, but would help us to get to the answer. Basanta Shrestha, Head of ICIMOD’s MENRIS Division, and the Regional Coordinator of SERVIR-Himalaya, presented SERVIR as a model for capacity building between countries for the use of Earth observation and geospatial information technologies through partnership and networking. SERVIR has been recognised by GEO as an early achiever of the GEO vision. In view of ICIMOD’s strategic areas, SERVIR-Himalaya will focus on thematic applications for cryosphere/ water, biodiversity/ecosystems, land cover and change analysis, disaster preparedness and risk management, and air quality monitoring. The inception workshop can be seen as a starting point for identifying priorities. He presented his interpretation of the SERVIR-Himalaya implementation framework.

SERVIR-Himalaya implementation framework



The chief guest, Manohar Bhattarai, underlined the importance of SERVIR-Himalaya for the developing countries of the region, which are held back by a dearth of information. The key value of the system has to be in the gathering and processing of satellite data and combining it with in situ observation. Such verified information would have a direct bearing on policies across several domains and will enhance the overall response capability of governments in the region. However, he saw a need to build absorptive capacities with an appropriate mobilisation strategy especially targeting the government and its stakeholders. Bhattarai also encouraged the inclusion of cloud computing, as the Government of Nepal had just rolled out a data centre enabling such activities.



Dan Irwin, NASA, at the opening session

During the workshop, participants were exposed to the key components of SERVIR-Himalaya implementation, including the needs assessment, development of a web platform, decision support applications, capacity building, and a sustainability framework, the group work focused on determining key priority applications.

Group Work

Five groups were formed to work on the following thematic areas using the steps outlined below:

Themes

1. Land use/land cover and REDD
2. Biodiversity and ecosystems
3. Cryosphere
4. Disaster management
5. Air quality

Steps

1. Identify the relevant institutions working in the thematic area
2. List recent studies and programmes
3. Identify the gaps in information
4. Identify the types of data services required
5. Identify the types of DSS tools/online applications that would be useful
6. Propose desired institutional arrangements

The results were presented in a plenary session with an opportunity for questions and feedback from all participants.

Group 1: Land use/land cover and REDD

Group 1 identified (i) wetlands, (ii) forests, (iii) mountains, (iv) coastal marine ecosystems, and (v) spatial distribution patterns of environmental threats as the critical areas where data/information is lacking and suggested the following areas for modelling and thematic applications:

- Mapping extent of vegetation types
- Drivers of change in vegetation
- Mapping biomass density, including below ground biomass
- Piloting studies on field carbon stocking
- Integration of climate change scenarios with vegetation types, and assessment of impact and intervention options

In terms of institutional strengthening, the group suggested a technical needs assessment, as well as capacity building measures at the sub-national, rather than regional, level. The group suggested that there was room for improvement in awareness-raising, communication, and technical assistance for policy makers.

During the discussion, it was mentioned that ICIMOD has been undertaking a regional

land cover mapping initiative, and land cover data have been derived from 2000 Landsat images for Bangladesh, Bhutan, Nepal, and Pakistan. Land cover data will also be prepared for 1990 and 2010 to gain a better understanding of the dynamics. SERVIR will stream this land cover information as one of its key functions. In the context of REDD, ICIMOD has already been collecting data from the field and working on a methodology with ITC-Netherlands for above ground biomass estimation using high resolution satellite images. It was emphasised that there would be easy access to US Landsat data for land cover studies. The key information on deforestation will create a basis from which the SERVIR team could start identifying pilot areas.



Group 2: Biodiversity and ecosystems

The second group listed the following as the data gap areas where SERVIR can work:

- Species distribution maps (in some countries like Pakistan baseline data is already available)
- Eco-zone maps
- Protected area maps and ancillary information
- Forest type maps
- Demographic and socioeconomic data
- High-resolution (temporal and spatial) data for hotspots (highly significant ecological/climatic areas)

They identified the following areas for analysis and modelling: eco-zone identification under climate change scenarios; eco-system services mapping; habitat mapping of endangered species; wildlife corridor mapping; and ecological degradation mapping in flood plain areas. The group also suggested that such information could be contained in a biodiversity web-portal, and that a 'Wiki-like' page on species sighting data would be beneficial. In terms of institutional strengthening, the emphasis should be on infrastructure development through the right institutions, networking with the Global Biodiversity Information Facility (GBIF) and GEO BON (Group on Earth Observations Biodiversity Observation Network), and advanced training. The engagement of local institutions at the activity level was identified as a very important strategy. The group recommended that SERVIR follow ICIMOD's approach, namely, treat local institutions as partners and give them increased visibility. During the discussions, it was recommended that data compatibility and good metadata should be assured as this also sets standards for data contributed in the future.

Group 3: Cryosphere

The third group identified that snow cover and glacier information including region, basin, altitude, and time should be gathered in the short term. As a long-term goal, the group listed the following:

- Models at regional and local scales
- Sustainable use of water resources
- Future changes in water availability, different types of modelling, and data

More specifically, the group identified the individual parameters to be provided, stating that much of the data is already available, while other data will have to come from field measurement. The group also developed a list of institutions in each country that would be supplying different types of data. The group presentation was followed by discussions that focused on willingness to share data and the procedures for access. It was suggested that each country have one focal institution to use the network to share the central satellite and the local ground observation feed.



Group 4: Disaster management

The fourth group identified the relevant national institutions and existing studies for disaster management in each country in the HKH region. In addition, there are regional initiatives through Sentinel Asia, the International Charter, and regional space agencies. The group pointed out one issue relating to GIS/RS data, that even if the data are available, they are often not compatible or harmonised. Further, there is a lack of awareness of what data are available and how to use

them. Data sharing-mechanisms, the involvement of interdisciplinary scientists, and a re-alignment of national level data were identified as needs. More specifically, the type of data required concerns:

- Digital elevation layers
- Usable data (raw data, products)
- Demand-based/information products
- Integrated geospatial data services
- Quick access related to disaster products (e.g., rapid response mapping)

Regarding decision support applications, the group listed disaster specific assessment tools (e.g., seismic tools, flood inundation mapping); interactive web map services; forecasting/early warning tools; the development of a space-based disaster information system; and the development of a disaster grid distributed system.

The group recommended the establishment of SERVIR sub-nodes in each country. They also recommended memorandums of understanding on data and cooperation, inter- and intra-organisation cooperation, and cooperation between regional and international space agencies on timely data access as institutional mechanisms. The group suggested the development of disaster management information systems through demonstration projects under the SERVIR initiative.

Group 5: Air quality

The use of Earth observation data for air quality has been significantly underexploited. The group identified national institutions in each country relevant to air quality. Regardless of the number of agencies involved, only China, India, and Myanmar have done considerable work after the Male Declaration. Therefore, most of the gaps have remained, and were identified as:

- Technical: Lack of in-situ data and ground monitoring stations, lack of consistent data sets on air quality and emission inventories; and
- Institutional: Lack of infrastructure, human resources, policy on sharing, and coordination.

The group identified the data needs as dissemination of processed satellite data, meteorological datasets, and data on forest fire/smoke, haze, dust; aerosol optical depth (AOD); ozone, NO₂ and SO₂; evapotranspiration and water vapour; and black carbon and trajectory. They also suggested a real time air quality monitoring system (visualising satellite and ground-based data), and the establishment of an air quality blog on the GeoPortal (similar to Smog Blog) for the dissemination of air quality information.

Potential areas for SERVIR were identified as studying the effects of black carbon on snow/ice; mapping the area of pollution with regard to health issues; agricultural impact assessment study; meteorological data for farmers; and awareness raising on air quality.

Concluding Session

Summing up the presentations, Carrie Stokes raised some questions for the participants to consider:

- Who will take the lead in each of the areas to follow through? It usually takes a champion to make things work.
- SERVIR will need to prioritise which components are suitable for a pilot and demonstrate how SERVIR can deliver.
- What is the most realistic timeframe to show actual delivery?
- Where do we see SERVIR one year from now? How can we pick the 'low hanging fruit' (the easily achievable first results) to create credibility and critical mass?

In conclusion, Basanta Shrestha informed participants that there will be national visits and workshops in individual countries as a follow up to complete the needs assessment and facilitate wider consultation in the national context to further refine priorities. Looking ahead to one year from now, he suggested that, under the main theme of information services in the context of climate change, the system would enable individuals to log on to SERVIR and to browse, discover, download, and use some of the tools. In exchange, individuals and institutions would make their value addition by validating and contextualising remote sensing data. In this way, not only would credibility be established, but a critical mass would be created.

In his closing remarks, Madhav Karki summarised the take-home messages as:

- Climate variability will influence policies.
- Success will depend on how innovatively we combine local and international expertise.
- There is a need for a multi-temporal, multi-scale, and multidimensional approach.
- The success of networks has helped create SERVIR and will support dissemination to reach mountain communities in the Hindu Kush-Himalayan region.

About ICIMOD

The International Centre for Integrated Mountain Development, ICIMOD, is a regional knowledge development and learning centre serving the eight regional member countries of the Hindu Kush-Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and based in Kathmandu, Nepal. Globalisation and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. We support regional transboundary programmes through partnership with regional partner institutions, facilitate the exchange of experience, and serve as a regional knowledge hub. We strengthen networking among regional and global centres of excellence. Overall, we are working to develop an economically and environmentally sound mountain ecosystem to improve the living standards of mountain populations and to sustain vital ecosystem services for the billions of people living downstream – now, and for the future.



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