# MOUNTAIN GIS PORTAL - A STEP TOWARDS REGIONAL SPATIAL DATA INFRASTRUCTURE IN THE HINDU KUSH-HIMALAYAN (HKH) REGION

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**ABSTRACT:**

Usefulness of Geo-Information technology to address various issues on sustainable development has been well realized. However, the real applications of the technology are hindered due to lack of proper data sharing mechanisms, giving rise to lot of duplication of efforts. Many countries are working on developing National Spatial Data Infrastructures (NSDI) to look after various components necessary to facilitate spatial data sharing to a broad user base. In this context, the International Centre for Integrated Mountain Development (ICIMOD) has been working on spatial data infrastructure at a regional level in the Hindu Kush- Himalayan (HKH) region to develop a common framework for sharing data and knowledge for application of GIS to sustainable mountain development. A mountain GIS Portal has been developed using the latest GIS and the Internet technologies. The portal developed to share GIS resources such as metadata, spatial data, application methodologies, publications and training materials will certainly reinforce the NSDI efforts in the countries of the HKH. ICIMOD is also working with its national partners to develop national portals in the similar framework which will be a part of the larger network at the regional level. It is envisaged that this distributed network with a building block approach will ultimately grow into a regional spatial data infrastructure in the HKH.

## INTRODUCTION

Sustainable development has been the main guiding principle in all the development initiatives. Sustainability issues are more prominent in the mountains due to their fragile ecosystems, and socioeconomic and environmental vulnerability of the mountain societies. Many efforts are underway to improve the quality of life of the mountain people. The celebration of the International Year of Mountains this year clearly shows the global concern over the sustainable development of mountain areas. The International Center for Integrated Mountain Development (ICIMOD) has been working as the only regional center for promoting economically and environmentally sound development of mountain ecosystems in the Hindu Kush-Himalayan (HKH) region.

Many issues of mountain development are of trans-boundary concern such as environmental degradation, forest depletion and soil erosion, poverty and migration, and sharing of water resources. To effectively address the regional environmental issues, an improved understanding of key components of these issues is necessary. ICIMOD has been working as a facilitator for generation and sharing of mountain specific knowledge. It has been working on promoting regional cooperation through interdisciplinary and cross sectoral partnerships. The partnership plenary session on regional implementation at the recent World Summit on Sustainable Development (WSSD) held at Johannesburg has also emphasized on the need to focus on trans-boundary issues and externalities, regional advocacy and information sharing, promoting and monitoring regional sustainable development related strategies, advocacy, awareness-raising and capacity building (UN,2002). During its last two

decades of partnership initiatives in the HKH region, ICIMOD has developed a strong network of national and local institutions in the region. The capacity building and networking activity of ICIMOD through its Mountain Environment and Natural Resources Information Systems (MENRIS) division towards dissemination of Geographic Information Systems (GIS) and Remote Sensing (RS) technology in the HKH region has been a major contributor in bringing together different national organizations into a common platform to benefit from the new technologies.

The scope of spatial information has become enormous with its wide applications in scientific, technical and social disciplines. The usefulness of geographic information and GIS/ RS technologies to address various issues of mountain development has been well recognized. Much has been achieved in generating awareness and human resources development over the last one decade of efforts by MENRIS. However, due to the lack of central oversight, there has been an extensive overlap and duplication in spatial data collection. Data collection and manipulation form a major component of expenditure and time in the implementation of GIS. The availability of consistent regional datasets, based on the integration of national datasets will improve our ability to investigate the issues related to natural resources and environment management, and the sustainable development of the HKH region. With proper coordination and cooperation in data sharing, an enormous amount of resources can be saved in various applications using geographic information. The major problems in using GIS are that the knowledge of existing information resources and their use are insufficient, information is dispersed, heterogeneous, and inaccessible. Considerable effort is required to integrate the separate national datasets to produce a consistent regional dataset.

**SPATIAL DATA INFRASTRUCTURE IN THE HKH**

Spatial Data Infrastructure (SDI) has been conceived as an environment where - the core geographic datasets are easily available; existing geographic information are well documented; available geographic information conform to accepted standards; policies encourage exchange and reuse of geographic information; and there are sufficient human and technical resources to handle geographic information. SDI encompasses the networked geographic databases and data handling facilities, the complex of institutional, organizational, technological, human, and economic resources which interact with one another and underpin the design, implementation and maintenance of mechanisms facilitating the sharing, access to, and responsible use of geographic data at an affordable cost for a specific application domain or enterprise (Groot, 2001). Although the formal definitions of SDI may vary around the world, it can be seen as the broad policy, organizational, technical and financial arrangements necessary to support access to geographic information (Rhind, 2001).

ICIMOD is working for a Regional Spatial Data Infrastructure (RSDI) to develop an environment for economic use of the grographic information which is accessible to all the professionals working for the development of the region. The long term goal of having a RSDI is to develop networks of institutions linked by intra-regional institutional framework that provides mechanisms for sharing experience, technology transfer and coordination in development of fundamental datasets of the region. In this regard, ICIMOD is working along the line of global initiatives such as Geography Network and UNEP.net. The Geography Network is a global network of geographic information users and providers using the G.net architectural vision by ESRI for sharing and using GIS information from distributed sources (ESRI, 2002). This architecture is multi-participant, collaborative, and allows organizations to openly share and directly use geographic information from many distributed sources at the same time. It provides the infrastructure needed to enable the sharing of geographic information between data providers, service providers, and users around the world. The Internet is used to deliver geographic content to the user's browser and desktop. Through the Geography Network, one can access many types of geographic content including live maps, downloadable data, and more advanced services. Similarly, UNEP.net is a decentralized and distributed system that allows the integrated applications to query and generate reports from remote environmental databases and servers (UNEP, 2002). This architecture enables the contributing publishers to continue to upgrade their systems and update their information holdings locally with the benefits being realized directly by the partnership. ICIMOD has developed a Mountain GIS Portal based on a similar architectural framework, focusing mainly at sharing GIS resources in the HKH region.

## THE MOUNTAIN GIS PORTAL

The Mountain GIS Portal has been developed to serve the GIS resources that address sustainable mountain development issues in the HKH region (figure 1). The GIS resources include training and educational resources, database and meta-data resources, map resources, and application resources. More importantly, it is aimed at serving a common platform to access and share information and knowledge about the GIS technology and its applications in mountain development. The portal is envisaged as an important step in accomplishing towards a RSDI thus facilitating the sharing, integration and use of geographic information across a broad user-base, giving particular consideration to standardized datasets, using the potential of modern information and communication technologies, particularly the Internet. The portal will be a virtual platform for sharing data and information by the users and providers, offering a new one-stop experience for all geographic data needs in the region.


Figure 1. The Mountain GIS Portal Concept

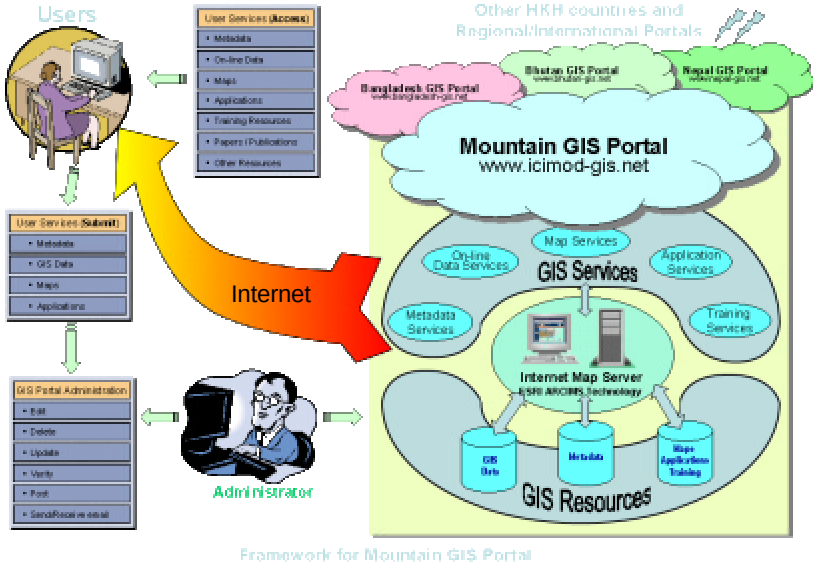


Figure 2. Functioning of the GIS Portal

The portal provides a number of GIS services and resources as shown in the figure 2, which is accessible to the user through the Internet. The user can access the metadata, on-line data, maps, application and training resources. Similarly the user can also submit his own data, metadata, maps or application cases. The system administrator manages these materials and posts them as appropriate. In this way a user can also be a provider of the resources through the portal.

An extensive system is designed to serve the GIS database on the Internet using the new technologies e.g. ArcIMS, SQL server, Active Server Pages (ASP) etc. The system includes a ***Metadata Editor*** for customized entering and viewing metadata. The editor has been developed using Visual Basic and ArcObjects (metadataEdit interface) and integrated within the ArcCatalog environment. It has an easy-to-use interface that is targeted to the groups in the region who need only basic but relevant information. Users can view the metadata using the ***MENRIS stylesheet*** or other standard stylesheets within ArcCatalog such as FGDC, ESRI or Geography Network. A spatial search engine has been made available with the spatial and textual search capability to view the data and the associated metadata using ArcIMS tools and Active Server Pages.

**Components**

The contents of the portal has been designed with the following components.

**Issues in Sustainable Mountain Development** This section provides a general overview of the mountain characteristics of the region and various issues related to the sustainable development. It also illustrates the application of GIS and RS to various themes related to mountain development, for example, Monitoring Glacial Lakes and Glacial Lake Outburst Floods, Biodiversity Mapping and Conservation Management, State of the Environment, Urban Management, Land Cover Mapping etc.

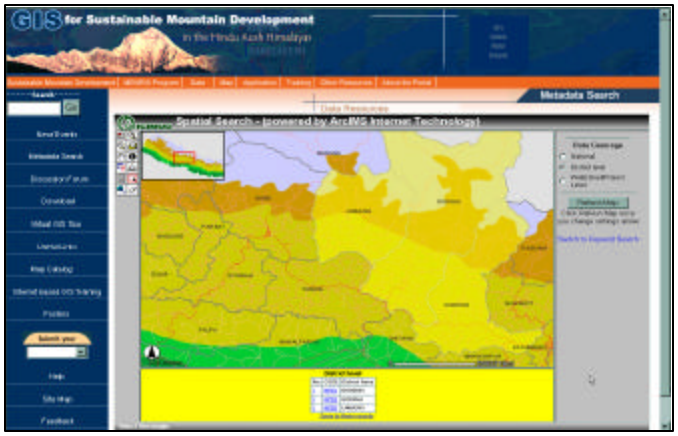


Figure 3. Spatial search for metadata

**Data Resources** The major objective of the portal is to encourage and facilitate data sharing among the different users in the region. As an initiation, databases at different themes and scales that have been generated and accumulated by ICIMOD through its various activities are made accessible through the portal. A metadata system provides the facility for spatial and textual search of data (figure 3). Options are provided for direct download of data as well as on-line ordering depending upon the nature of the data. The portal also provides facilities to prepare the users own map with the database available on-line using the Internet Mapping facilities of ArcIMS. There is also an option to submit the user's own metadata and/or data to the system which will be served to a wider audience through the portal.

**Map Resources:** The section on map resources provides through a dynamic interface the maps published in various reports and documents of ICIMOD. It is possible to search the maps based on title, theme, location, source etc. There is also an option for submitting the user's own maps to be served on the portal. The user has to fill in an on-line form with some basic information and upload the graphics file which will be then incorporated into the map catalog.

**Applications Resources:** Sharing of knowledge and experiences is equally important as sharing data, and this section is the place to disseminate the different applications of GIS and RS to address the real problems of the mountain development. Various application projects carried out by ICIMOD and its partners are presented here. Short descriptions on various application projects along with published reports are provided. The users can also submit their application cases and reports for wider dissemination.

**Education/ Training Resources:** Under its capacity building activities, nearly 800 people from over 100 partner institutions have been trained by MENRIS in the use of GIS technologies since its inception in 1990. Recently, its training programs are focussed to GIS/RS applications that are specific to mountain areas e.g., Basic Infrastructure and Facility Planning; Mountain Agriculture and Land Use Planning; Monitoring, Assessment and Planning of Mountain Natural Resources; and Slope Stability Analysis and Hazard Mapping. The training materials developed for these different training courses have been compiled in a CD-ROM "*Application of Geo-informatics for Sustainable Mountain Development".* The CD is served on-line for use as a self-learning kit, or web based training, or reference material for the students. Also available on the portal is *"GIS for Beginners",* an introductory textbook which was launched in Nepal on the occasion of GIS Day 2000 (figure 4).

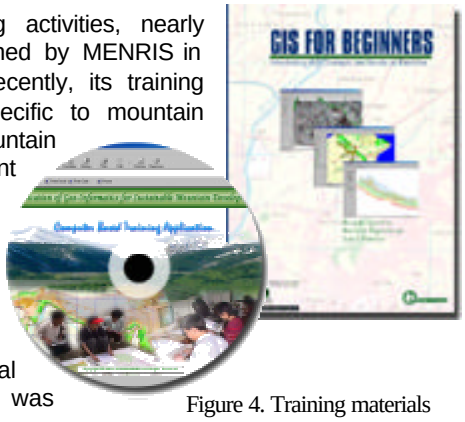


Figure 4. Training materials

**Other Resources:** Apart from the above resources, the site also provides news on GIS activities and a Discussion Forum to bring together different users from the region and abroad to share knowledge and experiences on the use of GIS/RS technology. Also available is a picture gallery from across the mountains depicting various natural, social and cultural heritage of the region. Virtual tours of mountain areas including some glacier lakes prepared using different satellite images and Digital Elevation Models (DEM) are included in this section which gives the user a better picture of the mountain environments.

**Country Pages** The country pages of regional member countries are designed to have the GIS resources served in the common and consistent format as that of the main regional page. Development of Bangladesh, Bhutan and Nepal country pages has already been initiated in collaboration with the national institutions. These pages will further provide a platform for national institutions to host their data, metadata and other resources specific to the countries.

**MAJOR ISSUES**

The main purpose of building such a system is to encourage sharing of geographic information among the potential users. Such a system will also bring together all the stakeholders in a common platform to share their experiences and knowledge as well as discuss about various issues related to application of geographic information in the mountain environments. The portal is a dynamic system which has to be updated continuously. With active participation of providers and users of GIS data in the region, it is envisaged that the portal will be the foundation stone for scientific discussions, sharing data and knowledge for the benefit of the mountain people in general and the sustainable development of the HKH region. However, there are some issues that need to be considered for the success of such a system which are discussed below.

**Internet connection**

One of the major issues of going for such a system is the availability of the Internet facilities in region. However, use of Internet is growing rapidly in the region with the introduction of computer education in schools. Besides, the growing number of cyber cafes in the towns of the HKH countries indicates the increasing number of Internet users. As the user community of geographic information is at the forefront of using the Information and Communication Technologies (ICT), it can be expected that they will have fairly good access to the Internet.

Another issue for such a system is the speed of the Internet connections in the region which can be quite frustrating for the users to browse large geographic data. However, with the present trend in development of information and communication infrastructure in the region, the scenario looks optimistic.

**System administration**

The portal has to be maintained and administered continuously which require financial and human resources dedicated for the purpose. As the portal is designed as a network of different national nodes linking to the regional portal with similar look and capabilities, each node will need to allocate some resources for administration of these national nodes. Since the national nodes will be using the same system design and architecture, the shared development costs will be low. Remote administration at the central level may be considered during the initial stage to keep the maintenance costs minimum.

**Development of Metadata**

Metadata is the most important part in facilitating data sharing. However, it has remained the most neglected part during the implementation of GIS projects in the region. The existing databases are the product of discrete project activities in different sectors. It is difficult to find adequate information of the existing data which makes their quality and reuse uncertain. The portal will definitely demonstrate the need of metadata and encourage the GIS users to create metadata along with their new databases. The problem lies with creating the metadata of existing old databases which needs to be given some priority.

**Data sharing culture**

Topographic maps are restricted in most countries of the region. Sharing these data in digital format through the internet needs a very bold step from the governments of these countries. With the growing users of GIS, digital geographic data in general, and the topographic base in particular, has become a commodity of basic need. It is a good indication that the governments are already taking NSDI initiatives and it is expected to involve more stakeholders as the process goes on. Such a portal will definitely encourage to publish the geographic data. As different country pages are being developed in a similar framework, it is hoped that the institutions in these countries will slowly come up with more liberal approach to data sharing to make their page a better one.

**Mechanisms for data distribution**

There are other important issues like the data holding, pricing of the data, and the method of payment for the data and resources. There are no clear policies for digital data as these are relatively new products. Besides, due to the lack of strong enforcement of copyright law in the region, the data providers are more concerned with the unauthorized copying and distribution of the data. Strategic pricing policies and other institutional arrangements may be necessary to deal with this issue. However, the portal can be initiated with public domain and free data to start with. Regarding the delivery of the data, most of the data may still have to be delivered through mail instead of on-line downloading due to the large file size.

**CONCLUSION**

The need for a Regional SDI can not be overstated in a region like HKH where there are so many trans-boundary issues to deal with for its sustainable development. ICIMOD has been working on developing a regional SDI for economic and effective use of geo-information technology in the region. A

mechanism for sharing geographic data and resources is very important in a SDI and the Mountain GIS Portal developed by ICIMOD fits in very well to address this need. The system designed using the latest IT and GIS tools provides a platform for all the GIS users in the region to share their data and resources. By bringing together different countries on board, the portal will help to promote regional cooperation in data sharing. Participation and partnership are the keys to evolution of a successful SDI and it is hoped that the portal provides such a forum. With active participation from the institutions in the region, the pertaining issues in sharing geographic information will gradually be dealt with and the users will have easy access to data and resources for all their needs in the near future.

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