

Role of ICIMOD in Promoting GIS in HKH Region

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Abstract

The International Centre for Integrated Mountain Development (ICIMOD) has adopted the concept of sustainable development as the main goal of development for the Hindu Kush-Himalayan (HKH) Region. The HKH Region is not only the highest mountainous region of the world, but also one saddled with a wide range of ecological and developmental problems.

One critical issue in long-term policy planning that is in direct conformity with the principles of sustainable development deals with the need for appropriate information for improved decision-making at all levels - from senior decision-makers at national and international levels to others at the grassroots and individual levels. To ensure that decisions are increasingly based on sound information, planners and decision-makers must endeavour to bridge the data gap and improve information availability. Bridging the data gap is a complex multidisciplinary task that will not only require considerable resources but also substantial time and appropriate human resources. ICIMOD is committed to helping to bridge the data gap in the HKH region. In this process it seeks to work together with all the different stakeholders in not only identifying different high priority information needs, but also in helping to develop those approaches and skills by which these information needs are most effectively fulfilled. Hopefully this will set in motion other processes that will help organizations in the region to move forward in this area of information management for sustainable development.

The MENRIS Programme of ICIMOD focuses on building the capacities of institutions with a major mandate in sustainable mountain development to use GIS and remote sensing for planning, monitoring, and assessment of critical areas in integrated mountain development.

Introduction

The International Centre for Integrated Mountain Development (ICIMOD), together with its eight Regional Member Countries (RMCs) in the Hindu Kush-Himalayan (HKH) Region has adopted the concept of sustainable development as the main goal of development in the HKH Region. The varied and complex issues relevant to sustainable development involve both human and biophysical aspects. It is necessary to adopt an integrated approach to action that hinges on the availability of timely, reliable, and usable data, not only on environmental issues but also on socio-economic aspects. An integrated, multisectoral analysis of these data becomes imperative in order to promote sustainable development policies and decisions.

The HKH Region, extends over 3,500km from Afghanistan in the west to Myanmar in the east and stretches from the Tibetan Plateau in the north to the Ganges Basin in the south (Fig. 1). The Region is saddled with problems such as a rapidly increasing population, growing poverty and unemployment, migration of people to the lowlands and urban areas, declining agricultural productivity, poor infrastructure, environmental degradation, and depletion of natural resources. Isolated solutions to these ecological and development problems have proved counter-productive, since most of the problems are interconnected, and therefore, development interventions must be formulated and implemented in an integrated manner. While one should take into account the

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comparative advantages of mountain areas for specific development opportunities not available elsewhere, an integrated approach to solving the problems and making use of the opportunities for development should have a strong database and an appropriate methodology for interdisciplinary analysis.

In its experience covering more than a decade, ICIMOD has recognized that the critical component in long-term policy planning is the need for appropriate information flow, which leads to improved decision-making at all levels from senior decision-makers at national and international levels to others at the grassroots and individual levels. To ensure that decisions are increasingly based on sound information, planners and decision-makers must endeavour to bridge the data gap and improve information availability. Bridging the data gap is a complex, multidisciplinary task that requires not only considerable resources but also substantial time and appropriate human resources. While the UNCED Meeting recognizes the need to bridge the data gap between developed and developing countries, the ICIMOD is committed to helping to bridge the data gap in the HKH region for the mountainous areas in its RMCs.

In this process, different kinds of stakeholders have been networked to identify different high priority information needs as well as develop approaches and skills by which these information needs would be most effectively fulfilled. ICIMOD's emphasis is placed on beginning the process with the identification of appropriate methodologies, and facilitating capacity-building and institutional strengthening programs in the HKH Region. The main objective is to motivate other organizations in the region that are working in the area of information management for sustainable development to develop more refined processes, leading to self-sustaining developmental activities.

In 1990, the Mountain Environmental and Natural Resources' Information System (MENRIS/ICIMOD) was established, to assimilate multisectoral analysis of data through the application of Geo-Information System and Remote Sensing (GIS/RS) technologies. Since its establishment, MENRIS has benefited from the generous support of various donor agencies including the United Nations Environment Programme (UNEP), Asian Development Bank, and the Government of Germany, the Royal Government of The United Kingdom, the Government of The Netherlands, besides the internal resources of ICIMOD.

The main objective of the MENRIS program in the RMCs is to promote/facilitate capacity-building and strengthen national institutions, with mountain focus on: (a) establishment of GIS/RS centers in the national focal points through provision of GIS hardware and software; (b) provision of GIS training at three levels - policy workshop, professional, and technical levels; and (c) development of relevant case studies as an instrument of training at the national level.

Application of GIS and remote sensing in mountain region

The mountain areas present a wide diversity of environments in terms of physical, economic, cultural, and political diversity. The diversity, marginality, and strategic importance of mountains, together with markedly different rates of change in different components of their physical, biological, and societal systems, present great challenges for the use of GIS/RS.

Agenda 21 of UNCED noted the general lack of capacity for collecting and assessing data, and, even where data are available, there was a lack of financial resources and appropriate technology, including trained manpower, to make these data accessible. The same can be said of the HKH Region. ICIMOD is aware of such limitations and earnestly recognizes the lack of advanced, technical use and application of GIS technology in the Region. As a focused approach, ICIMOD has categorically selected the following sectors, in which it envisages to offer benefit to the RMCs from GIS/RS applications.

1 Sustainable mountain farming systems

Farming continues to be the dominant activity of mountain households in the Hindu Kush-Himalayas. In

spite of its significance as a source of livelihood, recent performance indicators of mountain agriculture have been a source of great concern for policy-makers in the countries of the HKH Region. Declining productivity in the face of a growing population and increasing depletion and degradation of available natural resources are common problems throughout the mountain areas. In order to reverse these trends and develop more sustainable agriculture, attention is being focused on more specific agro-ecological planning and targeting of agricultural development interventions. In view of the crucial role of physical infrastructure and basic services for sustainable agriculture, locational decisions have become extremely critical as the needs are vast and resources limited. Many of these decisions are still being taken on an ad hoc basis, resulting in a limited impact. In the long run, the development of appropriate location-specific program packages will certainly contribute to the reduction of poverty and protection of the environment in mountain areas.

2 Sustainable management of mountain natural resources

In spite of the general consensus on the need for sustainable management of mountain natural resources, the main obstacles have been the continuing lack of information, lack of coordination among different agencies, and lack of suitable monitoring systems. In the absence of a baseline database, it has become extremely difficult to identify critical areas for immediate attention. Some of the areas for which useful databases have been provided through the use of GIS are biodiversity mapping, identification of critical habitats, and other land cover assessments. All the major sectoral line agencies concerned with natural resources in the RMCs are convinced of the potential value of GIS as a planning and monitoring tool for management of natural resources and have taken some steps to develop in-house capacities. What is needed still is a wider dissemination and the development of practical GIS application methods to a greater number of natural resources' management problems.

3 Locational guidelines on rural infrastructure, basic services and urban development

Large areas of rural mountain regions lack basic infrastructure and services. While the demand for these has increased significantly, providing them is very costly, and the available resources are very limited. It is therefore necessary to develop planning methodologies that facilitate desirable locational decisions concerning rural infrastructure and basic services, taking into account different factors such as the population serviced, harnessing growth potentials, market linkages and minimizing the impact of infrastructure development on fragile mountain environments. The use of GIS to facilitate appropriate locational decisions in the framework of integrated area planning in mountain areas has substantial potentials, and the limited work undertaken so far in this field has been very encouraging. With investments in rural infrastructure and basic services likely to increase substantially in future, the use of GIS as a practical planning methodology is of relevance not only to the central agencies but also to local governments, for which planning capacities need to be developed.

4 Slope instability and landslide hazard mapping

Being one of the world's youngest geological formations, the HKH Region is prone to landslides, both occurring naturally and through man-made interventions such as the building of roads, irrigation canals, hydropower plants, etc. GIS is a very effective tool for identifying the potential for landslide hazards, based on information on geomorphology, topography, climate, etc. Appropriate landslide hazard mapping using GIS would be extremely useful for planning infrastructure development in the HKH.

GIS/RS capacity-building in partnership through case studies

ICIMOD's mandate envisages a strong capacity-building intervention in developing, organizing, and implementing integrated mountain development activities. To reach over 140 million people living in the HKH Region, ICIMOD works in partnership with national and local organizations, which are their only source of new

ideas, technologies, inputs, skills, and services (Table 1). ICIMOD has conducted hundreds of GIS/RS-related training courses, policy workshops and seminars to reach a wide range of institutions and professionals from various disciplines (Table 2). While the Regional Training Courses focus on issues of common interest to the majority of RMCs, these are well complemented by capacity-building at the national level.

Table 1 Status of capacity-building in regional member countries

Regional member countries	Training	Alumni		Systems	Case studies	Database	
		Total	Female			250 K	50 K
Bangladesh	· Basic	186	25	35	4	1998	1999
Bhutan	GIS/RS	37	11	15	2	1994	1994
China	· Advanced	110	43	35	4	1998	
India	GIS/RS	125	28	35	6	1999	
Myanmar	· Regional/National	128	33	25	3	1999	
Nepal		287	64	45	15	1995	
Pakistan	· Policy awareness	101	11	25	4	1999	1995
	Total	974	215	215	38		

Table 2 Participants in regional/national training programs (January 1997-June 1999)

Regional member countries	Number estimated		Number of trained professionals (female participants)				
	Regional	National	Course I	Course II	Course III	Course IV	Total
Bangladesh	18	16	2 (1)	3 (1)	20 (6)	3	28 (8)
Bhutan	16	12	2	3	6 (3)	3 (1)	14 (4)
China	20	16	3 (1)	2 (2)	3 (2)	16 (6)	24 (11)
India	18	16	15 (3)	2 (2)	3 (2)	6 (2)	26 (9)
Nepal	20	16	2 (1)	5 (2)	9 (3)	8 (3)	24 (9)
Myanmar		16		16 (6)			16 (6)
Pakistan	18	16	2	4 (1)	5 (1)	6	17 (2)
Total	110	108	26 (6)	35 (14)	46 (17)	42 (12)	149 (49)

While strengthening of human resources potential in HKH institutions is essential, ICIMOD also provides other types of supports to implement the mandate in mountain development properly. Such supports could be in the form of hardware and software provision, or towards the development of mountain-focused case studies and databases. The support for such activities not only bridges the data gap in mountain areas but also contributes to the development of methodologies for mountain-specific applications.

ICIMOD in its efforts to build the national geo-informatics capacity has, from the beginning, placed emphasis on the development of collaborative case studies, which are mountain-focused and are conducted in close collaboration with nodal agencies. These collaborative case studies have confirmed the relevance of using GIS in detecting the underlying causes of apparently unexplained phenomena in several sectors. GIS-based analysis has revealed the linkages that are often hidden amidst the complex factors impinging on a problem. New management options to address the problems have emerged in several cases. The case studies have contributed to the development of national expertise in the collection of data, their input into GIS in the digital format and in carrying out the needed analysis. ICIMOD has provided technical and backstopping support to promote the development of analytical skills.

Usually, a collaborative case study is initiated right after the training, which then helps the participant not only to utilize the new knowledge immediately but also to disseminate the newly acquired knowledge amongst various colleagues within the organization and beyond. It is also envisaged that the effort of these institutions to replicate the collaborative case studies in the remaining hill districts within their jurisdiction, shall eventually

lead to the completion of the digital database of the country and hence the whole HKH Region. Within the framework of these collaborative case studies, ICIMOD continues to provide further training, information on technology progress and some funds for the upkeep and operation of the established network.

Application of GIS/RS for planning of agriculture development

MENRIS-ICIMOD in cooperation with the Government of Nepal has established a GIS database with baseline data of the Gorkha District of Nepal. The purpose is to enable decision-makers in the Gorkha District as well as the Department of Agriculture to 1) better identify existing natural resources and infrastructure, 2) integrate natural sciences and socio-economic data, and 3) use the information thus gained for improved area-specific planning and program monitoring.

The Gorkha District lies in the western mountains of Nepal and covers an area of about 3,642 sq. km, stretching over a 100km north-south distance (Fig. 2). As such, the area is a land of extremes - the climate ranges from subtropical to arctic; the physiography includes fertile alluvial plains below 500masl and very rugged, permanently snow-covered peaks. Major Himalayan ranges are part of the district, namely, Manaslu Himal (8,162masl), Sringi Himal (7,138masl), and Ganesh Himal (7,424masl). Bedrock and surface geology, climate, vegetation, and land use are the differentiating criteria for the three physiographic regions in the district, i.e., Middle Mountains, High Mountains, and High Himalayas, their areas amounting to 28 %, 25 %, and 47 %, respectively.

- * The study focused on four activities, basically aims at addressing development problems and evaluating potentials in the agriculture development of the Gorkha District.
- * Agroclimatic zones : The assessment of agroclimatic zones was conducted in line with the theory of zonal approach, which is considered to be most suitable for planning development interventions in the agricultural sector in mountainous areas.
- * Feed situation analysis : Although animal husbandry is an integral part of the agricultural system in Nepal, there is a shortage of fodder, limiting the animal productivity. The analysis of the feed situation, *i.e.* feed supply, feed requirements, and livestock carrying capacity in the Gorkha District, was conducted to better understand the spatial relations of the feed deficit problem in the district and to identify smaller units for immediate intervention.
- * Potential horticultural development areas : Horticulture is considered to be an effective tool for reducing environmental degradation and improving the economic conditions in mountainous areas. There is a great potential for the development of various fruit species in Nepal. The case study assessed the potential of horticultural development and particularly fruit crops in the Gorkha District, taking into account various parameters, *i.e.* temperature, land use, aspect, and accessibility to marketing infrastructure.
- * Potential potato production areas : In the Nepalese mountains, in particular in the Gorkha District, potato cultivation has a high socio-economic value, either as a staple crop in the high mountain areas or as an important vegetable crop in the mid-hills. Furthermore, marketing and bartering of seed potatoes contribute to household incomes and diversification of diets. In general, potatoes can be grown on all cultivated land, and GIS technology is applied to analyze the appropriate locations for potato production during optimal growing periods.

This study gained the understanding and appreciation for the application of GIS and remote sensing as a useful and effective tool in the frame of area planning for agricultural development at the district level. The study has not only encouraged the Government of Nepal to establish GIS databases in 47 out of 75 districts, but also promoted the utilization of the existing maps and data for similar applications and development activities in mountain areas in other HKH countries.

Geo-informatics activities under regional collaborative program (RCP-II, 1999-2002)

During the period 1999-2002, ICIMOD will focus on four major activities related to geo-informatics applications and development in the HKH region. These activities are directed towards increasing the capacities of local and national institutions to apply the knowledge generated by ICIMOD and its partner institutions.

1 Regional training in the application of geo-informatics to sustainable mountain development

In view of the rapid technological development and the decreasing cost of information technology, geo-informatics may become a key tool in decision support for sustainable development of the environment and natural resources. Geo-informatics will be used increasingly at the government, non-government, and individual levels. These modern technologies are powerful tools to integrate social, economic, and biophysical data on a common and dynamic platform of interchangeable maps. The objective of this training program is to provide the senior staff of partner institutions in the region with knowledge on the innovations of geo-informatics that are relevant to the key areas of sustainable mountain development. These key areas of training are : Course I : Planning of mountain areas and land use management, Course II : Assessment, monitoring and management of natural resources, Course III : Locational planning of infrastructure and basic services, and Course IV : Analysis of slope instability and hazard mapping.

2 Capacity-building in geo-informatics in national institutions

A large number of institutions are increasingly accepting geo-informatics as a key tool for decision support in planning, management, and management of sustainable development of the mountain environment and natural resources. Since the onset of its geo-informatics program, ICIMOD has gained a reputation for leadership in introducing geo-informatics technology in many mountain development organizations. The objective of this capacity-building program is to sustain initiatives taken by ICIMOD, in particular by continuing the institutional strengthening support provided to selected national institutions in the HKH region. The program has a special thrust on promoting geo-informatics at university-level degree courses and support faculty and students in their research studies and graduate thesis with focus on mountain specificity.

3 Development of essential elements of a regional geo-informatics infrastructure to facilitate access to and use of spatial data

Experiences in the past have indicated that there will be a continuing need to ensure that available geo-information technologies are used in such a way that the information gathered is accessible and compatible. This can be best accomplished within the framework of a geo-informatics infrastructure. In view of the regional geo-political situation, some aspects of database development and dissemination of data may need legal or other rights at the national level. However, ICIMOD plans to make a significant contribution to this infrastructure at the regional level, by giving particular consideration to standardized regional data sets and facilitation of exchange and development of mountain-specific application methodologies. The production and exchange of regional key data sets such as a Digital Elevation Model, land cover, biodiversity inventory, agro-ecological zones, and mapping of snow cover, glaciers and glacial lakes will provide the information quest at the regional level.

4 Geo-information systems and remote sensing technology for classifying and monitoring mountain land use

Over the years, the understanding of macro- and micro-level processes of development in the HKH region has improved, but also new questions and issues have been raised. These relate to the extent to which one can generalize for instance in agriculture. Which are the major crops and what is their coverage? Do crops in one-growth belt face similar problems to those in others? What is the extent and quality of various natural resources

such as water, forests, and rangelands? What is the influence of accessibility, markets and social services? There is an urgent need to develop a systematic classification system for the mountain areas based on these and other important issues, which would make the monitoring of change more reliable and relevant. This program envisages creating a comprehensive database on major land-use systems in the HKH region that can be applied for monitoring changes in environmental stability.

Availability, accessibility and affordability of GIS/RS data

Geo-informatics technology is a tool that has the capacity to deal with dynamic processes. The spatial and temporal changes in the mountain region cover are affected by various factors and can be realized on different scales, from regional scale (1:1,000,000) to large scale (larger than 1:25,000). Several studies, observed on a national scale in Bangladesh, Bhutan, India and Nepal, suggest the existence of 1:250,000 scale data sets in the region. The UNDP-FAO has prepared a District-Wise Land Resources Appraisal of Bangladesh for Agriculture Development on a 1:250,000 scale. Under the Land Use Planning Project in Bhutan, land use maps on national scales of 1:50,000, 1:125,000 and 1:250,000 have been prepared. Under the Land Resources Mapping Project in Nepal, land use maps on national scales of 1:50,000, 1:125,000 and 1:250,000 have been prepared. In India, WiFS data have been used to prepare national scale maps of baseline data sets. And similar other works have also been recorded in other countries, which need to be shared and used for regional development. However, the Region tends to adopt a conservative approach to information sharing.

In view of the recent technological developments, the major obstacles for sharing geospatial data sets are mainly of bureaucratic and political nature. Whereas the stakeholders of geospatial data, including line agencies and other data providers, are well aware of the current development and capability of geo-information and remote sensing technologies, there is still a strong feeling of insecurity towards releasing the existing geospatial information. Most of the regional countries still lack clear policies on data release and utilization of powerful high-resolution satellite data for disseminating new maps and data. There must be a great effort to bring awareness amongst politicians and policy-makers in this regard to enlighten them about the usefulness of these geospatial data and applicability in the decision-making processes.

The HKH Region is blessed with good space technology programs in China and India. To make the GIS/RS data sets easily available, accessible and affordable, it is important to support these programs as well as revitalize the space programs of SUPARCO in Pakistan and SPARSSO in Bangladesh. Countries such as Nepal, Myanmar, and Bhutan should also consider installing low-cost portable satellite data-receiving stations for acquiring Japanese satellite data, which is being promoted at a very low cost or almost free. With its above 100 m resolution, the JERS data could represent the most suitable information for carrying out various research programs and studies in the HKH region. ICIMOD considers that the establishment of a Regional Remote Sensing Center in the host country Nepal, for which the National Space Data Agency (NASDA) of Japan has shown keen interest, may contribute to disseminate the satellite data images at a very affordable cost to all the regional institutions.

Concluding remarks

ICIMOD, through its quest for the promotion of geo-informatics technology and applications in the national institutions, has gained a wide recognition in the HKH Region. While the large size of the region has constrained the small efforts of ICIMOD to reach all the institutions, its experience shows that the amount of information available within the existing systems or from satellite-based technological infrastructure and options, provides opportunities for wider exploration in the region. Under the region's conservative geo-political conditions, major constraints on obtaining spatial information, in terms of availability, accessibility, and affordability for geo-

informatics applications tend to prevail.

It is encouraging to observe that small countries like Bangladesh, Bhutan and Nepal have relaxed their national policies towards making their spatial data sets (up to 1:50,000 scale) available to their respective national institutions, and some RMCs are beginning to obtain 1:250,000 scale data sets. The availability of proper data, right methodologies, human resources and an affordable system are still crucial issues in many HKH institutions. The accessibility issues mostly deal with the lack of communication between organizations, absence of proper data distribution mechanisms *e.g.* meta data, and often sometimes the denial of access to spatial information. Users' unfamiliarity with available spatial data products such as digital geographic data and satellite data may also lead to accessibility problems, as they are unable to realize their potential applications. The affordability issues relate to the high cost of technology and satellite data, which many institutions see as the major constraint for utilizing geo-informatics technology.

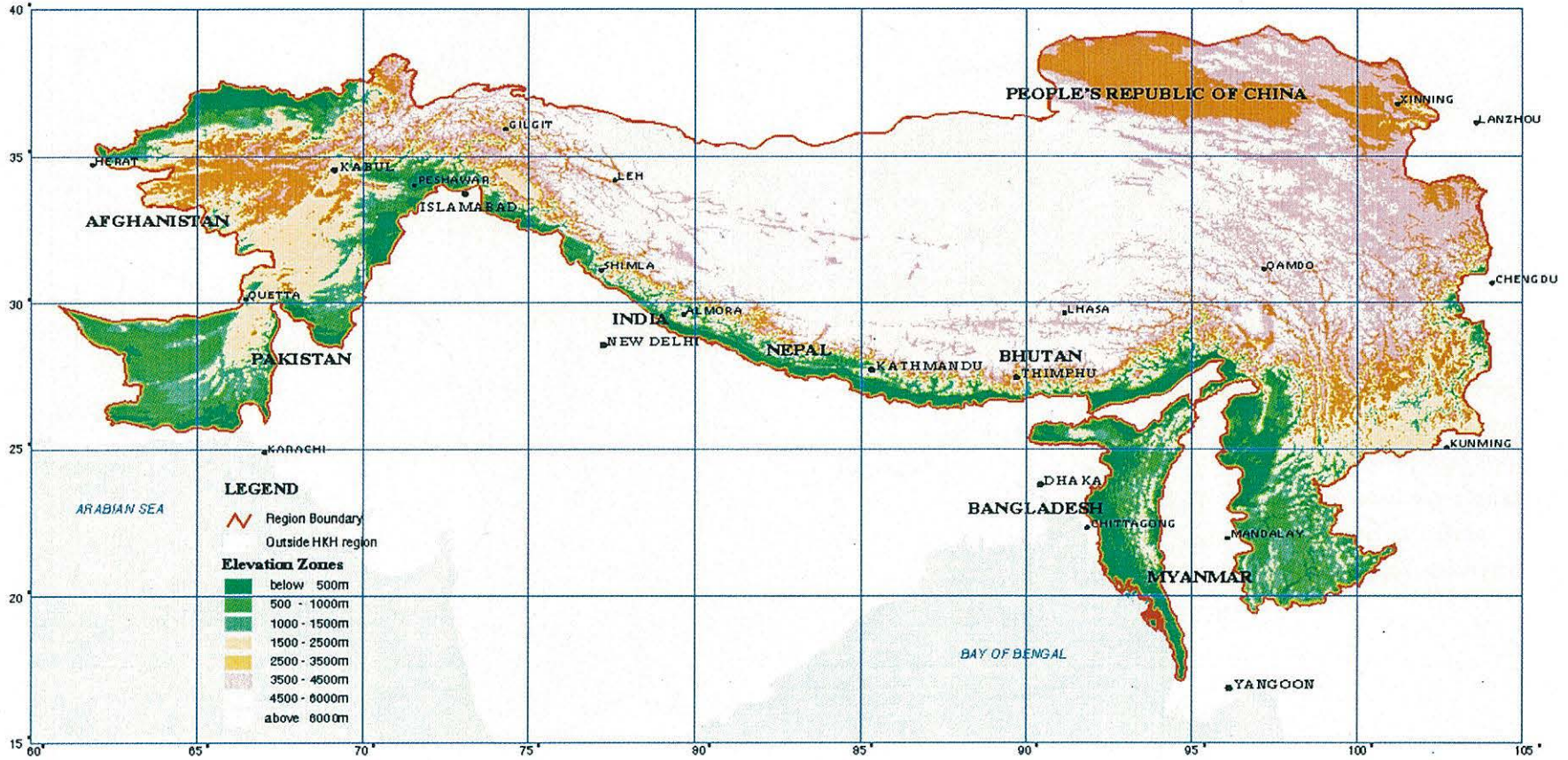
Today, it is widely recognized that the introduction of information technology in general, and a GIS in particular, into organizations can offer opportunities to improve decision-making and lead to more effective and less wasteful administration. The success or failure of GIS implementation is mainly attributed to the organizations' inherent receptivity and the ability to sustain the development of innovations such as GIS. Moreover, a substantial change in the conservative approach to information and data-sharing is necessary. Whereas close collaboration between various data users and data providers is inevitable, the national institutions, controlling the flow and release of GIS-related data sets, must be sensitized to the aspect of data sharing and accessibility issues. Through the use of modern communication such as Internet home pages, national and regional data sets could be easily shared within the region and beyond as well. The multi-media technology could be of great assistance for mass-circulation of information and data. The question here is not of technology but the attitude and approach of national institutions toward data release and availability. ICIMOD, like many other institutions engaged in handling GIS and remote sensing data, has considered that the data users and data providers need to develop concept and access to "data about data" better known as "meta data". It is essential to know which data are available on the national, regional, and global scales. Access to data of different kinds, primarily "ground truth" data to verify remotely sensed data information and other "conventional" data, such as maps and statistics for use in a GIS, remains a major problem. In most of the ICIMOD member countries it is still difficult to release topographic maps and other biophysical maps, with scales larger than 1:250,000. ICIMOD has been addressing these issues through its policy awareness workshops and hopes that the situation may improve in the future, because national and international agencies that collect and manage data have begun to cooperate in the matter.

In the last ten years, ICIMOD has endeavoured to transfer geo-informatics technology to the HKH region with strong support from various donor agencies and regional partner institutions. Its strong network of institutions in the region is ready to promote geo-informatics applications in all spheres of development, research and policies. The need is to support and provide continuity to these efforts at national, regional and global levels.

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Fig. 1 The Hindu Kush-Himalayan Region



Source: GTOPO30 (1 km resolution) USGS National Mapping Division EROS Data Centre
 Note: Some contiguous plain areas have been included in the HKH because of the use of administrative districts in the identification of the HKH region.



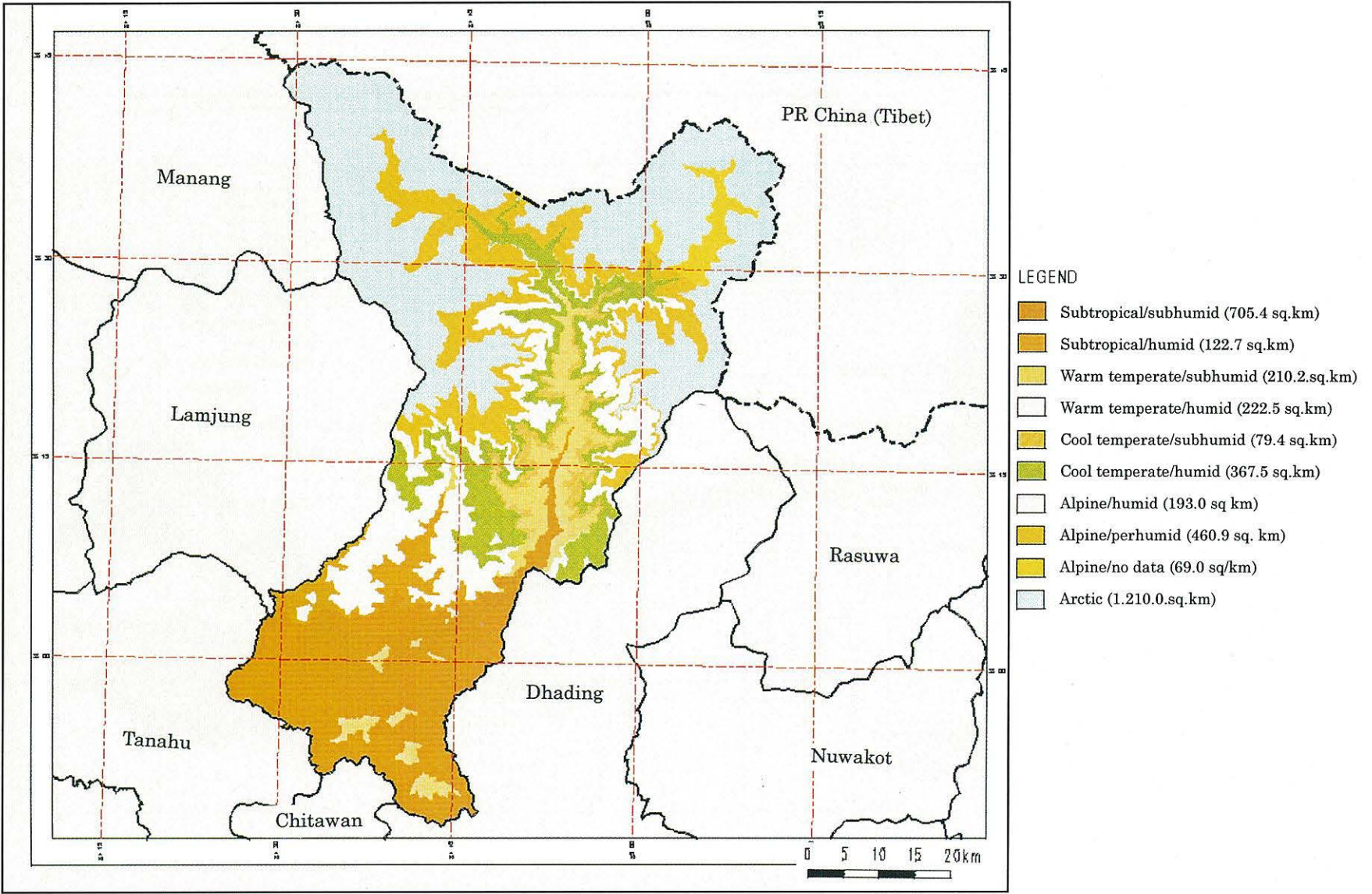


Fig. 2 Agro-Climatic Zonation of Gorkha District (western region of Nepal)