

**NEPAL  
NATIONAL REPROT  
FOR  
PHOTOGRAMMETRY AND REMOTE SENSING  
1992-1996**

Prepared for Nepal Remote Sensing & Photogrammetric Society

by  
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**ABSTRACT**

*The National Report of the Himalayan Kingdom of Nepal outlines activities and new development in photogrammetry, remote sensing, GPS, GIS, digital mapping, education and research related to them during the period 1992-96. The involvement of various organizations is described including government departments, non-government organizations, private companies, consultancy services and end users. An attempt is made to describe on the aspect of application and facilities are mentioned. This report has been prepared from the collection of information written and verbal, replies and responses to questionnaires sent to organizations involved in photogrammetry or remote sensing or both, from published literature and seminar and from the author's personal knowledge of activities in these disciplines, as precise as possible due to page limit constraint as circulated by the ISPRS.*

**1. INTRODUCTION**

The kingdom of Nepal is a landlocked mountainous country in the Himalayan region with an area of 147,181 km<sup>2</sup>. It is situated in between India and China(Tibet), the elevation ranging from 60 meter from MSL to 8,848 meter(Mt. Everest). The kingdom comprises of five physiographic regions having Tarai plain 14%, Siwalik Low Hill 13%, Middle Mountain 30%, High Mountain 20% and High Himal 23%. Nearly 14% of total area of the country is covered with perpetual snow and ice. Within a short distance there is a sharp elevation differences which causes marked changes also to the micro-climate flora and fauna as well. Nepal has nearly 20 million population(with 1.1 million in the Capital Kathmandu valley) with 42% literacy and per capita 165 US\$.

Nepal has different forms of devastating catastrophic hazard zones with its physiographic and human influence such as, Glacial lakes outburst flood, Landslide, soil erosion, land use changes, Earthquake due to tectonic activities underneath the Himalaya, Deforestation, flash flood havoc, river channel course shifting, environment pollution and degradation etc., The effect of catastrophes are directly or indirectly inter-connected in the whole physical, socio-economic and environmental system of the country. Several organizations in Nepal are applying remote sensing data and techniques for natural resources survey, monitoring & management and environmental impact assessment as well.

**2. DEVELOPMENT OF REMOTE SENSING**

The establishment of National Remote Sensing Center in the country through the joint co-operation between HMG Nepal and U.S. Aid in early nineties was a landmark in using remote sensing technology in the field of forestry, watershed management, agriculture, land use classification, geology, hydrology, water resources and glaciers etc. The center in fact was a focal point for remote sensing activities concerning natural resources monitoring and evaluation in the country and it rendered services providing new and better information in the form of imageries, maps and organizing training/workshops as well. The center was equipped with interpretation lab, photo lab, cartographic unit, reproduction section, computer wing, training and technology transfer unit with a number of trained and qualified multi-disciplinary staff.

In the late nineties, the remote Sensing center (RSC) was merged with Forest Survey Division as Remote Sensing Section. It hindered a little bit for the further development of remote sensing activities in some extent. A kind of setback in remote sensing application is felt by the present democratic government of Nepal. Realizing the fact, some arrangement is now being considered to revive RSC and its function upgrading the status and revitalizing the activities. It is hoped that this will help to expand future remote sensing activities in the kingdom, co-ordinating with other concerned agencies and organization both in the public and private sectors. Royal Nepal Academy of Science & Technology (RONAST) will play a facilitating role in boosting the capability and bringing technical people to work together. There is a felt need to expand the application of remote sensing technique for the study of water resources potentiality, snow and glacial movement, havoc of flash flood and monitoring of environment and pollution in the country.

## **2.1 Remote Sensing Application on Forest Survey Division FSD**

The activity of FSD is to develop Forest Resources Information System (FRIS) for the preparation of an inventory of forest. This activity was started with the assistance of FINNIDA. The main objective of the inventory was to assess the forest area and the growing stock of forest and to monitor the changes taken place in the forest cover of Tarai plain belt (20 districts bordering India) from 1978 to 1992. In this study Thematic Mapper (TM) satellite imagery 1991 data with the field sample plot measurements and other digital map data were used for resources assessment. The study has been completed in November 1993. The information obtained were the size of timbers, volume of firewood biomass and also showed that 15 percent of the total forest land of Tarai belt has been changed in non-forest land or deforested during 12 years period. At the end of the study in 1993, FRIS project improved the infrastructure of digital lab necessary for image interpretation and map production, and development of skilled and qualified personnel.

Spot imageries were used for Land Cover Mapping in eastern hill districts of Nepal with visual interpretation technique and through this it was to compare prints of panchromatic, multispectral, principal component analysis and band ratio in terms of their effectiveness. This study resulted 5 major land cover classes i.e. forest, cultivation, scrub, rock and grass. From July 1994 onward FSD is mainly concentrated on FRIS development through forest resources assessment in the hill and mountain regions of 75% of eastern and central Nepal with the assistance of FINNID. It is anticipated to complete the work by the first half of 1996. Remote sensing tool has been used with aerial photographs and satellite imagery based system overlapping frequently used simultaneously.

## **2.2 Department of Mines and Geology DMG**

Remote Sensing Laboratory has been established in 1992 in the DMG. They are using the hardcopy of satellite imagery, Thematic Mapper (TM) Scene on the scale 1:125,000 along with aerial photographs 1:50,000. The methods they are using are the visual interpretation of these images and photos and the ground truthing (verification).

Using remote sensing technique with field verification and ground truthing DMG has completed the works of geological mapping as follows:

- Geological mapping of 500 sq. km. Nuwakot and Sindhupalchowk and 1,500 sq. km. of Makawanpur and Sindhuli districts during 1992-93.
- During 1993-94 ground truthing of 1,000 sq. km. of Baglung, Parbat, Gulmi and Syangja districts of western Nepal had been completed but editing have been remained.
- Completed the geological mapping of an area of 1,000 sq. km. of Myagdi, Parbat and Kaski districts of west Nepal in 1994-95
- Geological Map of Nepal-1994 has been printed and published.
- In the current fiscal year of 1995-96, ground survey of 1,000 sq. km. of the districts of Palpa, Rupandehi, Nawalparasi and Kapilbastu have been completed.

## **2.3 International Center for Integrated Mountain Development ICIMOD**

This organization was established with an objective to promote the development of environmentally sound mountain eco-system operating at the interface between research and development activities along the 8 countries of Hindukush Region. Image facilities have been established in this Center with a view to develop Mountain Environment and Natural Resources Information System (MENRIS) and Geographical Information System (GIS). The PC based as well as ARC/INFO 03.4.2 for GIS applications and read/write magneto optical disc drives are used for storage of satellite image data.

ICIMOD is using Landsat Imageries and data for Environment Impact Assessment (EIA) of the river basin of East Nepal which is flowing from Tibet. At present ICIMOD MENRIS holds various satellite images acquired through Landsat MS, TM and SPOT. Steps are underway to acquire satellite imagery from Indian Space Research organization to enhance its collection of satellite data and materials. MENRIS is exploring possible application for radar satellite technology which is expected to be of particular interest for Hindukush Region.

## **2.4 Department of Hydrology and Meteorology DHM**

Satellite meteorology is being handled by Meteorological Forecasting Division of DHM. The department has facilities in receiving the visual pictures of NOAA and GMS satellites. The main aim is the reception and reproduction of cloud imageries in visual and infra-red forms to forecast and predict the weather.

## **2.5 Application on Thematic Land Resources Mapping by Department of Survey DS**

This department had used the Landsat imageries to prepare land use and resource maps of above 4,600 meter height and aerial photographs were used for lower part of the High Himal area in bygone days. DS has used satellite images in some extent in 1994 only for comparison with the aerial photographs of high altitude areas during the preparations of basic topographical maps of eastern Nepal.

## **2.6 Geology Department and Geography Department of Tribhuvan University TU**

Landsat and SPOT images and data have been used in research and study purposes by the department of Geology and Geography of T.U. in the context of writing thesis and dissertation in master degree level courses candidates.

## **2.7 Application on the Study of Snow and Glacier**

The mapping and monitoring of snow and glacier in Nepal are very important in order to predict run-off from their melting. Due to sudden movement and fall of avalanche in Thyangboche-Pheriche area of Mt. Everest Khumbu region, 16 persons including foreign trekkers and Nepalese Sherpa guides lost their lives during November 1995. Geography Dept. of T.U. has conducted research work on glacial environment of Rolwaling Himal Dolakha Area using remote sensing digital data in collaboration with ITC the Netherlands in 1993 and 1995. Geology Dpt. has monitored and measured the speed of Khumbu glacier in 1993.

## **3. DEVELOPMENT OF PHOTOGRAMMETRY**

Aerial photography have been taken in the regional basis in course of the preparation of basic topographical maps and also in patch up basis for the planning of development projects such as road, irrigation, forestry, watershed management etc. Photogrammetric methods are applied specially for basic map preparation. Followings are the purpose, area, date and scale of the aerial photographs:

**3.1 Preperation of Basic Topographic Maps** of East Nepal (Six Zones of Eastern and Central Development Regions) in 1992 on the scale 1:50,000 with the assistance of FINNIDA. Photogrammetric techniques are adopted for mapping.

**3.2 Telecommunication Network Planning** of Kathmandu Valley in 1992 on the scale 1:10,000 with DANIDA assistance. Digital data and maps have been prepared. GPS receiver was mounted on board during aerial photography flight for positioning to facilitate the photogrammetric work.

**3.3 Road Alignment Planning of Gaighat, Diktel Okhaldhunga and Salleri area** in 1992 on the scale 1:25,000.

**3.4 Forest and Rural Development** of Chitwan Hetauda, Parasi, Butwal, Gulmi, Arghakhanchi, Siraha, Sunsari, Damak and Ilam areas in 1992 with the scale 1:10,000.

**3.5 Irrigation Development** of Bagmati Plain area in 1993 with the scale 1:20,000.

**3.6 Assessment of Flood Disaster** of some district of Tarai area in 1993 on the scale 1:42,000 and 1:50,000 and to make rehabilitation program.

**3.7 Water Induced Disaster Prevention** of Kulekhani, Bhainse areas in 1994 at the scale of 1:20,000.

**3.8 Town Development of Pokhara** Urban area and Phewa Lake area in 1994 at the scale of 1:10,000.

**3.9 Expansion of Tribhuvan International Airport** area for the facility of Civil Aviation in 1995 at the scale of 1:4,000.

**3.10 Watershed Management Study** of Kaski, Parbat and Arghakharchi districts for JICA in 1996 on the scale 1:25,000.

**3.11 Preparation of Basic Topographic Maps** of West Nepal (eight zones of Western, Mid-Western and Far Western Development Regions) just started in early 1996 on the scale of 1:50,000 with the assistance of FINIDA. Photogrammetric methods will be applied for mapping.

## **4. DIGITAL MAPPING**

Digital mapping activities in Nepal is not so much expanded due to technical and financial difficulties. In the past digital map of Mt. Everest area was prepared by Boston Museum of Science, U.S.A. with National Geographic and Swiss Air Photo Surveys Switzerland. Followings are the main activities in the field of digital mapping:

**4.1 Digital Mapping of Kathmandu Valley** for Nepal telecommunication cable network development by DANIDA (KAMPSAX) in 1993. Digital data and map printout on the scale 1:1,000 - 2,000.

**4.2 Digital Topographic Mapping Pilot Project** of some districts of Tarai and Middle Mountain areas (12 map sheets) on the scale 1:25,000 in 1995-96. This is being prepared in survey Department by FINNMAP financed by FINNIDA. In future, Survey Department is planning to make topographical base maps in digital form as far as possible.

**4.3 Digital Mapping of Tribhuvan International Airport area** have been prepared in 1995 for the extension of facilities by Civil Aviation Dept.

**4.4 Orthophoto Map** of Mahakali Irrigation project and Bhirahawa-Lumbini Ground Water Project have been prepared in 1991-92 by Auto Carto Consult Company.

**4.5 Digital Geological Mapping.** The Dept. of Mines and Geology is engaged in building the digital data sets for the country and transforming all its manual cartographic procedures into an automated system.

## **5. GLOBAL POSITIONING SYSTEM (GPS)**

Nepal has entered into the age of satellite geodesy in the fiscal year 1991-92 with the collaboration of the University of Colorado, U.S.A. Followings are the list of GPS WORKS:

**5.1 GPS Control points** for mapping to expand and strengthen the geodetic network and for the study of crustal deformation were monumented, observed and processed in the fiscal year 1991-92 for the first time in Nepal initiated by Survey Department with the collaboration of University of Colorado (CIRES) Boulder, U.S.A. Altogether 27 points were monumented and observed all over Nepal from east to west and Tarai plain to high mountain including the fundamental station at Nagarkot. Along with the GPS work, fundamental gravity stations were established and measured at Nagarkot and two more subsidiary gravity stations at Tribhuvan International Airport and Simra. On most of those 27 stations, GPS re-observations were made during October 1992 collaboratively. In 1993 no measurement was done due to rude idea, behaviour and lack of knowledge of the then Director General of Survey of Nepal, even though it was tried to convince him that technically Nepal Survey may take a motion of retardation in the development of technology. In 1994 March-April, it was remeasured only at Nagarkot station managed separately by the Nepalese survey operators not to stop the pace of development in GPS activity. It was also monumented a subsidiary satellite station and observed to co-relate with the Nagarkot fundamental station precisely for future works. In 1995 GPS work was revitalised due to new appointment of a technical minded Director General. During October-November 1995, GPS observations were carried out in 26 stations traversing north-south from Syangboche to Saptari including previous points, old Survey of India Stations and some more new points.

**5.2 GPS for Topographic Mapping** was conducted in 1992 to prepare topo maps (1:25,000) of Lumbini zone (6 districts) with the assistance of JICA. Also GPS technology was used to establish control points for topographic mapping of 6 zones (35 districts) of eastern Nepal on the scale 1:25,000-50,000 in 1992-1993 by FINNIDA.

**5.3 GPS Observation for Geo-physical Research** was carried on in Mt. Everest Khumbu region in 1992 and re-observed and monitored during 1993, 1994 and 1995 for the study of deformation and heightening of Everest region by Boston Museum of Science U.S.A. and Bhumichitra Mapping Company Nepal. Also slope distance of the top of Everest from Namche Station was measured by EDM laser beam.

**5.4 GPS Works by the Italian Everest -K2 -CNR Project** were carried out for the study of Geodynamic Evolution of the Highest Peaks of Himalayan Chain with collaboration of RONAST during Sept.-Oct. 1992. This Italian team had done GPS campaigns at Kodari friendship Bridge, Dhunche and Lobuche Pyramid during fiscal year 1991-92 jointly with Nepal and China for the study of geodynamics and crustal deformation.

**5.5 GPS to Determine Amount of Vertical and Horizontal Movements to Understand seismic hazard** was initiated by DMG with the collaboration of National Center for Scientific Research (CNRS) France. It aims to assessing in detail the active process of the Himalayan mountain, responsible for the present deformation, erosion and quaking of the range. GPS field observations have been completed in November 1995 on 30 different locations covering all zone of the Himalayan mountains from the High Himalaya (Simikot and Jomson) down to Tarai plain (Bhairahawa to Mahendranagar).

**5.6 GPS for Watershed Management and Soil conservation** was conducted to establish necessary control points in 1995 in Syangja and Gulmi districts by JICA to prepare resources maps of that area.

**5.7 GPS Observation for West Seti Hydro-Electric Project area** were carried out to fix the control points for mapping jointly by SMEC/Auto Carto Consult/Bhumichitra Mapping Co.

**5.8 GPS for Civil Aviation** is carried out at the Tribhuvan International Airport in 1992 and 1995 for the purpose of the determination of exact height of airport runway.

**5.9 GPS for Cadastral Survey & Mapping** has been carried out sequentially from 1993 to this date of 1996 to establish the different orders of geodetic control points to provide the grided sheets for cadastral operation in Gulmi, Arghakhanchi, Parsa and Jhapa districts by the Department of Survey.

**5.10 GPS for Forest Demarcation** is being considered to get the exact position of the demarcation pillars as to facilitate accurate pixel location on the ground and get meaningful and correct information of some districts of Tarai plain area at first.

## **6. DEVELOPMENT OF GEOGRAPHICAL INFORMATION SYSTEM (GIS)**

GIS activities are expanding and increasing since the last five years. Originally it was started as Land Information System (LIS) and it developed into GIS in broader aspect to build up data base and information on both bio-physical and socio-economic aspects for the development of natural resources and infrastructure. Most of the GIS systems are based on micro-computer available in Nepal and maintenance of these systems are carried out by local private companies. In Nepal, several external agencies have been supporting GIS technology dissemination and implementation to plan and formulate various development projects. GIS is being handled by various government agencies in their field of interest.

**6.1 National Planning Commission (NPC)** has worked as the nodal agency for GIS in Nepal since 1992. It has a GIS cell which is involved in dissemination activities. National GIS Steering Committee has been formed under the chairmanship of the Honourable Member (Science & Technology) of NPC. This committee is active in policy formulation, guidance and implementation of GIS in Nepal.

**6.2 Mountain Environment and Natural Resources Information System MENRIS of ICIMOD**, has collected data and information on both bio-physical and socio-economic aspects of the Hindukush Region through case study approach and builds up at least one district level digital data base of each eight countries. Major sources of database are inhouse digitized data sets, remotely sensed data sets and sets received from outside agencies. A systematic and gradual build up of basic data sets of this whole region is expected finally. It has the capability to aggregate district level data sets to a national GIS data base. Also it has GIS digital data base of Jikhu Khola Watershed study area.

**6.3 Geographic Forest Resource Information System, (GFRIS)** has been developed from July 1994 onward to assess forest in the hill and mountain regions of the country in Forest Survey Division with the assistance of Finnida. Its main objectives are to prepare National Forest inventory and maps to establish proper database system, to develop appropriate inventory methodology for the allocation of land to community forest, leasehold forest, national forest delineating the total forest areas.

**6.4 GIS Unit in the Dept. of Mines and Geology (DMG)** has been established in 1992 in connection to the preparation of geological mapping. DMG is engaged in building the digital data sets for the country and transforming all its manual cartographic procedures into an automated system with an assistance of GTZ.

**6.7 Agricultural Project Service Center (APROSC)** has established a GIS center in preparing an Agro-Ecological Zoning/farming System study using GIS for agricultural planning and development of Nuwakot district in 1992. It was also engaged in preparing digital road network data sets for western and far-western regions of Nepal during 1993-94.

**6.8 Nepal Telecommunication Corporation (NTC)** is using GIS to establish digital base for large scale mapping of Kathmandu Valley in 1993 for the planning and design of telecom network, utility services, drinking water supply, sewerage and garbage management, road and traffic management, health and education facilities, municipal development works urban and housing development.

**6.9 Geography Department of TU** has started a GIS Center in 1994 to establish database for the study of natural resources and environment in master degree courses. GIS laboratory is established with the support of UNEP and ICIMOD and has PC based ARC/INFO and IDRISI software.

**6.10 Department of Land Survey, Integrated Land Resources Mapping Unit** is using GIS to slowly transform all the analog data into digital format. Formerly it had data on IDRISI system and now since 1995 MENRIS is assisting in establishing a GIS to adopt ARC/INFO system for existing land use and resources data and the department's cartographic applications as well.

**6.11 Ministry of Land Reform & Management** had applied the land information system for the Land Revenue Department for data base of land titling, ownership land classification, land ceiling, assessment of government and public land etc. as a pilot project in some of the district including mainly Bhaktapur. Now the ministry has undergone to establish an Integrated Land Information System in 1996 to formulate planning policy and future program of land reform in Nepal.

**6.12 GIS in Private Sector**

- Auto Carto Consult has established in 1993 a LIS database of Lalitpur Sub-Metropolis of ward number 16 having house numbering, types of houses, population, religions.
- Bhumichitra Mapping & Land Development Company has started in 1995 to establish a GIS data base of Kathmandu Metropolis, ward number 10 and 32. It's purpose is to prepare Ward Development Map to have cultural preservation and to make a future plan of development to solve environmental pollution, sewerage, garbage, problems and utility purposes.

**6.13 Mercantile Communications Pvt. Ltd.** has established a network communication systems connected Kathmandu to Singapore over a higher speed link, thus providing a gateway into the internet. The main services currently put into use are E-mail, On-line Communication and Netscape to access WWW. Until now four Nepalese Newspapers (daily and weekly) have been entered into Internet.

**6.14 German Technical Co-operation (GTZ)** is engaged in several projects to establish GIS data e.g. Melamchi-Kathmandu Water transfer, Identification of small hydel power plants (Master Plan Project), rural development planning (Gorkha), carrying capacity of Land (Dhading) etc.

## 7. EDUCATION AND TRAINING

There are not so many institutions who conduct training, research and education on remote sensing even though they are listed as below:

**7.1 Remote Sensing Technology Training** is imparted by Remote Sensing Unit of Forest Survey Division. It has interpretation lab, photo lab, reproduction unit and has a facility of both manual and micro-computer based digital interpretation.

**7.2 Photogrammetric Training** is offered by the Survey Training Center of Survey Department. It provides Junior and Senior Surveyor Courses with aerial photo interpretation, photo verification, aerial triangulation and how to make maps with aerial photographs. It has stereoscope, plotters and other equipments.

**7.3 GIS Training** is conducted by several organization. Among them are:

**7.3.1 MENRIS of ICIMOD** imparts GIS training to the organizations of the Hindukush region and provides hardware and software facilities as well in some extent to establish GIS center. MENRIS provides a forum where the professionals engaged in GIS activities meet, discuss and co-operate.

**7.3.2 Geography Dept. of T.U.** is conducting GIS training courses with the help of MENRIS. It is disseminating the technology through case studies. It operates GIS courses for other organizations as well. It has introduced remote sensing and GIS technology in its curriculum.

**7.3.3 Agricultural Project Service Center (APROSC)** is engaged in disseminating the GIS technology through inhouse training of its professionals affiliating with WINROCK International.

## 8. SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

There are a few active and key organizations related to remote sensing, space application, GIS etc. as follows:

- Royal Nepal Academy of Science & Technology (RONAST), Bijuli Bazar P.O. Box 3323 Kathmandu, Nepal.
- National Council for Science & Technology (NCST) under T.U. Kirtipur, P.O. Box 1030 Kathmandu, Nepal
- Nepal Surveyor Society, P.O. Box 3109 Kathmandu, Nepal
- Nepal GIS Society, P.O. Box 3837 Kathmandu, Nepal
- Nepal Geological Society, P.O. Box 231 Kathmandu, Nepal
- Nepal Geographical Society, T.U. Kirtipur Kathmandu

## 9. PUBLICATIONS

- MENRIS Bulletin, RONAST Newsletter, Nepal Surveyor (Journal), Nepal Geological Bulletin

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