

NATIONAL REPORT OF BANGLADESH

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KEY WORDS: Bangladesh, Photogrammetry, Remote Sensing, GIS, EGIS, SOB, SPARRSO

ABSTRACT

The complex and dynamic environment of Bangladesh, its susceptibility to natural hazards and heavy dependency on natural resources makes spatial information a crucial ingredient for the development process. The existing communications infrastructure is inadequate to support efficient collection and dissemination of information. Therefore, activities related to photogrammetry, remote sensing and spatial information science have been developing over the past three and a half decades. During the nineties, increasing numbers of development activities within the country and tremendous technological advances worldwide have caused a major increase in the use of these technologies. Practical applications of remote sensing products started filling the gaps in available up-to-date information. Huge amounts of spatial and attribute information are being digitized in order to make best use of GIS technology for enhancement of planning and management capabilities in the country. The nineties have also seen a large increase in local professionals capable of dealing with these technologies. However, the activities are still mostly limited to government organizations and donor funded projects. The major agencies that have been working in these fields are SPARRSO, SOB and EGIS.

1 INTRODUCTION

As the first National Report of Bangladesh for the International Archives of Photogrammetry and Remote Sensing this report describes in brief the developments in remote sensing and photogrammetry activities in Bangladesh so far. Although remote sensing was introduced in Bangladesh in the late sixties, its institutional recognition came with the establishment of SPARRSO, the Space Research and Remote Sensing Organization of the Government of Bangladesh in 1980. SPARRSO has since been operating as a research and development agency working on applications of remote sensing in different sectors. EGIS, the Environment and GIS support project for water sector planning has played a major role over the last decade in the application of remote sensing technology with specific emphasis in the water sector. In the field of photogrammetry, the leading agency is the Survey of Bangladesh (SOB) which uses aerial photographs to carry out national level surveys. Other agencies have also been developing large spatial databases and analytical capabilities to serve their own purpose and mandate in different sectors. This report summarizes the activities of the major organizations in Bangladesh working in related fields.

2 SPACE RESEARCH AND REMOTE SENSING ORGANIZATION (SPARRSO)

2.1 Introduction

SPARRSO is an autonomous organization under the Ministry of Defense of the Government of Bangladesh. Its major objective is to apply remote sensing technology to surveying the natural resources and monitoring the environment and natural hazards in the country. It operates and maintains satellite ground receiving stations, conducts research and develops capabilities for both visual and digital interpretation of satellite and airborne data for applications in various sectors. It advises the government on matters related to space science and remote sensing. It also provides data and services to government and non-government organizations engaged in development and policy-making activities. Total number of personnel is 190 which includes scientists, engineers, technicians and administrative staff.

The history of remote sensing technology in Bangladesh dates back to 1968 when the first Automatic Picture Transmission (APT) Station was set up. With NASA's launch of the ERTS-1 satellite, the Bangladesh ERTS Program, one of 35 Principal Investigator Programs worldwide, was initiated in 1972. Subsequently renamed the Bangladesh Landsat Program (BLP), it was basically building institutional and technical capability in Bangladesh for remote

sensing activities. A major activity of BLP included the generation of the first landuse/landcover map of the entire country using Landsat MSS data of 1979. During this period, GMS and NOAA ground receiving stations were made operational. The BLP became SPARRSO in 1980 under an expanded budget of the Government. UNDP, French Government and USAID continued supporting SPARRSO's build up. Between 1980 and 1983, a LANDSAT/SPOT ground receiving station along with a VIPS digital image processing system was set up under French support, but unfortunately did not become operational. In 1983, under the UN/ESCAP Regional Remote Sensing Program, SPARRSO became the national focal point for space and remote sensing activities in Bangladesh.

Under its Agro-Climatic Environmental Monitoring Project (ACEMP) sponsored by USAID in the early eighties, SPARRSO acquired complete digital image processing system including the necessary hardware and software. Scientists and engineers were trained in hardware, software maintenance and image processing techniques.

2.2 Routine Monitoring Activities

Bangladesh being highly prone to tropical cyclones, tornadoes and heavy monsoon rainfall, many of SPARRSO current activities are concerned with meteorology and climatology.

The Advanced Meteorological Satellite Ground Station (AMSGS) receives data from Japanese Geostationary Meteorological Satellite (GMS-5) and NOAA series of polar orbiting satellites. The data from GMS-5 is acquired on an hourly basis and is used to study the large-scale atmospheric processes and the dynamic features of the weather in the entire region covered by the satellite. The NOAA AVHRR data is collected on a 6 hourly basis. The GMS-5 and NOAA AVHRR images are regularly analyzed to identify the rain bearing clouds from cloud top temperature, tornado cells, depressions and tropical cyclones. As the Bay of Bengal is a well-known breeding ground for tropical cyclones, once a cyclone is identified it is continuously tracked. The hourly images from the satellite are used to produce animated motion pictures of the cyclone which help in forecasting its track. The weather monitoring data and forecasts are disseminated to different user agencies, e.g. the Bangladesh Meteorology Department, Disaster Management Bureau and the media for disaster preparedness. The catastrophic cyclones of 1970, 1985, 1991 and 1994 were monitored in near real time using GMS and APT and NOAA AVHRR data.

On an operational basis SPARRSO provides crop maps (Figure 1) and acreage estimates by analyzing NOAA AVHRR imagery to the Ministry of Food and Agriculture in support of their Early Warning and Food Monitoring System. Post flood crop damage estimations are also performed and district-wise statistics are provided on crop damage. Large-scale flood mapping and monitoring is performed regularly using NOAA AVHRR and flood maps are provided to relevant government agencies.

2.3 Research Activities and Application Projects

Remote sensing technology is being applied in different sectors, for example forest cover mapping and monitoring, landuse/landcover mapping, mapping of water resources, agriculture, fisheries studies, coastal zones and marine environment studies, geology, meteorology and climatology. A few of SPARRSO's notable projects of the past four years are briefly described below:

SPARRSO is developing a model for rainfall estimation from cloud-top temperature of tropical cyclones in the country. A model is also being developed for long-term climate variability and its consequences in crop production in relation to the El-Nino/La-Nina phenomena.

A research project was conducted on "Remote Sensing Study of Marine Environment in the Bay of Bengal with ADEOS Data", with support and cooperation from NASDA and UN/ESCAP. The objective was to monitor the marine environment in the coastal areas using ADEOS-1 data. The work involved the development of algorithms for estimation of turbidity, sediment concentration, chlorophyll concentration and sea surface temperature in coastal areas.

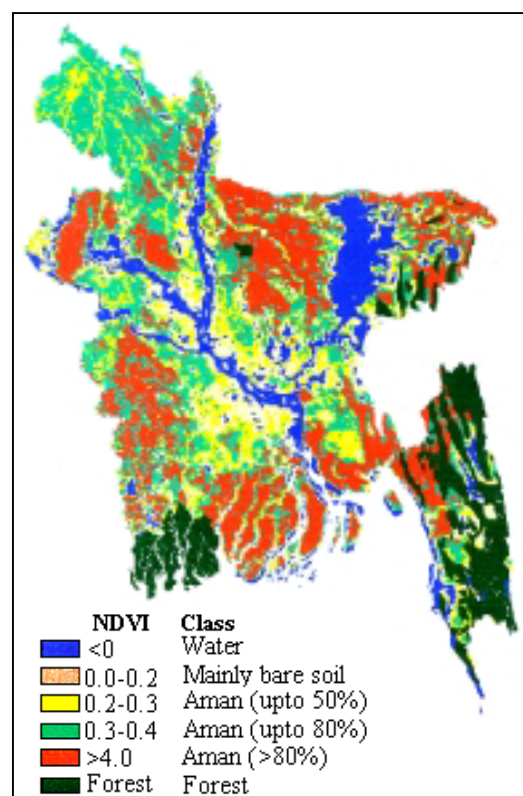


Figure 1. Rice (*aman*) map of 1999 based on NOAA AVHRR image (26th October 1999).

In 1998, SPARRSO conducted a flood mapping and monitoring project with RADARSAT images under an Applications Development Research Opportunity (ADRO) project of the Canadian Space Agency. Following the flood, a project was conducted, again using RADARSAT data to study the progress in post-flood agricultural rehabilitation.

SPARRSO in collaboration with Indian Space Research Organization (ISRO) is conducting a project on "Coastal Zone Development and Fishery Environmental Analysis using Remote Sensing Techniques" with funding from UN/ESCAP. The objectives are to develop a database, prepare an inventory of coastal resources, and to develop a package for sustainable coastal zone development emphasizing coastal aquaculture and environmental management.

2.4 Facilities

Apart from the GMS and NOAA ground receiving stations, SPARRSO facilities include Microvax 3400 Computers, Pentium III PCs, ERDAS Imagine, PC ARC/INFO and IDRISI. It has a well equipped photographic laboratory, photogrammetric equipment and groundtruth equipment.

2.5 Available Data

SPARRSO has a large archive of historic satellite images of Bangladesh from 1972 onwards. Entire country coverage with Landsat data of 1984 and 1988, and a large number of images of the early nineties are available. SPARRSO continues to acquire, process and analyze images for various end users. Color infrared photographs of the whole country dated 1983-84 are available at a scale of 1:50,000.

2.6 International Cooperation

SPARRSO participates in and is strongly supported by the UN/ESCAP Space Applications Program for Environmentally Sound and Sustainable Development in Asia and the Pacific. It is a member of the Asian Association on Remote Sensing (AARS) and the Inter-Islamic Network on Space Science and Technology under Organization of Islamic Countries. It has also developed close collaboration with NASA/NOAA of USA, CNES of France and NASDA of Japan.

The main obstacles to optimal satellite data use at SPARRSO is the high cost of satellite data which restricts regular availability. High cost of ground stations and prohibitive access fees prevent the real time acquisition of high resolution satellite imagery which are much needed for mapping and monitoring the environment.

3 THE SURVEY OF BANGLADESH (SOB)

The Survey of Bangladesh (SOB) is the national surveying and mapping agency under the Ministry of Defense. The organization employs over nine hundred employees working in different fields of surveying, mapping and photogrammetry. Among them are twenty five professionals with specialized training in photogrammetry from foreign institutes.

Major activities of SOB include: the establishment of trigonometrical and primary geodetic control network; ground survey; and the preparation, revision and updating of topographic maps of the entire country at different scales. It is the custodian of all aerial photographic negatives and is responsible for their control, processing, development, printing and maintenance. It carries out large scale contour surveys and also produces various thematic maps.

The topographic maps of the entire country at 1:50,000 scale are updated every 5-7 years. The production and updating of maps are done by land survey, photogrammetry and satellite image interpretation. Photogrammetric methods were introduced in SOB through a UNDP assisted project in 1964. From that time onwards, SOB has updated a large number of topographic maps of the country at scales of 1:50,000 and 1:25,000 by photogrammetric methods. Aerial photographs covering the entire country are available of 1974-75 (scale 1:30,000), 1983-84 (scale 1:50,000) and 1999-2000 (scale 1:25,000). Their use requires clearance of army headquarters.

Recently, digital photogrammetric equipment have been procured and SOB has generated orthophoto of the capital city, Dhaka and the surrounding areas. Plans are under way to expand the digital photogrammetric section. The available equipment at SOB include: GPS receivers, Total Station, digital levels, tidal stations, stereo-plotters (analogue, analytical and digital), high resolution matrix scanner, photo processing machine, offset printing press.

With the technical assistance of IGN of France, SOB has in 1998 incorporated remote sensing technology. IDRISI, ER- Mapper, Multiscope are in use to process acquired digital satellite data. Presently, base map updating is being done digitally with the help of SPOT satellite images. SOB is working on generation of a digital topographic database at a scale 1:50,000 and it targets to complete the coverage of the entire country by the year 2000.

SOB works in cooperation with national organizations like SPARRSO, Bangladesh Bureau of Statistics (BBS), Directorate of Land Records and Surveys (DLRS) and international organizations like Japan International Cooperation Agency (JICA), IGN of France, ITC of The Netherlands and Ordnance Survey of England.

4 ENVIRONMENT AND GIS SUPPORT PROJECT FOR WATER SECTOR PLANNING (EGIS)

4.1 Introduction

A range of environmental and GIS projects initiated in 1991 under the Flood Action Plan (FAP) of Bangladesh were integrated into a single Environment and GIS Support Project for Water Sector Planning (EGIS) in 1995. It is a project under the Ministry of Water Resources funded by the Government of the Netherlands. EGIS has a team of 40 professionals specializing in GIS, remote sensing, databases and different disciplines of the environment who work together to produce integrated environmental studies and provide spatial analysis support to planning, monitoring and management of natural resources, the development of databases for the water and environment sectors and training in environment and spatial analysis.

In the year 2000, EGIS will be converted to the Center for Environmental and Geographic Information Services (CEGIS), an independent institute under a Board of Trustees with a majority representation of public agencies. CEGIS services will be available to both the public and private sectors and will include: consultancy, research and development, and training.

Over the last decade, EGIS has developed capabilities in terms of expertise, hardware and software for digital image processing, GIS analysis, building digital spatial databases, GIS modelling, differential GPS surveys and metadatabases. It strives to introduce new and improved data sources, e.g. SAR and high resolution optical imagery, and develop applications and outputs such that they can be of practical use for planning and management in Bangladesh.

4.2 Research Activities and Application Projects

4.2.1 Flood mapping and monitoring with SAR. Floods inundate 30 percent of the country in normal monsoon years, and occasional excessive floods inundate more than 60 percent of the country. Because of dense cloud-cover during the monsoon flooding period, SAR has proven to be the most reliable tool for mapping and monitoring the dynamics of the flooding process. EGIS carried out research in 1993 (FAP19, 1995), 1996 (EGIS, 1997) and 1997 (EGIS, 1998) using the European ERS-1 and Canadian RADARSAT-1 SAR images (under ADRO funding) and developed a methodology to map open water flooding. Results from RADARSAT SAR show over 90 percent agreement with field observations for the open water class derived from digital classification. During the catastrophic floods of 1998, RADARSAT ScanSAR Wide and ScanSAR Narrow images, covering almost the entire country, were used in near real time mode. Flood maps showing open water flooded areas and percentage of area flooded (Figure 2) were produced for disaster management and relief distribution.

4.2.2 RAPIDS ground receiving station. RAPIDS, a low-cost, small sized, easily transportable, PC based ground receiving station was set up for the monsoon of 1999 for nine months to receive ERS SAR images for demonstrating near real time flood mapping and monitoring. A large archive of multitemporal ERS-2 images both in ascending and descending mode were collected for a major part of the country and processed in near real time. The images were applied in flood extent and depth mapping (Figure 3), crop and shrimp farm

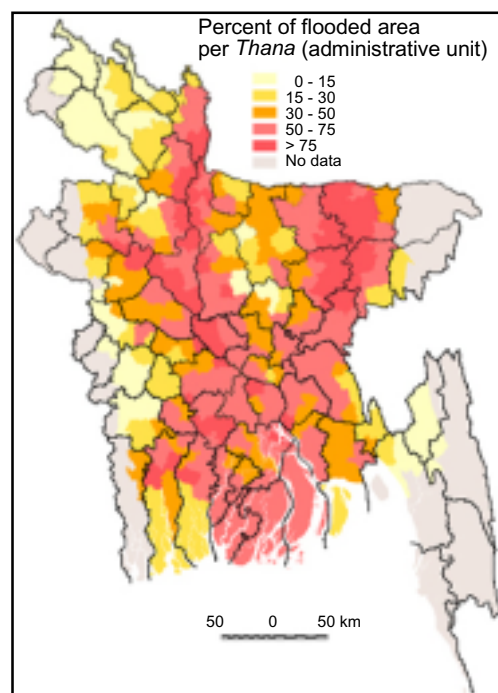


Figure 2. Flood map derived from RADARSAT images

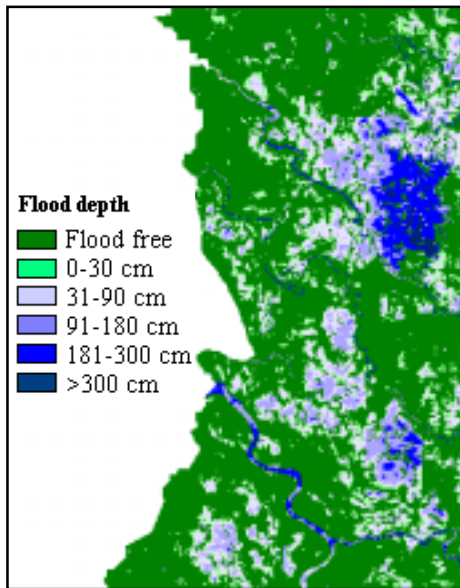


Figure 3. Flood extent and depth from ERS-2 SAR (31st August 1999) and DEM

mapping. The station was set up at SPARRSO and the project was carried out in collaboration with SPARRSO, NLR and SYNOPTICS of The Netherlands with funding from the European Space Agency.

4.2.3 Floodplain research. In 1998, a pilot study area in north central Bangladesh was selected and methodologies have been developed for computing flood extent, depth and duration using a time series of ten RADARSAT F3 SAR images, digital elevation model, GIS data and hydrological information. Land use/land cover patterns were generated from the SAR images with the support of ground truth information. The output of this study can be used to assist in the planning and management of floodplain resources in Bangladesh.

4.2.4 River morphology dynamics. EGIS has set up a River Morphology and Resource Information System (RMRIS). The RMRIS has a spatial database and analysis capability for storing and analyzing multi-temporal satellite images (Figure 4), historical maps, topographic data, hydro-morphologic data of the major rivers of the country. On an operational basis, it supports the maintenance of a number of bank protection, flood control and infrastructure projects along the rivers by providing spatial data on bank erosion, accretion, char (bar) development and river channel migration. Predictions of planform developments are made based on channel and char geometry from dry season satellite images for taking precautions against possible severe attack of the river on bank protection structures constructed by the Bangladesh Water Development Board.

4.2.5 Landuse zoning. A study is in progress to determine and compare the landuse suitability and current landuse practices for the southwestern part of Bangladesh. Landuse suitability is being developed based on the physical parameters like soil and water while current landuse is being derived from Landsat TM, IRS PAN and ERS-2 images. Outputs are being analyzed in an ArcView environment. Socio-economic data will be collected to explain these discrepancies.

4.2.6 Remote sensing and GIS support to Environmental Impact Assessments (EIA). Several Environmental Impact Assessments of water sector projects are supported and strengthened by using remote sensing data and spatial analysis capabilities. An example is the EIA study of the Gorai River Restoration Project which aims to increase dry season flow in the river and reduce salinity intrusion from the Bay of Bengal. Remote sensing and GIS techniques are used for data on channel networks, communication infrastructure, settlements, landuse patterns, seasonal and perennial waterbodies and flood extent maps derived from Landsat TM, IRS and RADARSAT satellite imagery. The remote sensing data are also used for monitoring the environmental impacts as predicted in the EIAs. GIS based models are prepared to present predicted environmental impacts of different alternative interventions and scenarios.

4.2.7 The National Water Resources Database (NWRD). EGIS is the main executing agency in the development of the NWRD for the Water Resources Planning Organization. The NWRD consists of themes such as hydrography, geology, soils, topography, demography, flood depth, agroclimatic data, infrastructure and

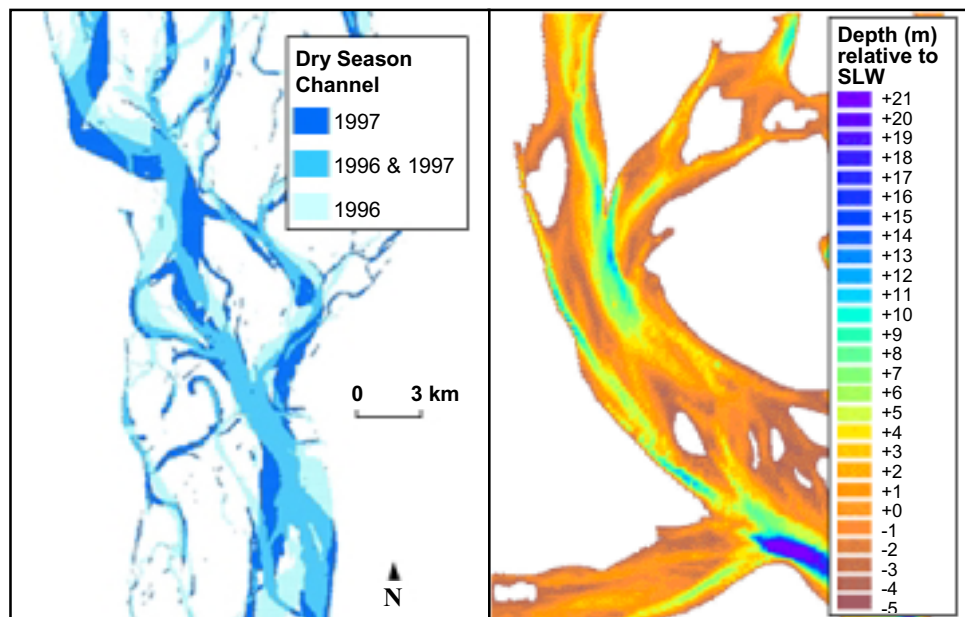


Figure 4. River erosion and morphological change are quantified through multitemporal presentation and analysis (left) and with river bathymetry mapping (right).

administrative boundaries. EGIS has developed the only existing national DEM from spot heights at 300m intervals.

4.3 Training

Training courses are offered in ARC/INFO and ArcView to both public and private sectors. Curricula are being developed for training to be provided in ArcView and Spatial Analyst using local databases suitable to local needs. EGIS and ITC have jointly conducted two refresher courses for regional ITC alumni in 1998 and 1999 on "Natural Resources Management Using GIS and Remote Sensing Tools". EGIS professionals undergo periodic training in GIS and image processing software to keep abreast with technological development.

4.4 Facilities

EGIS computer base consists of Windows NT 4 servers, Pentium II PCs running under Windows NT4 Workstations, Digital Dec Alpha Workstations with UNIX along with plotters, printers and digitizing tablets. The GIS and image processing software include ARC/INFO NT, PC ARC/INFO, ArcView, ArcView Spatial Analyst and ERDAS Imagine. Differential GPS is used for GPS surveys.

4.5 National and International Cooperation

EGIS works in collaboration with the agencies in the country which are the major spatial information providers and/or users, e.g. SPARRSO, SOB, BARC, BBS, LGED for having a better exchange of ideas and expertise for a more harmonious development.

EGIS is facilitating the creation and operation of a functional geographic information infrastructure network between spatial data users and data providers in different sectors and different layers of government. The aimed activities of Bangladesh Geographic Information Infrastructure (BGII) are: establishment and management of metadata, standardization of data, establishment of policy on availability and prices of data, formulation of joint standard for quality control, creation of communication network links between databases

EGIS works in cooperation with international agencies such as RADARSAT International, Canada, Space Imaging, USA, National Remote Sensing Agency (NRSA), India, Asian Institute of Technology (AIT), Thailand as well as ITC and National Aerospace Laboratory (NLR) of The Netherlands.

5 OTHER ORGANIZATIONS

5.1 Local Government Engineering Department (LGED)

Local Government Engineering Department's prime mandate is to provide technical support to local government bodies for planning and implementation of development program. LGED has started to prepare planning maps with local level information of rural infrastructure in the early 80's. It established a GIS set-up in its headquarter in early nineties with a view to facilitate development of nationwide spatial database for rural infrastructure and to enhance institutional capability for planning and monitoring of rural development programs in Bangladesh.

The GIS unit has completed digitization of *Thana* Base Map at 1:50,000 scale for the whole country which comprises of various layers including administrative boundaries, physical infrastructure, educational institutions, settlement pattern and other agriculture and socio-economic infrastructure based on nationwide coverage of SPOT panchromatic satellite imagery of 1989. *Thana* is the lowest administrative tier of the Government. These maps became an important tool in the nationwide training campaign introducing basic planning methods to the members of locally elected bodies. It has developed a number of GIS based planning tools to be used by the decision makers at the local level.

With technical assistance from International Center for Integrated Mountain Development (ICIMOD) based in Nepal, LGED has organized six international training courses on GIS through which, a total of 60 professionals, both in public and in private sector, have been trained.

5.2 The Bangladesh Agricultural Research Council (BARC)

The Bangladesh Agricultural Research Council (BARC) is a coordinating agency of all the national agricultural research organizations and aims to facilitate the formulation of agricultural policy guidelines of the government. It is executing a project "Utilization of Agro-ecological Zones Database and Installation of GIS for Agricultural

Development” initiated in 1996 with support from UNDP and FAO. The main objectives of the project is to create a National Agricultural Land Information System Database in GIS environment to fulfill the agricultural planning and research needs.

An important activity was to convert the Land Resources Inventory (LRI) which is a compilation of agro-ecological zones data base of the entire country consisting of data on soils, land resources, climate and inundation to GIS format. The inventory consisting of more than forty themes, at a scale of 1:250,000, related to agricultural planning had been developed starting in the early eighties but was not geographically referenced. An automated system has now been developed to display, query and produce maps from the database. For pilot areas GIS based crop or cropping pattern suitability application has been developed based on the revised crop suitability rules, updated climatic layers incorporating inundation layers. A GIS based decision support system is being developed using cropping pattern suitability and socio-economic factors to assist in agricultural planning and research.

The project has a GIS setup with ARC/INFO, ArcView, IDRISI as the key GIS software for the project. Six professionals with expertise in GIS and database management work with agricultural scientists to develop spatial analysis capabilities in the agricultural sector.

5.3 Directorate of Land Records and Surveys (DLRS)

DLRS is entrusted with the mandate to carryout periodical cadastral survey and settlement operations for preparing, updating and publishing land records of every piece of land of the country. It is a government organization responsible for preparation of maps and ownership records. The entire set of land related data published by DLRS are grouped as follows: “Record of Rights” containing cadastral maps and record of ownership rights, land use, etc. which are published and used as legal tenure documents, “Thana administrative maps” and “Data on agriculture and livestock”.

The actual work processes and the technology were introduced in the 1880s. DLRS has recently started the huge task of updating cadastral maps and land ownership records with improved accuracy. In the late nineties, it has initiated a number of projects at a pilot level to perform digital cadastral surveys and mapping using modern ground survey technologies such as survey-grade dual frequency GPS receivers, Total Stations, photogrammetry and GIS technology.

The vision set-forth under the modernisation efforts is to build up a comprehensive Land Information System (LIS) for Bangladesh where information on every piece of land will be available digitally for public and departmental use.

5.4 Bangladesh Bureau of Statistics (BBS)

The Bangladesh Bureau of Statistics (BBS) is the national statistical organization responsible for collecting, compiling and disseminating statistical data relating to a wide variety of sectors. BBS carries out population census every decade as well as agricultural census, household surveys for sample sites and maintains and updates the national database including all sectoral information by administrative units in digital form. Its large conventional cartographic section is gradually being automated with GIS and remote sensing support. It now has a PC ARC/INFO and ArcView based GIS set up for presentation and simple analysis. BBS has acquired monochrome aerial photographs of 1999-2000 of the northern two thirds of the country, which will be used in combination with GPS surveys and GIS for mapping of enumeration areas for the census of 2000.

6 ACADEMIC INSTITUTIONS

Department of Geology, Dhaka University, has established a remote sensing laboratory initially with an ERDAS Imagine based system in 1999 in order to offer courses on remote sensing for the Masters students. Masters thesis students and faculty members will also use this facility to carry out research on geological problems.

Department of Geography & Environment, Dhaka University, started its GIS laboratory in 1993. Remote sensing and GIS courses are offered at undergraduate and graduate level. Short certificate training courses are offered in PC ARC/INFO. On going research includes landuse change and bio-ecological mapping. Facilities include PC ARC/INFO, ArcView with Extensions, IDRISI and ILWIS software.

Department of Geography and Environmental Studies, Rajshahi University, set up its remote sensing and GIS facility in 1993. Courses are offered to undergraduate and graduate students, and students at Masters, M.Phil. and Ph.D. level also conduct research. Research is carried out on landuse change, environmental impact studies and urban planning. The facilities include IDRISI for Windows, PC ARC/INFO, ArcView, Cartalinx and Popmap.

Department of Geography and Environment, Jahangirnagar University, offers courses for undergraduate and graduate students in remote sensing and GIS. It also offers short training course on GIS and remote sensing. The GIS and remote sensing laboratory is equipped with PC ARC/INFO, ERDAS Imagine software with sufficient hardware support.

Department of Water Resources Engineering, Bangladesh University of Engineering and Technology (BUET), in 1998 introduced a course on remote sensing and GIS for Masters students with assistance from Delft University, The Netherlands. Research activities include studies on river morphology and hydrological parameter estimation. Laboratory facilities include PC ARC/INFO, ArcView with extensions and the necessary hardware support.

7 CONCLUSIONS

Starting in the mid 1960s, photogrammetry and remote sensing in Bangladesh has been growing at a moderate pace but was limited to specialized national agencies until recently. Widespread use of the technology began in the nineties with the establishment of smaller agencies in different sectors working to meet their own needs for spatial data and analysis. This was assisted by a dramatic increase in development activities and revolutionary changes in the spatial information sciences. A good network between these agencies needs to be established for avoiding duplication of efforts and enhancing smooth exchange of data and expertise.

The overview of the establishment and current activities of the organizations presented here shows that much of the work still largely depends on foreign funds because of the high cost of the technology. Initially most of the work was performed and managed by foreign experts. Over time, many nationals were trained both at home and abroad in related fields and have taken up technical as well as managerial aspects of the activities.

Operational applications of remotely sensed information is growing and as the traditional methods of collecting reliable field data is not time and cost effective, it appears to be the best alternative for Bangladesh. Opportunities are even more with the introduction of higher resolution satellite images. However, high costs of image data and technology restrict their use in a developing country like Bangladesh. Improvements in this context will certainly enhance an even wider scale application of the spatial information sciences for sustainable integrated development.

ACKNOWLEDGMENTS

The author gratefully acknowledges the contributions of Tarik-ul-Islam, LGED, Hasan Ali, BARC, Chapal Choudhury, Infoconsult and Mir Abdul Matin, Quazi Khalid Hassan and Dr. Khaled Hasan of EGIS to the writing of this report. The support of Rob Koudstaal, Team Leader, EGIS and his review of the report is highly appreciated.

Dr. M. U. Chaudhury, Advisor, EGIS, provided valuable information on the history of remote sensing related activities in Bangladesh. Dr. A. M. Choudhury, Dr. Nazmul Haque and Meherunnessa Begum of SPARRSO contributed with information on the activities of SPARRSO. Acknowledgment is due to Dr. M. Fazlul Bari, BUET, Dr. Raquib Ahmed, Rajshahi University, Nasreen Islam Khan, Dhaka University and Khondaker Shariful Huda, Jahangirnagar University for providing information about their respective departments. SOB is acknowledged for providing information about its activities. The assistance of Ahmadul Hassan, Maminul Haque Sarker, Mohammad Hossain, Syed Aneeqa Shireen and Sayeefur Rahman Rizvi of EGIS is appreciated.

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