

## EGIS plans new project: Environmental Monitoring and Information Network (EMIN)

EGIS is launching a project on Environmental Monitoring and Information Network (EMIN) in conjunction with RADARSAT International (RSI), Canada. Endorsed by the Ministry of Water Resources and funded by CIDA, the project aims to improve water and natural resources management in Bangladesh through an enhanced and accessible information network using satellite imagery and advanced information technologies. The project is to be executed in two main phases, with the 12-month long pilot phase launched in May 2001, and the second phase to commence in July 2002 for three years.

Flooding, drought and erosion endanger this country's crucial agricultural and fisheries sectors. Therefore, it is essential to manage the natural resources of Bangladesh more efficiently. To do this, enhancements in flood and erosion monitoring are desperately needed, as well as supply of reliable and timely information to stakeholder groups for improved decision-making. In view of this situation, EMIN has been conceived to improve access to information and communication among national and local organizations.

The first phase of EMIN had three goals: to meet with project stakeholders and conduct a detailed needs analysis; demonstrate the benefits of improved access and sharing of water resource data to stakeholders; and to develop prototype Decision Support Tools (DSTs). During the second phase of EMIN, the DSTs will be expanded and integrated into a Water Management Practices component in the information network. EMIN II will link and coordinate the efforts of several key agencies such as, BWDB, FFWC, DAE, WARPO as well as NGOs and international projects.

The core of the information network will be a Geographic Information System (GIS) which will manage multiple data sources including remote sensing imagery, existing geo-spatial data, and hydrological models. The interface for the network will be a web portal, and customized access levels would be assigned to different user groups.



A workshop was organized in Dhaka by EGIS on 'EMIN': Strengthening Governance and Communication in Bangladesh's Water Sector' on January 23, 2002. The Hon'ble Minister for Water Resources Engr. L.K. Siddiqi, and His Excellency Mr. David Preston, High Commissioner of Canada in Bangladesh are seen in the picture. See page 4.

### Contents

- ♦ New Project: EMIN
- ♦ EGIS-UNICEF initiative
- ♦ EGIS client services
- ♦ DRAS
- ♦ Workshop on EMIN
- ♦ Activity update
- ♦ Satellite Images
- ♦ Issue in Focus: IEM
- ♦ Metadata - a new concept



## EGIS-UNICEF initiative in arsenic affected Upazilas

EGIS has undertaken a four month long project on "Logging of well locations, preparation of maps and design of national approach to GPS/GIS use". This is one of the UNICEF funded initiatives to conduct location surveys of approximately 65,000 tube wells in three Upazilas, namely, Bhanga, Sirajdikhan, and Muradnagar under the districts of Faridpur, Munshiganj Comilla, respectively. The project objectives are to assess the viability of the survey method of using a single hand held GPS, as well as understand the spatial pattern of arsenic contamination of these areas by linking arsenic test results obtained by other NGOs with location data, and to explore the resource needs (equipment, time, etc.) and cost estimate to carry out the activity in a wider scale. To date, EGIS has received 20 GPS receivers, GIS databases and well test results from UNICEF. A detailed modular approach methodology is being implemented along with field monitoring. The expected project outputs include maps of all the unions of the three upazilas and A3 size maps of the three upazilas showing well arsenic contamination, along with a report documenting field experience under the project, and recommendations for wide scale implementation.

## WMAs participate in developing Integrated Water Resources Management Plans



An Environmental and Social Impact Assessment (EIA and SIA) of the Khulna-Jessore Drainage Rehabilitation Project (KJDRP) was conducted by EGIS during 1997-'98. The study revealed that it would be useful to adopt a Tidal Basin Management (TBM) option to solve the problem of drainage congestion in the southwestern part of Bangladesh where the project is located. The recommendation of implementing a TBM option has been accepted by the Bangladesh Water Development Board (BWDB).

As a follow up of the previous study, EGIS is currently involved in assisting the local level Water Management Associations (WMAs) in putting together their own versions of integrated water resources management plans for their respective zones (there are nine WMAs for nine different zones). The approach in this context has been to stimulate discussions within each of the WMAs in a way that they themselves identify their water resources problems. They have also been encouraged to suggest their own solutions to the identified problems in conformity with the findings of the EIA and SIA study.

The WMAs, after the initial rounds of discussion sessions with EGIS, have come up with plans for their individual zones. The Water Management Federation (WMF), which represents the interest of all WMAs, is expected to integrate the zonal plans to address the overall needs of water resources management in the area.

As before, EGIS is going to play the role of a facilitator in the exercise. In this way, it is expected that a draft integrated regional water resources management plan can be put together by the people of the area by about the middle of 2002. Such a plan could then be shared with professionals in relevant government and non-government institutions as well as with other stakeholders. Once the feedback is received from them, each WMA can revise its own plan and the WMF can make the final integration. It is hoped that this process will be completed by the end of 2002, which will produce the desired output in the form of an integrated water resources management plan for the region.

## EGIS Client Services

EGIS provides the following services to its clients:

**SYSTEM DESIGN:** Provides assistance in systems design for database management systems. Services include applications needs assessment; user needs assessment; software, hardware and platform identification; and network, software and hardware installation and configuration.

**DATA CAPTURING:** Provides assistance in data capturing to build GIS database from digital and hardcopy satellite images, aerial photos, hardcopy maps, and field surveys.

**GPS SURVEY:** Uses GPS surveying to geo-reference existing hardcopy maps, satellite images and aerial photos since the Global-Positioning System (GPS) is currently used as one of the primary methods to accurately capture positional data. EGIS also provides consultancies in identifying optimal survey methods.

**TRAINING:** Conducts specialized GIS and RS software training independently and in collaboration with ESRI, South Asia. Provides training on ArcInfo for NT (Core, GRID, TIN, AML), ArcView GIS, ArcView Spatial Analyst, ArcView Avenue, ERDAS Imagine, Visual BASIC with MapObjects, and Internet Map Server. EGIS is the only authorized PC ArcInfo training center in Bangladesh.

**DATABASE DEVELOPMENT:** Provides expertise in the development of large databases, including database structure design and implementation; quality assessment and refinement of existing data for satisfying organizational need; and development of data standards (accuracy, unit, format).

**HARDWARE:** EGIS has a 100 users NT Network in operation. The computer base consists of five Windows NT servers and a mix of NT4 and 2000 servers. There are 70 Pentium III brand computers running under Windows NT4 Workstation and Windows 2000 Professional, two Digital Dec Alpha Workstations running under UNIX, and one wide carriage large format (54") heavy duty raster plotter using RIP technology. This plotter can print A4 to 54" as width up to 150' long as length. The average plot time of an A0 image is less than 10 Seconds with photo quality. EGIS also has two other large format (36") raster plotters and two pen plotters. There are Digitizer Boards of three different sizes (one A0, one A1 and A3) for digitizing maps. There is an A3 colour laser printer and five A3 black and white laser printers with duplex printing facilities along with two color DeskJet printers. All these equipment are connected to the central network.

**SOFTWARE:** EGIS uses licensed copies of the latest version of the software for GIS, RS, database and programming. The ArcInfo NT version 8.0.2 is used for GIS data analysis, manipulation, and metadata search and data management. For customized GIS application development, ArcView 3.2, Visual BASIC and Map Objects are used. EGIS has 10 licenses for ArcInfo NT, 16 licenses for PC ArcInfo, 26 licenses for ArcView. It has ArcView GIS extensions, ArcView Spatial Analyst, Image Analyst, 3D Analyst, and MapObjects

For software development and connectivity the Visual BASIC, Visual C++ and Microsoft SQL Server 7.0 are used. For image processing and analysis EGIS has the ERDAS Imagine 8.4 and Developer Toolkit and for metadata management it has the GeoKey 3.0. EGIS uses GPS and DGPS surveying to geo-reference existing hardcopy maps, satellite images and aerial photos. EGIS also provides consultancies in identifying optimal survey methods.

# DRAS - Methodology for drought assessment & management in Bangladesh

EGIS has developed a drought assessment and management methodology that could be applied at the national level. Given the situation where the intensification of agricultural practices and reduced water availability conditions have gradually converted Bangladesh into a drought prone country, EGIS decided to develop a practical drought assessment methodology and corresponding tools that could be applied at the national level to facilitate the management of present and future agricultural practices. Rainfall distribution and soil characteristics are the major contributors to the susceptibility of the country to drought. EGIS is particularly concerned that in the absence of a national level drought management methodology the balance between water demand and supply would deteriorate further.

DRAS (DRought ASsessment) is a computer based computational framework linked with GIS analytical tools. The model has been deemed successful as it has provided results which fairly corresponded with the reality of the seven thanas selected for the study. Ultimately, the thana level findings will lead to the creation of a national database which would help agricultural planners in preparing a sustainable irrigation management plan. DRAS appears to be dependable in successfully bringing the results and findings from the grassroots level to the national level.

The results and findings from the thanas show the drought vulnerability of Bangladesh, particularly that of the western part which is significantly more at risk. The results further show that severity decreases towards the northern and eastern parts of the country. Surface water availability is meager in the dry season, while groundwater availability in most of the studied thanas remains at a satisfactory level with respect to the present crop water demand. If all the potential irrigable areas are taken under intensive irrigation practices, the available groundwater may not be a sustainable resource in most of the places. Nevertheless, future irrigation development potentials are better in the northern part of the country than in the south.

## Transferable technologies for drought management

The study has identified DRAS as an effective tool for site specific on-farm water management and for a disaster management plan at the national level.

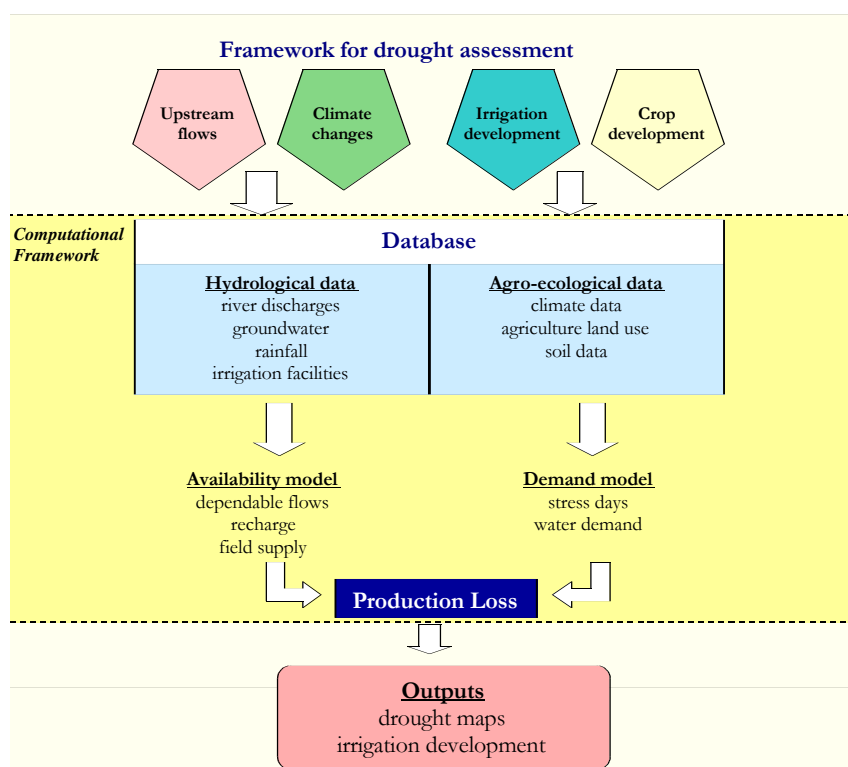
For drought management, it is essential to economize the use of irrigation water as water stress in a dry year, which causes drought and consequent yield reduction of crop, can be mitigated with application of irrigation water. The quantity of irrigation water and the timing for its application as well as the critical period for major crops are important information. The DRAS model can provide all this information to the farmers so that they could ensure water supply for periods when rainfall is inadequate. The model may be also used for assessing the loss in crop production in a particular dry year and the information can be utilized by planners in preparing a disaster management plan for the affected parts of the country.



## Future applications of DRAS

For thana development: A thana guide could be prepared on the net irrigation requirement of different crops, as well as drought assessment maps and irrigation schedules for different seasons. The guide could be made available at the thana development agencies for the adoption of drought management practices.

For national level application: A national drought assessment plan, based on respective thanas, could be made for the whole country. The work could be started with the most vulnerable area, which is likely to be the western part of the country. The findings of the model could be used for NWMP in adopting strategies for the development of sustainable irrigation.



DRAS - Drought Assessment Framework

## Workshop on EMIN

A workshop was held in Dhaka on the 23rd of January 2002 on *EMIN: Strengthening Governance and Communication in Bangladesh's Water Sector*. The objectives of the workshop were to inform the participants about the concept of EMIN, its goals and objectives, as well as to demonstrate tools and approaches for improving communication between stakeholders and to build consensus on recommendations for the operational use of EMIN tools for the implementation phase.

Participants at the workshop included representation from the Ministry of Water Resources, national level organizations, projects, local level organizations and NGOs. The participating organizations were those who are concerned with the applications, tools, products and outputs related to flood, erosion, agriculture (water related), fisheries, and communication network and infrastructure.

The focus of the workshop sessions were on issues like, participatory analysis of the current strength of communication relationships among water and natural resources stakeholders, and participants' desire for improvements, as well



as on formulating recommendations for communication mechanisms and tools that could lead to desired improvements in stakeholder communication. The participants were also asked to rank the most appropriate relationships, mechanisms and tools to improve communication relationships.



Small group exercises were arranged in which participants drew stakeholder communication maps, identifying relationships that they thought required improvement, and suggesting communication mechanism and tools that they thought would help strengthen those relationships.

**A number of important points have emerged from the workshop.** Firstly, the participants expressed their belief that Bangladeshi dimensions have to be added to the generation and provision



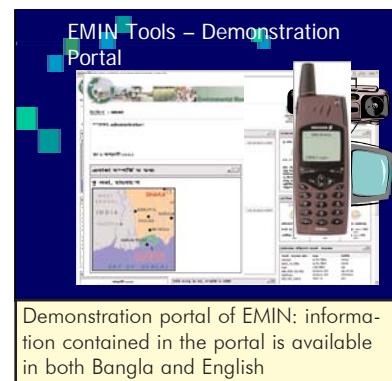
EMIN team members, first row (left to right): Scott McConnell, Badal Md. Faruque, Erin Johnston, Md. Hasan Ali, Nilmini Wijavakoon, Ahmadul Hassan. Second row (left to right): Gord Rigby, Shahed Kamal, Mir Abdul Matin, Sid Tupper, Kevin Jones, Jeff Woodward

of any information if it is to prove useful to local people. The real issue to be considered is ensuring that people derive the expected benefits of the process of information dissemination. Furthermore, in making forecasts of different kinds, it is felt that it would be necessary to make it

area specific to the extent that the information can be used effectively in making decisions that matter to people. It was pointed out that it would prove extremely useful to provide flood predictions over the submersible embankments in the northeastern region of the country, and also that the need was to provide a greater lead-time in forecasting floods since forecasts that do not give enough time to make adjustments to cope with the eventualities are not of much practical use.

Emphasis was also given to timely prediction on weather conditions to help make decisions regarding crop cultivation. It was pointed out that with appropriate information made available to policy-makers, measures could be devised for coping with erosion events and for taking up rehabilitation initiatives. It was agreed that new technologies should be explored in making information more useful and accessible, but that there is also the need to find out which other agencies are involved in similar exercises to avoid duplication of work and to fill existing gaps. But, the 'political' dimension of the generation and dissemination of information must be handled as certain institutions might feel that their domain is being intruded upon.

**The tasks now for EMIN II** are to finalize tools based on recommendations from the first phase. Operational tools are also to be developed and tested at national and local agencies. EMIN II will take up capacity building of national and local agencies by providing hardware/software and training. During this phase feedback on the tools will be obtained for their refinement, operationalization, integration and implementation. The expected benefits at national level are improved communication among agencies, improved tools for water resources management and monitoring, enhanced capability of institutions, and improved ability to fulfil their mandates. With regard to local agencies, the benefits are expected to include improved access to information through communication, reduction in risk due to flood and erosion, better coordination on a regional/ local basis and with national agencies, and improved decision making at the local level by local government agencies, NGO's and end users.



Demonstration portal of EMIN: information contained in the portal is available in both Bangla and English



Left to right: Mr. Mukhlesuzzaman, Director General, BWDB, Mr. Faisal Ahmed Chowdhury, Secretary, Ministry of Water Resources, Mr. David Preston, High Commissioner of Canada in Bangladesh, Mr. Giasuddin Ahmed Chowdhury, Director General, WARPO, Engr. L.K. Siddiqui, MP, Hon'ble Minister for Water Resources.

## Activity Update

**Mauza database:** For the exercise of building a seamless mauza boundary for Bangladesh, EGIS is now in the process of rubber sheeting the districts with the international boundary and mosaic-ing the rest of the districts into a seamless database. A separate database will be maintained where all other information like district code and name, thana code and name, union code and name, and mauza names will be present. DLRS JL numbers have been incorporated which will help to establish a relationship between the DLRS maps and spatial database. Here, geocodes will act as a linkage with the spatial database.

**KJDRP study:** There has been substantial progress in the three sub-components (Monitoring; MIS/COMMIS development, and Integrated Water Resources Management Planning) of the present EGIS study on KJDRP "Monitoring and integration of the environmental and socio-economic impacts of implementing tidal basin management in the project". Started in May 2001, the study is expected to be completed by December 2002. To date, the inception work plan report and the first quarterly monitoring report have been submitted. The annual monitoring report of the study is scheduled to come out by mid January 2002. The training and consultation sessions carried out for the transfer of knowledge and dissemination of findings to project beneficiaries and professionals are also progressing well.

**Mapping the Jamuna - Meghna River erosion:** This project was designed to provide Remote Sensing/GIS support to the Jamuna Meghna River Erosion Mitigation Project of the Water Development Board. The major tasks of this project involved image procurement, georeferencing, classification and GIS analysis to produce channel migration maps of the Jamuna River along project areas of the Pabna Irrigation Rural Development Project (PIRDP) and the Meghna-Dhonagoda Irrigation Project (MDIP). All activities of the phase have been completed successfully, with the deliverables submitted on time. HAL-CROW DHI WAPCOS and Associates have requested EGIS II to undertake the same sort of activities in the next phase with Landsat images of 2001/2002. The output of this phase would also include a brief short-term prediction report of the Jamuna River along the PIRDP project area. Image processing of archived images and the search for new images continue under the project.

**Remote Sensing Support for PDO-ICZM & MES II:** All activities of the phase have been completed successfully, with the deliverables submitted on time. A proposal is being prepared for similar kinds of activities for the year 2001-2002. This time, a request has been received for procuring more images in addition to the previous six image frames. The project design for this phase is underway.

**Jamuna Bridge Area Mapping:** The fourth year of the project is running. The Landsat 7 ETM+ image of November 2001 has been selected for mapping the Jamuna Bridge Site for the November - December phase. Image procurement continues. Products are expected to be delivered within the first week of February 2002.

**Training:** During the July-December 2001 period, the main training courses were on spatial analysis. EGIS entered into an agreement with UNICEF to offer six courses on ArcView GIS from November 2001 to March 2002. Two courses for twenty professionals, mostly medical professionals selected by UNICEF, were organized in November 2001. An ArcView spatial analyst and a Digital Global Positioning System course was also organized for the EGIS professionals. Another course on environmental awareness was organized for policy planners, professionals and officials from the government and private sector organizations, academic and research institutes, universities, NGOs and individuals. In all, there were 32 participants attending the course. The fish-GIS course on the application of GIS on fishery data planning and management was attended by participants from the Bangladesh Agricultural University, the Fisheries Department and Caritas.

In the planning period of January to June 2001, the emphasis was on offering courses that are demand driven and market oriented. During this period, EGIS has also offered advanced presentation and computer graphics courses for the first time.

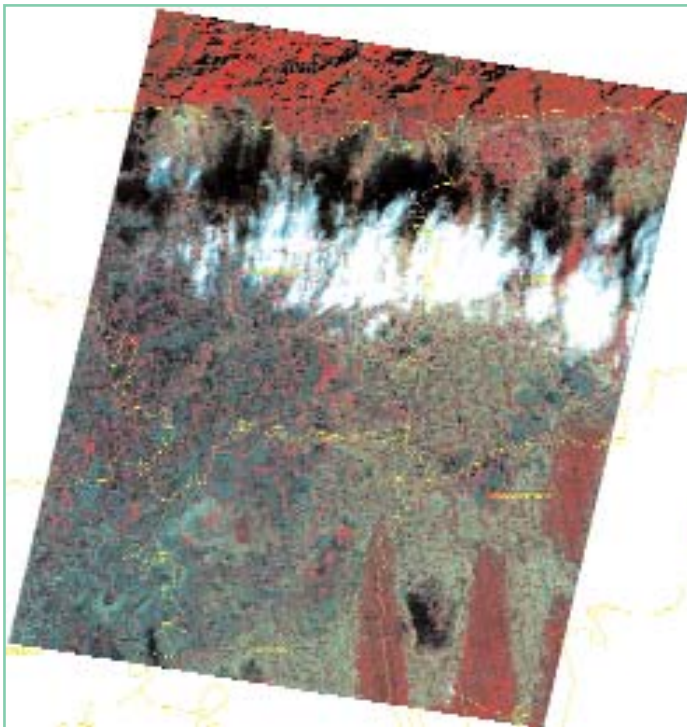
| Courses during July - December 2001 |                   |              |
|-------------------------------------|-------------------|--------------|
| Course                              | Period            | Participants |
| ArcView                             | 22 - 31 July 2001 | 11           |
| ArcView Spatial Analyst             | 12 - 19 August    | 23           |
| Fish GIS                            | 14 - 21 October   | 9            |
| Environmental Awareness program     | 25 October        | 32           |
| ArcView (unicef)                    | 04 - 07 November  | 9            |
| ArcView (unicef)                    | 12 - 15 November  | 12           |
| DGPS (Logging of well location)     | 26-27 December    | 22           |
| Total                               |                   | 118          |

| Courses planned for January-June 2002                               |               |              |
|---|---------------|--------------|
| Course  | Period        | Participants |
| ArcView (UNICEF)  | January 2002  | 12           |
| ArcView (UNICEF)  | January 2002  | 12           |
| ArcView (UNICEF)  | February 2002 | 12           |
| ArcView (UNICEF)  | February 2002 | 12           |
| EIA course (reviewers)  | February 2002 | 12           |
| Environmental awareness program                                     | January 2002  | 25           |
| Environmental awareness program                                     | March 2002    | 25           |
| Environmental awareness program                                     | April 2002    | 25           |
| Advanced presentation course with examples on environmental issues  | February 2002 | 12           |
| Computer Graphics and office based desktop printing and production. | June 2002     | 12           |
| EIA course (practitioners)  | May 2002      | 15           |

# Satellite Images processed by EGIS



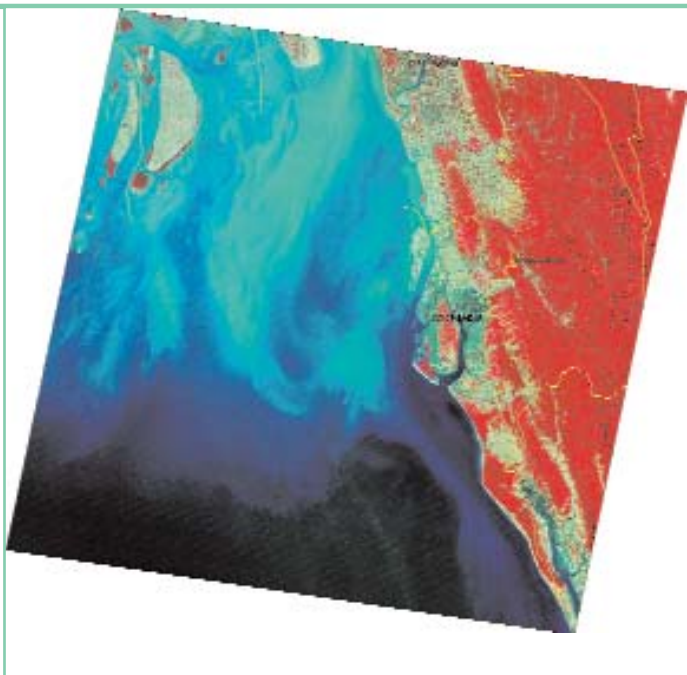
**Image Information:**  
 Sensor: AVHRR,  
 Location: Bangladesh  
 Remarks: Georeferenced to BTM



**Image Information:**  
 Date: 28-Dec-72  
 Path: 147  
 Row: 43  
 Sensor: MSS  
 Location: Sylhet Quarter Scene  
 Format: X  
 Bands: 1,2,3,4  
 Remarks: Entire image rectified  
 Source: FAP 6



**Image Information:**  
 Date: 30-Jan-99  
 Path: 139  
 Row: 43  
 Sensor: TM  
 Location: Ganges  
 Format: BIL  
 Bands: 4,3,2  
 Remarks: Major River areas rectified  
 Source: WARPO/NWMP



**Image Information:**  
 Date: 19-Jan-97  
 Path: 136  
 Row: 45  
 Sensor: TM  
 Location: Lower Chittagong  
 Format: BIL  
 Bands: 4,3,2  
 Remarks: Entire image rectified  
 Source: EGIS/CARE

## Integrated environmental management

Integrated management implies that the desired mix of outputs from the natural system is maintained over time. In connotation with "sustainable", this implies that the integrity of the natural system is at least maintained, economic development is stimulated and the quality of life improved.

Historically in Bangladesh, the focus in the management of the water resources was on the intervention in water supply, but none were directed at the demand side. Thus, a circle of problems, interventions, impacts, problems and new interventions were created. At present, the concern for a sustainable use of the resources is increasing, and the management has been increasingly looking at the demand side as a factor to be actively considered. Likewise, institutional factors (resources) have started playing a significant role in all environmental planning processes. More importantly, in contrast to the reactive character of past management decisions (i.e., only after the identification of a serious problem, action is undertaken) a more pro-active attitude is being adopted.

Currently, national resource planning is virtually non-existent. EGIS needs to develop IEM expertise for the integrated management of natural resources (water resources management up front) and to support capacity development of WARPO. In this regard, a framework is required for IEM. Because of its multi-disciplinary structure, EGIS is ideally suited for the development of such a framework as IEM problems typically deal with many alternatives, interests and uncertain developments. Thus in 2000, EGIS selected the development of such a framework as a research project. The project was concluded recently, with two technical notes published as its output.

The Technical Note 19 on Integrated Environmental Management, A Case Study on Shrimp-paddy Land Use Strategies in the Southwest of Bangladesh presents the results of an IEM exercise in the shrimp-paddy region of the Greater Khulna District. The aim of the study was to project the choices with regard to land use on the basis of economic, social and environmental considerations. A conceptual framework was devised for the management of land resources in relation to shrimp-paddy production. National objectives were translated into various criteria and indicators relevant for the study area. Different scenarios were also conceived and strategies stipulated. The computational framework for the study generates and quantifies the environmental, economic and social trade-offs between shrimp and crop cultivation in the study area through a spreadsheet model. A major part of the computational framework is based on spatial models including a salinity intrusion model and a land use allocation model.

The adoption of the Golda-Boro crop cycle in the study was found to be an attractive strategy on economic, social and environmental grounds. Golda cultivation is a recent phenomenon in the study area and has less social and environmental impacts than Bagda cultivation. A number of supporting strategies have been suggested by the study in order to sustain the benefits of Golda cultivation in the coastal region without damaging the environment.



The Technical Note 20 on Development of Decision Support Systems documents the experience of developing two decision support systems (DSSs) at EGIS, one for the Nijhum Dwip Integrated Development Project and one for land allocation, based on a shrimp-crop trade off in the southwest region of Bangladesh. These DSSs have been developed to build capacity in constructing DSSs and to demonstrate its utility in decision making for natural resource management and planning in Bangladesh.

DSS can be described as analytical tools which can be used to assist planners and decision makers in developing and comparing alternative courses of action and preparing preferred interventions for subsequent decision making. Major attention is given to a user friendly interface, which allows an interactive exploration and specification of alternatives and a comparison of their performance under different assumptions of exogenous developments. In an elaborate form, a DSS would include tools to give preferences or weights to different objectives and criteria and obtain a priority ranking of alternatives.



A view of Nijhum Dwip area.

## Metadata - a new concept for information management

The National Water Resources Database (NWRD) is the single largest data bank in the country, which comprises almost three hundred data layers. Three main categories of data are made available in NWRD that include spatial data, time series data and attribute data. As water resource planners and prospective users need to analyze data in order to assess resources, demands and constraints, evaluate options and formulate alternative strategies, a number of application tools have been developed to facilitate the users to access the data server and retrieve data. These tools are simple to use and help in enhancing the authenticity of this database. The tools can be used for:

- Metadata Viewing
- Graphical presentation of spatial data
- Tabular presentation of time series and attribute data
- Data exporting
- Graphical presentation of time dependent data
- Simple statistical analysis of time series data

To make NWRD more user friendly and increase overall performance, it has been redesigned to convert data in Oracle, ASP to develop tools, COM+ for accessing data and ASP Map to view shape files.

### Why Web?

- Centralized control on NWRD tools
- Make all NWRD tools available on a single page
- Makes Database available to all internal users through intranet
- Need not install tools on every user's machine

### Why Oracle?

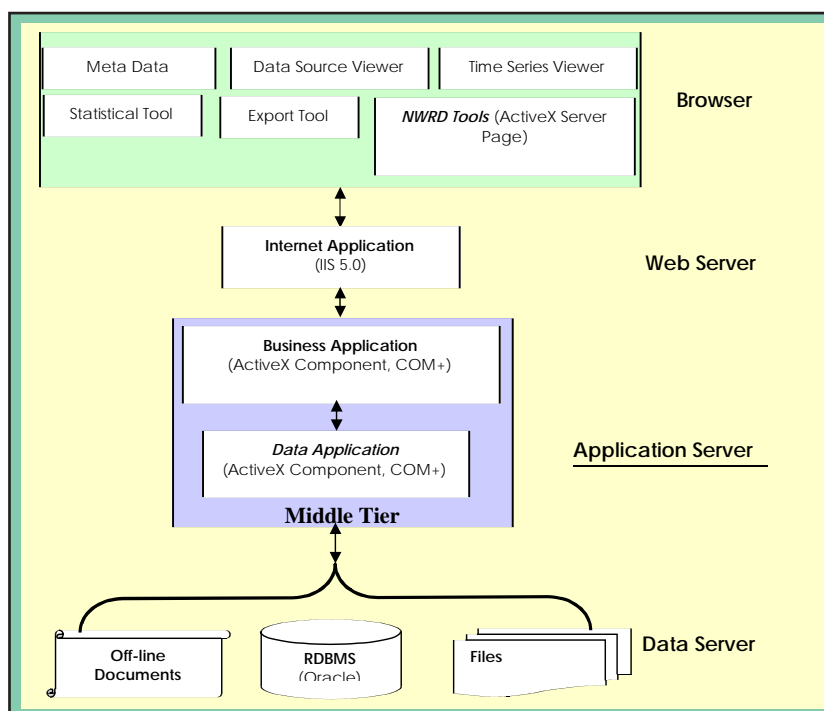
- More secure
- Performance tuning is much more structured
- Oracle can retrieve data from large tables more efficiently
- Only oracle can store and query spatial data
- It provides special functionality for time series data

### Why COM+?

- Faster access to database
- Resource sharing
- Role based security
- Application logic resides on server
- Centralized Control on Business and Data Components

### Why ASP?

- Server side scripting
- Many ActiveX components are available for ASP
- Components developed using COM+ technology can be used with ASP
- Less development cost and effort required
- Compiled components run faster than interpreted code



### Contributors in this issue:

Muhamad Mustafa Alam, Technical Adviser  
 Md. Hasan Ali, GIS Application Engineer  
 Ehsan Hafiz Chowdhury, Hydrologist/GIS Specialist  
 Pia Afreena K. Huq, GIS Specialist  
 Abu Mohammed Ibrahim, Soil & Agriculture Specialist

A.K.M. Azad Hossain, GIS/RS Specialist  
 Mohibbur Rahman  
 Shahed Kamal, System & Network Manager  
 Md. Rezaur Rahman, Environmental Expert  
 Md. Wazi Ullah, Hydrologist



### Environment and GIS Support Project for Water Sector Planning (EGIS)

House #49, Road #27, Banani, Dhaka-1213, Bangladesh  
 Phone: 880 2 8821570-2, Fax: 880 2 8823128  
 Email: egis@cegisbd.com, WEB: www.cegisbd.com

**Editorial Board:** Riaz Khan  
 Rob Koudstaal  
 Mujibul Huq  
 Mustafa Alam  
 Mohibbur Rahman  
**Editor:** Asifa Rahman  
**Design and Layout:** Sayeefur Rahman Rizvi