SUSTAINABLE DEVELOPMENT OF NATIONAL WATER RESOURCES DATABASE IN BANGLADESH AND IT'S MANAGEMENT ISSUES

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ABSTRACT

This Paper deals with the management of the data needed for water resources planning in Bangladesh and provides the basis of the entire process of information management, from data collection to dissemination of information. We reviews the agencies' perceptions about their needs for improved facilities to execute their mandates and the need to stay up-to-date in order to take advantage of new technologies. The need for data processing, quality control and data storage issues are also reviewed. GIS based some tools are developed and designed to assist users in their analyses.

Data collected at public expense is suggested to disseminate freely to all, with the fewest possible restrictions, to ensure that its value is maximised. The paper reviews the facilities needed to do this, and the provisions being made to allow the greatest number of users to benefit. The need for metadata facilities for allowing people to find out about data holdings is discussed. Inter-agency co-operation is essential and the paper suggests that there must be benefits to all participating agencies in the process, not just the central agency. The paper points out the benefits of having a well-managed database and that the cost of properly maintaining the National Water Resources Database (NWRD) are less than 2% of the Annual Development Program (ADP) funding for technical assistance projects in the water sector. Suggestions are made about the use of licenses for access to the database. The paper concludes what is needed to ensure the sustainability of the NWRD in terms of staff, training, equipment, the costs and support.

1. INTRODUCTION

1.1 Background

In January 1999, the Government of Bangladesh issued the National Water Policy (NWPo). The NWPo has mandated Water Resources Planning Organization (WARPO) to create and maintain a National Water Resources Database and Information Management System. This sets out several decisions on policy with regard to data management and data collated from other agencies and makes it clear that the purpose of this activity is to improve water resources planning at all levels.

1.2 Need for a National Water Resources Database

Water resource planners need access to reasonably accurate spatial data and time series data in order to assess resources, demands and constraints, evaluate options and formulate alternative strategies. Data for the National Water Management Plan (NWMP) has been collected from different sources in many different formats (digital and paper) and on maps in different scales and projections, all stored in different locations. To increase the usefulness of this data, it needs to be put into a relational database format and stored in a centralised, secure and easily accessible location where proper protection facilities can be provided. These are easy to use by providing a consistent procedure to access and manipulate data for all users.

1.3 Data on Needs Assessment

The problem is how to organise this data in a way, which facilitates its use in the planning process. The way in which the data is structured will depend largely on the way it is planned to integrate it into the planning process. It could be structured to reflect resource issues, problem issues or geographic issues. At present all the data is being held in digital form, some on databases, and others as simple bullet points in word processing files. The decision on how this data will be properly stored will need to be taken as soon as the planning process itself is clarified. The more devolved the planning process, the greater the need to ensure local planners are aware of parallels between their own unsolved problems, similar problems occurring elsewhere, and solutions found to be effective (or ineffective) by others.

1.4 Impact of Technology Change

Technology change in instrumentation is rapid, and the new technologies for gathering information more precisely, accurately and safely should be adopted as rapidly as possible wherever appropriate. The impact of improved telecommunications is likely to be equally important in the future. Ground-to-satellite communications will take this a stage further, making it possible for people in remote areas to gather and react to information on the environment around them. The consequences of farmers knowing more of input costs and market prices, leading to behaviour change among the biggest users of water.

2. DATA COLLECTION

Data is constantly collected and processed by government data collection agencies (DCAs), non-government organizations (NGO) and projects. DCA collects data under a legal mandates, generally covers the whole country, whereas most NGO and project data covers only a limited area. Routine data collection is often not considered an important task, and assignment within the department responsible is seldom seen as important for career advancement. Departmental funds are often limited, so the process of collecting data from the field, checking it and making it available for use by others is not accorded priority. WARPO has contacted the 24 agencies to ascertain what their data holdings are,

and circulated a document so each can see what others hold, and correct any errors in the description of their own data.

3. QUALITY CONTROL

Random or systematic errors may all be introduced in the observations due to measurement/sensing, transmitting, and recording or processing. Random errors are inherent in the act of observation or measurement. Systematic errors are associated with the measuring techniques, measuring device and computation techniques. Such errors are brought about, for instance, by changing the type of raingauge, current meter or stage recorder during the period of sampling. All these sources of error must be minimised to improve standards of reliability and accuracy. There are serious concerns over the quality of much of the data that has been collected by various agencies. At present, there is no unique procedure/method for checking and maintaining the quality of water resources data at national level. Various collecting agencies are maintaining the quality of their data in different ways, even where the same data is collected by different agencies.

To be effective, quality control must be exercised from the point of collection, and this can only be implemented by the data collection agency. When agencies are assigned the responsibility to collect data, this responsibility should be interpreted to mean that the data is collected in accordance with recognised quality standards. The number of such errors can be reduced over time if there is feedback from users of the database so that whenever errors are detected, they can be checked and corrected in the database itself.

4. DATA PROCESSING

The water level data received from the field are adjusted for vertical shifts following check levelling and then keyed into the computerised system and a graphical presentation is displayed. In case of apparently incompatible data a reference is made to the field office for validation. After this initial check, the data is transferred to the database, and a second check made by drawing a superimposed water level hydrograph of the upstream and down stream stations. A spreadsheet developed for entering discharge data allows several trial curves such as WL vs discharge, cross section area etc to be plotted to identify errors or incompatible data, and then transferred into the database. At the end of the year or when appropriate, data is retrieved for development of rating curve. From the database, observed discharge data can be downloaded in a spreadsheet file and displayed as graphs of level vs area, width, velocity, discharge. DCA regularly corrects for shifts, applying corrections when the rating curve changes with time due to changes in the cross-sectional characteristics along the cross section. The consistency of rainfall data is tested by examining the recorder chart and comparing 24-hour rainfall total with the daily rainfall of the manual gauge, to check:

- Consistency of daily records with daily data of the adjacent stations.
- Consistency of monthly rainfall totals with monthly and annual rainfall totals in a sheet of 13 maps and with areal rainfall distribution by drawing isohytes.

- Depth duration data on an annual basis for each station. Plotting of this map also provides an additional check in the areal distribution of rainfall.
- Long term trend in the average and standard deviation of rainfall by double mass analysis (and correction applied).

4.1 Need for Improved Processing Facilities

Gauge readers living in the remotest areas of the country and facing some of the most adverse physical situations are responsible for collection of data. These data have to be correct, mutually compatible and in conformity with the laws of hydraulics and river mechanics. To be useful, it needs supervision and quality control at the field level and validation and quality control in the data processing office. Data processing facilities are also available in private sectors. These organisations have the capacity for processing a large amount of data at a reasonable price, with good quality and on schedule.

WARPO is acting as a data collating agency, processing data and correcting it when errors are found and infilling any gaps. Discrepancies are being reported to the agencies for comment and improvement of mutually approved data layers. It is sharing information with other collecting agencies and aiming to create a sustainable database with facilities for easy update of its database in the future.

4.2 Adding Value to Data

Data has value added when its quality, both in collection and processing, is ensured with standard, internationally agreed, procedures, and when it is assembled in one place in a common format. The meaning of added value is *"the data or information generated through any analysis using authentic dat*a". Data generated from in-house analysis and from mathematical models are both examples of this.

5. DATA STORAGE AND ARCHIVING

Data storage and archiving (hardcopy or digital format) is an issue of great importance for a large database like NWRD. Although digital data is required for analytical tools and applications, data in paper format has some advantages. It is more expensive to produce and requires more room to store, but it is much simpler to use. Most agencies recognise this, and take care to preserve the original records as far as possible, despite the problems of damp and mildew in the five rainy months and with insects and rodents throughout the year. Printed tables and maps tend to have a longer life than digital data in Bangladesh, due to poor data storage and a lack of update policy. The storage of digital data is made difficult by the rapid pace of development of hardware and software.

Data storage media are constantly changing and the process of backing up data in the most suitable medium currently available needs to be institutionalised to keep pace with these developments.

5.1 Present Digital Storage Facilities

Data can be lost at any time due to hard disk failures, software conflicts, viruses and many other reasons, and backup is therefore essential. Data can be stored on different media, whether electronic (digital format) or printed (hardcopy format). Storage media for digital data are continuously changing with increased capacity and reliability. However, storage media needs to be updated regularly: 5.25-inch floppy diskette and drives are now obsolete and 3.5-inch floppies are not very reliable. Many new digital storage media are now available, suited for different tasks, and rapidly expanding capacity while reducing cost.

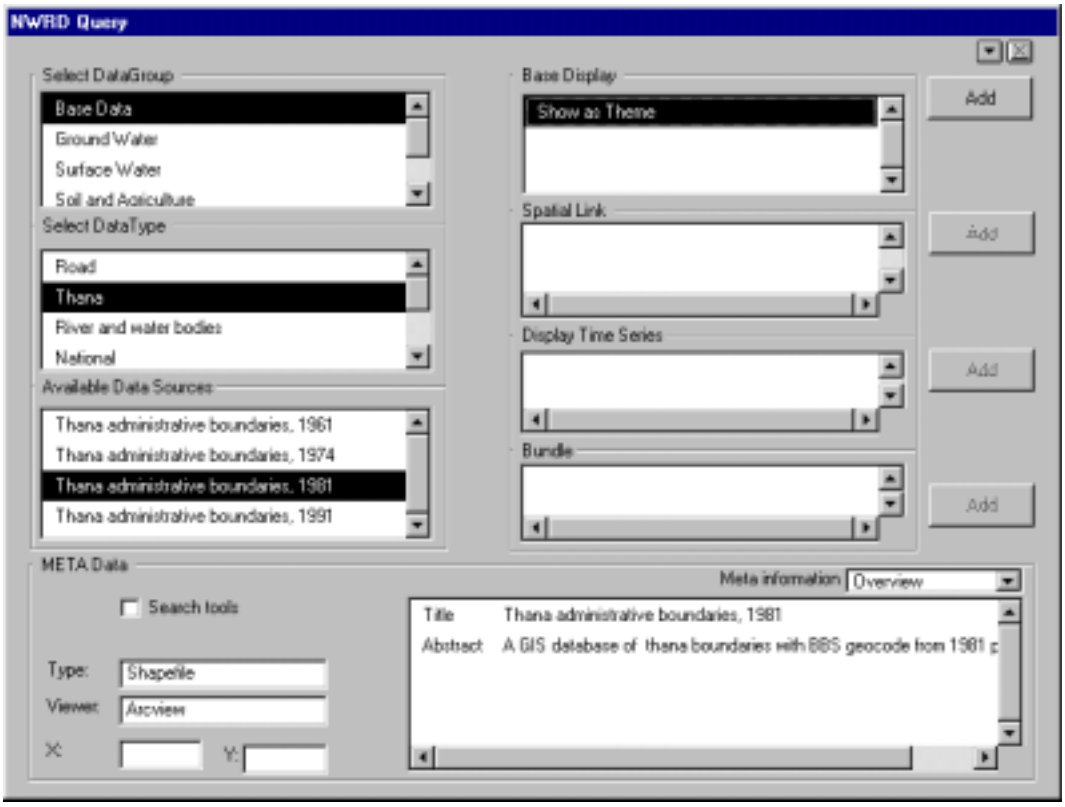
All spatial data, data in document form and the tabular data in the SQL server are stored in the database server, which uses a hot-swappable hard 8.4 GB SCSI disk facility with mirroring, tape drive is used to back up into tapes fortnightly. A CD-writer facilitates copying data into CD, and data collected from different sources are stored in CD before being processed.

5.2 Data Archiving

Data archiving is not only related with the media of storage, but also with the system software used to store and retrieve data. If the two are not considered together, stored data might be useless. There are many options, and the best solution will depend on network architecture and the amount of data. For different options, the three main factors to be considered are capacity, cost and reliability, and these will all vary from time to time. Costs are reducing rapidly, but are still an important consideration, as all parties have to be able to read and write to each other's systems. At present, considering cost, capacity and portability, tapes are the best choice to store large amounts of data.

6. TOOLS AND APPLICATIONS

ArcView and SQL server based tools and applications have been developed for the front-end users for searching, downloading, exporting, viewing, analyzing and sharing data. A number of system management tools have also been developed for updating the database. An Import Tool has therefore been developed to allow the easy transfer of data from the formats used by particular agencies into the NWRD format. It is not considered necessary or desirable to insist that all agencies use a common format. A Generic Export Tool has been developed as a stand alone application developed in Visual Basic, which can export the data to Excel, Xbase, Access, Comma, and Tab delimited Text format. The subset of tabular data kept into the SQL Server can be selected and exported at any location. Also this tool can export the shapefile with associated information to any desired location.



Metadatabases, or catalogues of data, enable people to find out whether data on a particular subject exist, and if so, where to find it. A key element of the dissemination system is therefore the provision of and access to the metadatabase. A comprehensive study was made of metadata standards and customized software to establish a metadata information system for the NWRD, bearing in mind that this might well set the standard for other Bangladeshi institutions. The configuration of *Geokey* includes specifications for data items and look-up tables that makes it possible for NWRD applications (as well as users) to access all the data types in NWRD.

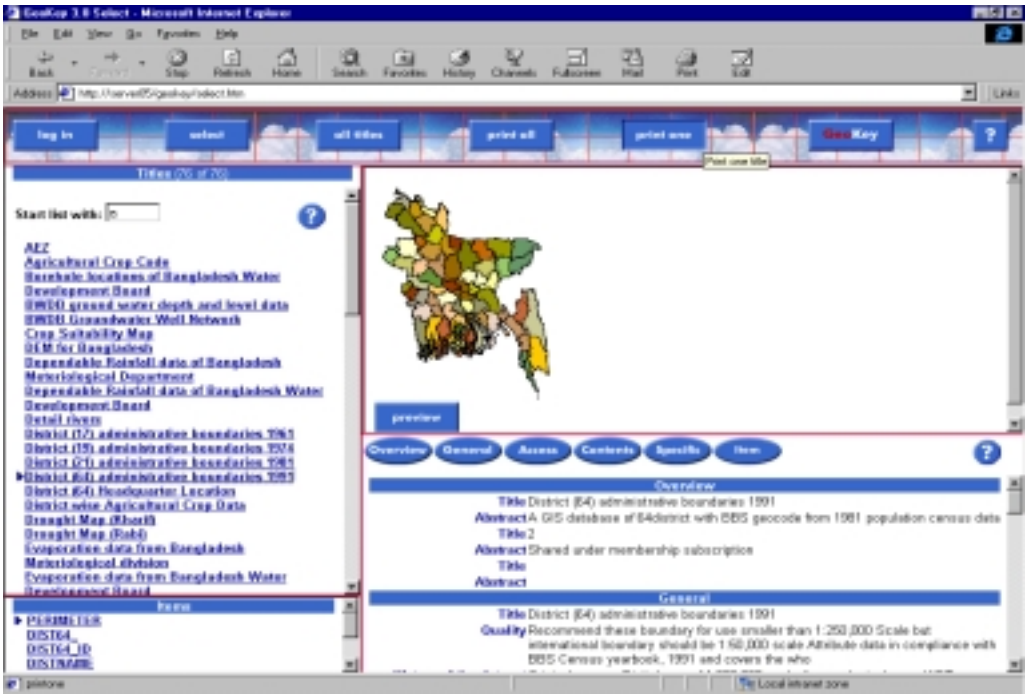


Fig. Geokey based Metadatabase System for NWRD

7. NEED FOR CO-OPERATION

The data collection and management process lacks institutional shape and the data handling process is often oriented toward project needs. This has resulted in a situation in which large quantities of data are spread over many different organisations. This creates duplication of work, gaps between data collected and user needs inconsistent data formats and wastage of manpower as well as money. There appear to be several areas where there is considerable overlap in data collection activities. While some duplication is understandable and even desirable, it is a luxury that may be difficult to justify if examined objectively. Usually these arrangements come about by accident, and a periodic review is needed to assess whether it is desirable that they should be continued, or whether there is scope for rationalising activities. The Bangladesh Geographic Information Infrastructure (BGII) in Bangladesh is being contemplated. The BGII aims to be a platform for users and providers of data to share and exchange information on metadata and data itself. The objective is to co-ordinate and help different organisations in issues of data management, through making available a set of basic services, which facilitates and enhances the collection, processing and dissemination of geographic information.

7.1 Relationship with Individual Agencies for Data Collection

The data needed for water resource planning goes well beyond relatively simple hydro-meteorological observations, and into the fields of agriculture, forestry, fisheries etc. The collection of such data requires a wide range of skills and a large field team, of a kind that would be difficult to integrate within a single organisation. Neither is it desirable, as knowledge of, and experience in, data collection procedures are assets for specialists in the

individual fields. A better option would be for WARPO to play a pro-active role, sharing with the collecting agencies its planning and database skills, but leaving each agency the responsibility for collection.

7.2 Relationship with Individual Agencies for Specialist Processing

Consideration needs to be given to the extent to which WARPO should do this work itself, contract specialist organisation to do it, or set up institutional relationships which ensure that WARPO's needs are met. Such arrangements could include WARPO setting up cells with specialist organisations. These issues need to be resolved within the overall framework of the sector.

8. INSTITUTIONAL DEVELOPMENT

There must be an institutional set-up for managing the NWRD within WARPO that provides quality control of data and an assurance to users that the data is available as and when needed for planning and monitoring purposes. Above all, it must be sustainable, as a well-managed database is an invaluable asset. The institutional set-up must be formulated within the framework of a coherent data policy for the NWRD and cover such management issues as data quality and standardisation, data dissemination protocols and facilities, back-up and data restoration, archiving, documentation and co-ordination with other organisations.

8.1 Human Resources

Adequate human resources are needed to support the obligations assigned to WARPO, assure good management of NWRD and serve data users. To handle, update, maintain, control quality and dissemination of NWRD data, a permanent skilled team is required. Apart from its basic tasks, the staff will need to support clients who need assistance when they visit WARPO. This is a new area of work, which is likely to expand rapidly and require additional staff. Computer technology is rapidly changing and staff will need to maintain skills through regular training, research and higher studies. The equipment and software changes fast in Information Technology (IT) that every five years computers and other accessories need to be upgraded.

8.2 User Charges for NWRD

Part of the funds needed to pay for the NWRD may be recovered by selling data and other database management services, but are unlikely to fully cover costs. However it is intended that each organisation should be able to use NWRD data at a nominal charge. The money recovered from data dissemination and service from NWRD can be used for updating the equipment as well as the purchase of software. There must be transparency about revenue earning from selling data or NWRD information. It would be desirable for user charges to cover the marginal cost of data dissemination and also make a contribution of the cost of data collection. However, if set at this level, such charges would limit access to the data to those able to afford it, effectively using public funds to provide data for a privileged few.

The biggest users of data are projects. Many collect data as well, but all make great use of records collected by others. Project inputs could be significantly reduced if the data were already available in processed form, as often a major part of experts' time is spent in collecting and analysing data (and identifying and removing errors) instead of interpreting it and considering its implications for projects. The technical assistance budget in water sector related projects was Tk. 886 million (ADP 1997/98). The entire annual cost of the NWRD for the staff, training, equipment and service support is estimated at Tk. 15-20 million a year, around 2% of the above figure. Universities and other researchers on Bangladesh are also users of data, but it is a disturbing feature of many of the publications available on the market that they seldom use up-to-date data. The value of the research to Bangladesh would be greatly enhanced if it were based on the best available figures. Any system of user charges should therefore be designed to promote rather than restrict use of data by the academic community. It is therefore suggested that a two-tier system be introduced, based on a licence to use the data.

Projects would be charged a lump sum access fee to use the NWRD, and be required to show that they have paid the licence fee to WARPO before donors settle their invoices. Once the system is understood, then project budgets will automatically include provision for the licence fee at the time of project formulation.

Other institutions (universities and other research organisations) would also be required to take out a research licence for their staff and students, two (or more) types being required, depending on whether the data is needed for pure research, for publication as a book, or for funded problem-oriented research. Renewal of the research licence would depend on the research organisation ensuring that its staff and students respect the rules. A lump sum fee, covering access to all data, is considered preferable to an item by item charge as this encourages users to make maximum use of all the available data rather than make false economies by limiting usage.

9. OPTIONS FOR IMPROVING CO-OPERATION

WARPO has both the mandates to hold the NWRD and the ability to integrate an overview of data needs into the planning process through the preparation of the NWMP and its involvement in planning institutional development of the sector. These two attributes should be fully utilised to allow it to play a pivotal role in improving the data management process. Some ideas on how this might be effected are set out below.

a) Make clear to the Government the value to the development process of a good quality, comprehensive database and the importance of ensuring that adequate funds are available to fund all the components needed.
b) Liaise with DCAs and others to ensure that their mandates to collect and process data are clear, comprehensive and non-overlapping. The mandates must specify that the process of data collection and processing meets with internationally accepted standards in respect of density and frequency of sampling and quality control.
c) Clarify which agencies should have the mandates for advanced processing in the fields of integrated water resources modelling, environmental modelling and macro- and

socio-economic modelling, and consultation, and their obligations to provide WARPO with the required support in these fields.

d) Request that DCA's draw up comprehensive plans to implement these mandates, with adequate provision for staff, training, equipment, consumables and an organisational structure designed to ensure a continuity of qualified staff.
e) Build into the NWMP adequate funding to implement these plans, monitor their effectiveness, and revise them from time to time.
f) Ensure that the necessary legislation is in place to allow the free exchange of data between the organisations and particularly to the NWRD, and from there to the public.
g) Determine a policy with regard to user charges and ensure that it is applied in a just and equitable manner.

10. CONCLUSION

Inter-agency co-operation and relationship is essential to sustainability of any development. The number of errors can be reduced over time if there is feedback from users of the database. Considering cost, capacity and portability, tapes are the best choice to store large amounts of back up data. Metadatabase is useful to know information about data in the database. Suggestions are made about the use of licenses for access to the database. The cost of properly maintaining the National Water Resources Database (NWRD) are less than 2% of the Annual Development Program (ADP) funding for technical assistance projects in the water sector. The paper concludes what is needed to ensure the sustainability of the NWRD in terms of staff, training, equipment, outside support and estimates the costs.

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BIOGRAPHICAL NOTES

Previous Activities : Served about 8 years as Database Manager, System Administrator, GIS / Remote Sensing Analyst for Water and Land Resources Planning and Management.

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