WWW-Technology Based Hydrological Information And Decision Support System

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Abstract: Several computer-based information and decision support systems have been developed to provide environmental and hydrological information in a timely manner. The Finnish Environmental Administration has used VMS/VAX-based application since late-80's, but the present system is not anymore capable to fulfill the informational and functional needs being addressed by the users. At the Finnish Environment Institute we have studied different solutions to build up a new comprehensive hydrological information and decision support system. WWW-technology based solution has been chosen Although the new complex technology has required training it gives a great possibility to develop an effective and user-friendly system for our purposes. The requirements of the system are high: the hydrometric network is wide, there are over thousand potential users, and in addition to data storage and browsing the system has to include wide range of tools for statistical analysis, tools for calculation procedures needed in water resources management and tools for presenting graphical plots and GIS-data. Software solutions in our system are mainly based on Microsoft-technology (NT4.0, IIS, ASP, MTS, DCOM and SQLServer). The GIS-maps are provided by the technology of ESRI (MapObjects, Internet Map-Server). Because of various type of use the system is developed to be a cross-browser application without any plug-ins.

1. INTRODUCTION

Several computer-based information and decision support systems have been developed to provide environmental and hydrological information in a timely manner. The role of the computer-based systems is becoming more

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and more comprehensive. They are not anymore only data storages but they also provide information in a useful form and solve complex problems being addressed by the users. The requirements of the systems are high and lot of weight should be put on the planning and development of the user interface.

Possible solutions for software and hardware selection for these systems have been the client-server type PC applications or in a case of efficient on-line distributed use, the applications where information is stored at and processing is done by server workstations (e.g. VAX, UNIX) and the information needed is viewed through terminal connections. The informational and functional needs have increased and the systems have to develop. The rapid development of the internet based technologies has given great possibilities to build effective hydrological information and decision support system for on-line distributed use.

2. CHARACTERISTICS OF THE PRESENT SYSTEM

The employers and the researchers of the Finnish environmental administration have used VMS/VAX based application since late-80's, but the present system is not anymore capable to fulfil the informational and functional needs being addressed by the users. The present system is developed using IT-methods that were available in 80's. The information is stored at the INGRES SQL-database. The size of the database is 1,5 GB and because of the operational nature of the system allocated space is increasing smoothly. All the applications are at and the processing is done by VMS/VAX server. FORTRAN programming language has been used as a tool for the business logical part of the system. The user interface is based on INGRES ApplicationBy-Form technology. The Form-type interface is opened via rather limited terminal connection.

The ten-year-old system has caused hardware and software related technical problems. The system architecture and the programming were not at that time planned carefully enough. Also the knowledge of the old technologies has almost disappeared and the compatibility of the old technologies with new ones is not anymore uncomplicated. Because of these problems the system administration has been laborious and time consuming.

The feedback from the users has also indicated that alterations are needed. The users have found out that: 1) the system is difficult to use, 2) it is hard to obtain information from it, 3) the character-based user interface is limited, and 4) the need for information has increased and the data does not cover the new areas. The hydrological information system of the Finnish Environmental Administration has over thousand potential users, but few of them are trained in their use or use the system as effectively as it could be used. The character-based user interface needs experience or learning by rote

and does not provide the interactivity and graphicness needed. Especially analyses and displays of spatial data should be included in a user-friendly and efficient environment information and decision support system.

3. REQUIREMENTS OF THE IMPROVED SYSTEM

There has been considerable interest in hydrological institutes and offices towards hydrological database management systems for maintaining large collections of data-sets and for user friendly presentation of information. For a state of the art of hydro-logical database management in Europe see Reed (1999) and for a operational data-base system with extensive software for control, analysis and presentation see Roald (1996), Taksdal et.al. (1999).

The Finnish national hydrometric monitoring network has two and a half thousand observation stations. It is observing hydrological inland parameters as surface water level, river discharge and some spatial parameters in a daily basis. The data can be divided into five categories in terms of monitoring objective: 1) water balance stations for the basic monitoring of large lakes and river basins, 2) spatial estimation for the transfer of discharge data to small natural catchment areas, 3) operational stations for the daily operative tasks of water resources projects. 4) planning and inventory stations for project planning of small river basins, and 5) research stations for process or impact studies (Puupponen, 1998). The data is transferred to databases in real-time on a daily basis preferably trough the e-mail or ftp - connections. Also the tradional forms are supported.

The new hydrological information and decision support system described in this paper will have various types of users and their objective varies from the browsing of the basic data to multi-objective operative water resources management problems. The system has to handle input information in various forms and from various sources. The data might come from the automatic observation stations in a digital format, or from the e-mail sent by some partner institute or company, or even from the on-line manual feed. The demands for the data browsing contain more than just data presentation in a table format: graphical packages for data analyses and displays and also tools for presenting GIS maps are needed.

Actually one of the goals has been that the users are able to find the information needed just by zooming and bounding the map coverages and selecting the map options. The system has to provide the observation values or the result values from the calculation or analysis routines in various file formats to assist later processing of the information. The topic itself requires that the system in addition to data storage and browsing includes wide range of tools for statistical analysis, tools for calculation procedures needed in water resources management, tools for optimisation and knowledge-based

decision support systems. D. P. Loucks (1995) described that the knowledge-based system are " the systems that can process rules and symbols to draw conclusions principally through logical or plausible inference sequences and that can provide users with an explanation of how those conclusions were reached".

4. WWW-TECHNOLOGY BASED SYSTEM

At the Finnish Environment Institute we have studied closer two basic solutions while building up a new comprehensive hydrological information system: 3-tier client-server application where the user interface is a PC-application and the database and the business logical components are held in a server workstation, and WWW-technology based application. We chose WWW-technology based solution because of easier on-line distributed use for various types of users and possibility to server-side administration and maintaining. It is likely that some applications are still needed to implement as 3-tier client-server applications because complex maintaining and tasks of water resources management, but these applications will be used only by few system administrations or persons who are in charge of the main watersheds.

Although the WWW-technology based solution has been chosen, there are still many hardware and software possibilities for the implementation. The software solution in our system is mainly based on the Microsoft-technology, because that has also been the direction of the recent development of our network, servers and personal workstations. The solution includes such technology recommended by MS as NT 4.0 server, Internet Information Server, Active Server Pages, MS Transaction Server, distributed component-technology which contains all the business logic, ADODB database connections and MS SQL database server. The user interface is a cross-browser application so that both Nestcape 4.0 and Internet Explorer 4.0 can be used. GIS map coverages are provided by the technology of ESRI MapObjects and Internet Map-Server.

It has been shown that the most time consuming parts in the system are the time that elapses while the data is transported across the net, the time that browser needs for printing HTML pages, and also the time needed for composing GIS map coverages. Thoroughly planned and constructed database and modern database servers are efficient, at least we have found them efficient enough for the needs of our environmental information system. DLL component-technology is proved to be powerful and because of they being modular and language independent the technology is used to commit the business logical part of the system as much as possible. Client-side and data transported across the net are held as thin as possible (and the same time trying not to lose user-friendliness and functionality). HTML-

strings, SQL-queries, plots of timeseries etc. are constructed and water resource management models are located in the components. While planning the system a lot of effort was put on forming the object model of the business logical part.

The system will have various types of users and the users are granted to use the system in various levels. The system is heavily parameterised. This means a little bit more planning and implementation work and causes retarding of the performance, but we gain e.g. multi-lingual user interface and various user levels. The cross-browser application is needed to allow this user-friendly internet, intranet and extranet use.

5. CONCLUSIONS

The modern WWW-technology gives a possibility to build up an effective and user-friendly hydrological information and decision support system. The information can be easily accessed from all locations and by different users. The user has to have only a network connection and a browser. The WWW-technology based solution is also easy to maintain because all the maintaining and the business logical parts of the system are implemented in the server computers. The applications do not have to be installed in several computers that would have various operating systems. Almost all of the potential users (e.g. researchers, decision-makers) are already trained in their use of internet, so the technical training needed will remain small.

The development process of the system has brought up some difficulties related to the WWW-technology. The technical knowledge of the new complex technology can be insufficient. It has been almost impossible to find and employ people who are at the same time available and proficient in the WWW-technology. Thus time consuming training has been needed. Opposite to the initial concept of the internet different standards exist and especially in the case of cross-browser application it has been difficult to compose an effective and functional interface.

All the environmental information systems of the Finnish Environment Administration will be planned and realised using technologies presented in this paper. The prototypes of hydrological and state of surface water information systems are already tested and the first version of these system will come out in summer 1999 and the rest of the environmental information systems will be planned based on the experience gathered from these two.

6. REFERENCES

Loucks D.P., 1995. Developing and Implementing Decision Support Systems: A Critique and a Challence. Water Resources Bulletin. VOL. 31, NO. 4. p. 571-582.

Puupponen M., 1998. Structural development of the Finnish national hydrometric monitoring network. Monographs of the Boreal Environment Research. No. 12. ISBN 952-11-0329-9. p.105

Rees H.G., 1999a. Issues of hydrological database management. In Proc. Internatio-nal Conference on Quality, Management and Availalility of Data for Hydrology and Water Resources Management, Koblenz, Germany, 22-26 March 1999. P. 205-210.

Rees H.G., 1999b. The management of the FRIEND European Water Archive. In Proc. International Conference on Quality, Management and Availalility of Data for Hydrology and Water Resources Management, Koblenz, Germany, 22-26 March 1999. P. 259-264.

Roald, L., 1996. Data quality control in Hydra II. In: Proceedings Nordic Hydrological Conference 1996, vol. 1. p. 247-254

Taksdal S., Beldring S., 1999. Hydra II – a comprehensive hydrological data base system. In Proc. International Conference on Quality, Management and Availalility of Data for Hydrology and Water Resources Management, Koblenz, Germany, 22-26 March 1999. p. 265-268.