The WaterBase Project

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Abstract: The WaterBase project is an ongoing project of the United Nations University. Its aim is to advance the practice of Integrated Water Resources Management (IWRM) in developing countries. Predictive modelling and decision support for water management in developing countries are plagued with a number of related problems: lack of money, lack of expertise, inadequate training capacity, dependence on experts from other countries. At the same time water resources are under increasing pressure, and aquatic ecosystems are being damaged by people who lack the resources to explore the consequences of decisions before they are made. Modelling tools are available, and have a proven success record in many countries. But they are typically difficult to use, require a lot of data, and are very expensive to buy. At the same time there is increasing availability on the internet of free GIS data, and standard PCs have processing speeds and storage capacities that make modelling on relatively cheap and common hardware feasible. The WaterBase project aims to exploit this situation, in three phases. In the first, current, phase a free, open source tool for hydrological modelling and scenario exploration is being developed. The tool is intended to be instantiable anywhere in the world using GIS data from the web, supplemented by more detailed local data if it is available. This tool is essentially a prototype, but will be usable by third parties. In an overlapping second phase, partner institutions will be sought, especially from developing countries, who will use the tool, provide feedback, and provide requirements and perhaps also effort for the third phase. The third phase, for which external funding will be sought, will develop the tool further according to the requirements that have been identified. It will also work on a metadata scheme for organising the various kinds of data that modelling requires. In addition, to improve training capacity, WaterBase tools will be integrated with the UNU's Water Virtual Learning Centre, by developing a module on "Watershed Informatics".

Keywords: integrated water resources management; hydrological modelling; decision support; SWAT; MapWindow

1 INTRODUCTION

Governments and watershed agencies across the globe are struggling to put into practice predictive modelling and decision-support capabilities, often under difficult circumstances (poor capacity, little money, well-meaning interference from the "North"). While environmental modelling to support water management has a proven success record, it is often too complex and expensive for use in the South. Our aim is to create a generic decision-support methodology, with supporting informatics, which is cheap to install, independent of foreign expertise, capable of local adaptation, and effective to operate. Foreign expertise is expensive and often in short supply, and those involved often have vested interests. Local customisation is necessary since developing countries vary widely in the resources, skills and environmental data they have at their disposal.

Need for these technologies is critical because of the crisis in effective water management in the developing world. Fragmented understanding of water resources and disconnected decision-making have stymied the provision of safe water and sanitation to billions and have accelerated aquatic ecosystem destruction on a large scale. This lack of an integrated approach is mostly a consequence of water managers not understanding the interconnected impacts of separate, isolated actions and not having the capacity to anticipate consequences and forecast outcomes. They need the capacity to "game" with "what if" scenarios, so that coherent actions with positive outcomes are possible. The decision support methodology is one structured and quantitative approach to strengthen this capacity to anticipate and prevent.

This kind of tool is particularly needed in developing country settings because often they are now facing multiple water problems simultaneously (contaminated drinking water, nutrient pollution, industrial toxic chemical pollution, biodiversity losses, dams and diversions, soil salination, etc, etc), unlike the past experience in the North where issues came sequentially over decades of development. The South also faces an urgent and accelerating timetable to resolve their water crises. Decision-support modelling has the potential to speed up the whole decision and management process.

While the need is very real, based on the success seen in the North (and, in some cases, the South), demand for these approaches at present in developing countries is varied. This is not surprising, for several reasons. In some cases, the sector is preoccupied with providing basic water and sanitation and not ready for a more integrated approach. In others, the demand is there, but there is hesitation to engage because of concerns about the complexity of existing imported systems from the North. And in many cases, decision-support systems have been acquired, but from Northern consultants who foist off inappropriate, complex systems that only they can sustain at great cost to the client. This is why we seek to demonstrate that it is possible to create a generic decision-support methodology - essentially as a public good - capable of local adaptation, effective at an appropriate level of complexity, cheap to install and not captive to foreign expertise.

The WaterBase project is an attempt to ameliorate these problems, and in this paper we describe the technical, educational and organisational strategy we have adopted. Section 2 explains the technical approach we are following. Section 3 covers the education aspect. Section 4 describes how we hope to build an organisation that can have a real impact in developing countries. Section 5 provides a summary and draws some conclusions.

2 TECHNICAL APPROACH

A decision support system of environmental modelling needs a number of components:

- A GIS system capable of displaying geographic (raster and vector) data plus technical facilities such as reprojection, clipping, reclassifying, recoding, resampling, import/export of different file formats, etc.
- Modelling tools for running simulations that can be invoked from the GIS system
- Support for instantiating the model with input data and parameters
- A repository for many different kinds of data, used as inputs or generated as outputs
- Decision support tools which can analyse outputs and generate results in human-consumable form

This is not the only way to divide such a system into components, but we will see it matches the way tools tend to be organised.

Within this structure we hope to use existing tools as far as possible. This is obviously sensible in terms of the effort involved, of not generally having the expertise of specialists who have written such tools, and in the usefulness of an existing user base. Before describing our choices for these components we explain two strategies we have adopted: the use of open source software and of free data, and the PC/Windows environment.

2.1 Open Source

WaterBase will use free and open source software. The free (of cost) part is important in developing countries, especially in view of the expense of commercial GIS tools. But it is also important that the tools are open source: it gives users confidence that they will not suddenly disappear with their original writers, or one day become something you have to pay for, and also gives users the possibility of adapting or extending them. This possibility ranges from the localisation of the interface to the local language to the adding of significant functionality.

2.2 Free Data

WaterBase will also support its users in using data that is freely available, generally on the internet.

Users should not be restricted to such data, of course, because where local data exists it will generally be finer grained and more accurate. But they should not be prevented from doing something even when there is no local data. We plan for the first release of the WaterBase tool to support in particular SRTM digital elevation maps (Int [2004]), FAO/UNESCO soil maps (FAO [2003]) and landuse data from the Global Land Cover Facility (Hansen et al. [1998]). The increasing availability of such data opens up a number of possibilities for its exploitation beyond water resource management.

2.3 Environment

A few years ago environmental modelling meant using high performance computers. But Moore's Law and Intel are changing this situation, and now one can run many models on standard PC hardware. So our goal is that our tools should be able to run on such hardware. For similar reasons, although eventually we would like WaterBase tools to run on any operating system (or at least on Windows, Unix/Linux and Mac OS) we chose what we expect most of our users have available: Windows.

2.4 Tool Choices

For the GIS system the main candidates were MapWindow (`http://www.mapwindow.com/`) and GRASS (Neteler and Mitasova [2004]). GRASS is a widely used open source GIS system, and is developing continuously with a very active group of maintainers. But it was written originally for Unix, and currently has to run under Cygwin on Windows. At the time we made our choice its user-interface was also a little old-fashioned: it has since improved considerably. MapWindow is a native Windows tool, and has been developing rapidly since it became open source. It has been selected by the EPA in the US as the basis for version 4 of BASINS (EPA [2001]), and the teams responsible for MapWindow and BASINS have warmly welcomed our working with MapWindow and are very helpful in assisting us. The MapWindow architecture is designed for easy extensions as "plug-ins".

We did a comparison of several hydrological modelling tools and chose SWAT (Arnold et al. [1998]). *to be expanded*by Vimal.

SWAT is free and open source, and is generally highly regarded. It has a substantial and growing number of users in the developing world, as shown by the papers presented at its biennial conference, the most recent of which was held in Zurich in July 2005.

That left three components to be provided: the MapWindow/SWAT interface, the repository, and the decision support.

MapWindow/SWAT Interface. This we are writing ourselves. It will be similar in scope to the ArcView interface to SWAT, which is probably the way most existing SWAT users set up the model. We are including in it the use of TauDEM (Tarboton and Ames [2001]) to do the initial watershed analysis.

Repository. Initially we will use a fairly simple system based on folders and standard file-name extensions. This will become inadequate as WaterBase grows, and will require more work in the future. Such work requires close attention to users' requirements: it is easy to dream up complicated metadata schemes that all but the most devoted user find quite incomprehensible. We will also try to use open standards for all the kinds of data we will use.

Decision Support. A tool is only useful if it produces reliable results, but reliable results are still not much use if they cannot be interpreted. Model writers tend to concentrate most on issues like accuracy, validity, and speed, and tend to worry less about what to do with all the numbers that flood out from their runs. "SWAT just gives you a lot of numbers" is a common user comment, and almost our first practical task was to create a tool that would support some basic graphical support for interpreting and comparing these numbers. *to be expanded*by Vimal

This visualisation tool is only the beginning of decision support. We will do more, but we need input from users about what they will find useful.

3 Education and Training

The UNU International Network on Water Environment and Health (UNU-INWEH, `http://www.inweh.unu.edu/inweh/`) is a partner in WaterBase. It has established an Internet-based "Virtual Learning Center for Water" (WVLC). This initiative provides distance learning opportunities and information on best water management practices for developing countries. The intent of the WVLC Program is to provide adult training in Integrated Water Resources Management (IWRM), through a core curriculum in distance learning. The WaterBase tools will be integrated into a "Watershed Informatics" module. This will cover not only the technical aspects of water resource management, but also the myriad political, educational, economic, sociological, legal and technical problems encountered in IWRM data, information and knowledge management.

4 ORGANISATION

WaterBase hopes to grow beyond the current small group of people developing tools. We envisage three stages: prototype, trial, development.

4.1 Prototype

Currently we are developing a prototype tool. It will be a prototype not in the sense of poor quality usable only by an experienced and gentle user, but in the sense of being limited to one environment (Windows) and one modelling tool (SWAT). It will be usable by other people, using either free data from the web or local data. Particularly when using data from the web, which tends to be coarse grained, it will be more useful in doing comparative experiments than in providing hard quantitative data. It will be provided free to developing countries, probably in the form of DVDs with dem, landuse and soil data included with the tool.

4.2 Trial

With the prototype we will seek to recruit partners from universities, government departments, etc across the developing world. They will primarily be trial users of the prototype tool, but we will also welcome people who wish to help develop it. We shall in particular be seeking feedback on what tools, training, and other support people on the ground need.

4.3 Development

The prototype is, as its name suggests, just a beginning. With it, through our partners, we will establish detailed user requirements/wishes for tools and training materials to assist in IWRM in developing countries. Then we will seek external funding to establish a project to satisfy these requirements. We expect these requirements to include adding other modelling tools, a repository based on a carefully designed metadata structure, more decision support capability, and availability of the system on other operating systems, particularly Linux: but our users will be the driving force.

5 CONCLUSION

WaterBase is an attempt to assist developing countries to improve their performance in IWRM, by making good tools freely available, through providing the appropriate educational material, and by linking users and developers in different countries together. Currently we are close to providing the first, prototype tool. This, together with the necessary educational material, will enable us to recruit partners to try out the tool, provide feedback, and help us establish a larger project with much larger ambitions and with more, externally funded effort.

Water management is not just a technical and training problem. It requires political will to balance the needs of different individuals and social groups. Modelling tools and trained users can help in offering sound strategies, but we believe that successful management can only come from the informed participation of local people. WaterBase therefore stresses the importance of people in developing countries being involved in all aspects of the project: it is primarily a cooperative project.

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