SIXTH WATER INFORMATION SUMMIT: BREAKING THE BARRIERS
LET WATER INFORMATION FLOW!

WATERWEB CONSORTIUM AND IRC INTERNATIONAL WATER AND SANITATION CENTRE
SEPTEMBER 9-12 DELFT, THE NETHERLANDS 2003

AQUASTAT - GETTING TO GRIPS WITH WATER INFORMATION FOR AGRICULTURE

Åse Eliasson[1], Jean-Marc Faurès, Karen Frenken, and Jippe Hoogeveen[2]

ABSTRACT: Water will continue to be the key resource for the production of food. Today, irrigation covers about 20 percent of the world's cultivated land and contributes to 40 percent of total food production. Agriculture uses approximately 70 percent of all the freshwater withdrawn in the world and in some regions competition with industrial and domestic uses and environmental requirements is increasing. Because of this increased pressure on water resources, the need for reliable and consistent data on the state of water resources and agricultural water use is widely recognised by governments as well as national, regional and international institutions. To support decision-making for improved access and sustainable use of water resources the Water Resources, Development and Management Service of the UN's Food and Agriculture Organization (FAO) initiated in 1993 "Aquastat", the organisation's information system on water and agriculture.

The Aquastat information system consists mainly of, a) systematic descriptions of the state of agricultural water management by country and by region with focus on developing countries and countries in transition, b) up-to-date online data by country, c) digital geographical data on water resources and irrigation and d) specific studies such as the review of world water resources by country, the irrigation potential in Africa, projections of future agricultural water use and irrigation development and contribution to the World Water Development Report.

The current data and information on the Aquastat website have been acquired through extensive surveys, which were carried out for Africa (1995), Near East (1996), the countries of the former Soviet Union (1997), Asia (1998) and Latin America and Caribbean (1999). Country information is updated regularly and currently the African countries are in the process of being reviewed and updated. The surveys follow a standard methodology, which strongly involves national expertise. They comprise, a) country based reviews of literature, b) data and information collection by national resource persons through a detailed questionnaire, c) critical analysis, data processing and standardisation of information and d) preparation of country profiles and tables, which are

[1] Land and Water Development Division, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, 00100 Rome, Italy. E-Mail: ase.eliasson@fao.org

[2] The Aquastat Team of the Land and Water Development Division (AGL) of the Food and Agriculture Organization of the United Nations (FAO); E-Mail: aquastat@fao.org

submitted to national authorities for feedback and approval before being disseminated. Tools such as remote sensing, geographical information systems (GIS) and hydrological models are applied to estimate data for those variables for which very limited information is available and to provide spatial data. Further, a country water resources calculation framework has been developed and applied globally for consistent water resources assessments.

The experience indicates the importance of systematic data and information collection and evaluation, harmonised definitions and classifications, associated metadata, support for evaluation in the database management system, website properties to guarantee quick and good access for all users and collaboration with other institutes. Printed information still remains the major information source accessed for most of the developing countries.

INTRODUCTION

Comprehensive, reliable and systematic information on the state of water resources and people's access to and use of them has been highly recognised by international and national institutions as a tool for improving food security and access to water and sanitation. The targeted commitments and actions have been agreed upon at the World Summit on Sustainable Development in Johannesburg in 2002 and outlined in the Millennium Development Goals. Agriculture is the largest user of water and as population grows the need for water in food production will increase further. Currently, 800 million people (FAO, 2002) are undernourished and more than 1 billion people have no access to safe drinking water and more than 2.4 billion lack access to any form of improved sanitation services.

It is in FAO's mandate, as stated in Article 1 of its constitution, to "collect, analyse, interpret and disseminate information related to nutrition, food and agriculture". Internet has become an important media for information dissemination and management, but other information media are just as important for FAO as internet is not accessible for many of the FAO targeted users (FAO, 2000a). As the information-rich countries are getting more and more information through the expansion of digital information the gap between the information-rich and the information-poor countries, *i.e.* the digital divide, is getting wider and wider.

Aquastat collects, analyses and disseminates data and information by country on water recourses and agricultural water use, targeted to users in international institutions, national governments and development agencies. It was used as a reference database for the World Water Assessment Programme, which is a joint UN initiative with the aim to improve global water management, were FAO is one of the partners. One of its components is the World Water Development Report (2003) "Water for People, Water for Life", which was presented at the Third World Water Forum in March 2003 in Kyoto. The report provides extensive analyses and facts of the world's freshwater resources and its stewardship targeted at those involved in formulation and implementation of water-related policies and investments.

However, the relation between water information, knowledge and decision making for development is not that straight forward (Dean, 2000, World Bank, 1998 and 1999). Parker

(2000) discussed this issue and illustrates the complexity by stating that *information is like water because:*

- *it comes from many different sources*
- *it may be easy to obtain, or difficult*
- *before it can be used, it has to be, collected, processed, stored and distributed*
- *it may be used for many different purpose*
- *it may be polluted through distortion or inaccuracy*
- *it may be lost through leakages*
- *it flows – but, unlike water, not of its own accord; the flow of information has to be managed if it is to reach those who need it, when they need it.*

The aim of this article is to describe the FAO information systems relevant to water, in particular Aquastat and experience and lessons learned concerning information management. The paper is organised in five sections, addressing the following questions. Section 1, What is the role of agriculture in the global water resource scarcity picture? Section 2, Which are the FAO information resources relevant to water? Section 3, How is information gathered in Aquastat and what are the products? Section 4, What are the experience and lessons learned on information management and Section 5, Which are the conclusions and recommendations drawn?

WATER AND FOOD SECURITY

To reduce the water and food scarcity problem that especially many developing countries are facing, there is a need to produce more crop per drop, to ensure equitable access to water and to conserve water quality. Irrigated agriculture is responsible for 70 percent of all the freshwater withdrawn in the world, while industry and domestic withdrawal represent 20 and 10 percent respectively. The daily drinking water needs, two to four litres per person, are very small in comparison to the water required to produce a person's daily food, which ranges from 2000 to 5000 litres.

Today, irrigation covers about 20 percent of the world's cropland and it contributes 40 percent of total food production. By the year 2030 FAO estimates that the world will require around 50 percent more food to feed a growing population. This might sound a lot, but in the last 30 years the food production increased by over 100 percent. The increase needs to be provided by both irrigated and rainfed agriculture. The expansion of irrigated agriculture is predicted to contribute for 70 percent of the increase in cereal production in the developing countries and is important in those countries where insufficient rainfall limits rainfed agriculture and where there is limited potential for expansion of arable land (FAO, 2003b).

Global totals and averages mask reality and national totals and averages still may hide enormous differences within the countries. Also the access to water varies in time, due to seasonal variations and extreme periods with droughts and floods, which does not show up in these long-term national averages. Water is already scarce in many countries. A number of countries are already pumping more water than it is recharged. Conflicts between upstream and downstream users within and between countries are arising because of increased demand of water. There is increased pressure from the industry and domestic uses and to sustain water for ecosystems, limiting the availability of water for agriculture. Figure 1 shows agricultural water withdrawals as percentage of the total renewable water resources by country, which indicates in which countries the human pressure on water resources are critical. However, water scarcity is not necessarily linked to food insecurity. For example, the Near East and North Africa are nutritionally relatively well off. This is, amongst others, due to major investments in water development, which have enabled foreign exchange and import of food. Also countries like India, China and Mexico would have shown a much darker picture if there had been not such large investments in water development.

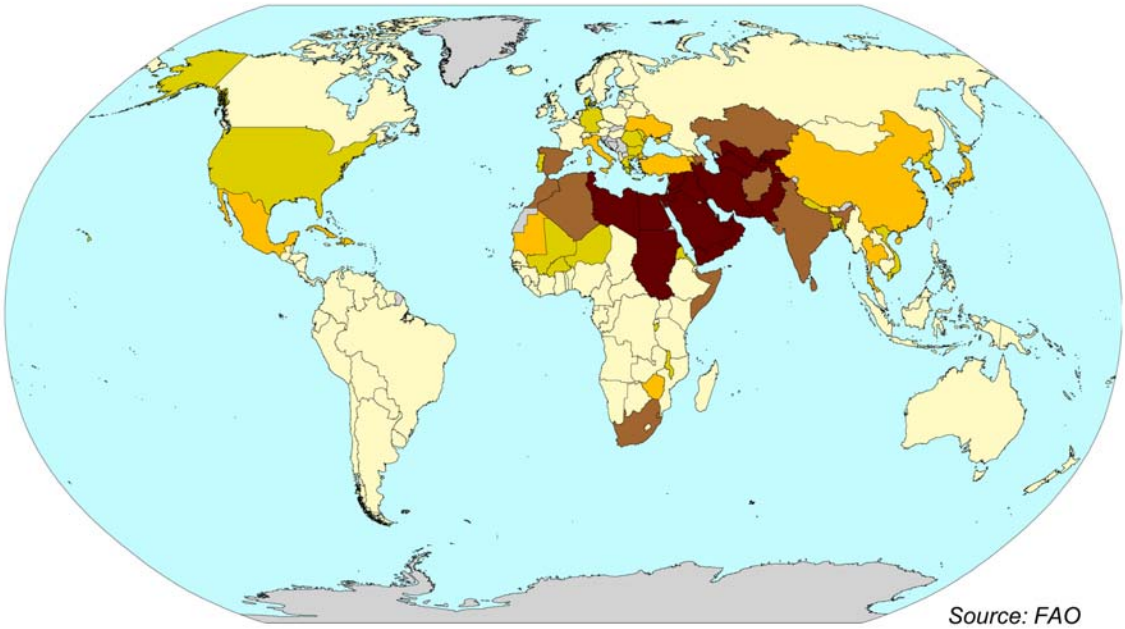

Figure 1. Agricultural water withdrawals as percentage of the total renewable water resources by country.

FAO INFORMATION SYSTEMS

FAO is disseminating a range of products, e.g. publications, statistics and geographical data through the internet, as printed publications and other information media. Table 1 describes a few selected information systems that are relevant for water management issues on global level.
Table 1. Selected information systems at FAO relevant for water management on a regional and global scale. The Internet addresses are provided at the end of the article.

Table 1. List of Selected Information Systems at FAO Relevant for Water Management.

Information system	Description
Aquastat	Global information system of water and agriculture developed by the Land and Water Development Division.
FAOSTAT	The statistical database is an on-line multilingual database currently containing over 1 million time-series records from over 210 countries and territories covering statistics on agriculture, nutrition, fisheries, forestry, food aid, land use and population. Data are also published on CD-rom and in various FAO yearbooks. The data is collected on a yearly level through the ministries in the respective countries. The database is arranged in 19 domains, such as agricultural production, trade, food aid, land use and population.
FIGIS	The Fisheries Global Information System is a global information system on fisheries aimed at providing policy makers with timely, reliable strategic information on fishery status and trends on a global scale.
FIVIMS	The Food Insecurity and Vulnerability Information and Mapping Systems project contains a network of systems that assemble, analyse and disseminate information on the problem of food insecurity and vulnerability.
GEONETWORK	The FAO portal to spatial data and information
GIEWS	The Global Information and Early Warning System on Food and Agriculture provides regular bulletins on food outlook, food crops and shortages, food supply situation and crop prospects, weather and alerts on a regional or country-by-country basis.
GTOS	The Global Terrestrial Observing System houses an international directory of sites and networks that carry out long-term terrestrial monitoring and research activities.
Waicent Infofinder	The world agricultural information centre portal improves access to agricultural information: essential documents, statistics, maps and multimedia resources
Water and food security country profiles	Information retrieval portal which groups the organization's vast archive of information on its global activities in agriculture and development in a single area and catalogues it exclusively by country.

AQUASTAT

The Aquastat programme, operated by the Water Resources, Development and Management Service of FAO, has been developed to meet the demand for reliable and consistent global data and information on water and agriculture from international institutions, national governments and development agencies. It was initiated in 1993 and it was later shown to be one of the main accessed resources by users from various institutions and universities. In 2001, a critical review of outputs, tools, users and user needs were carried out. Information needs and lacks were identified after which the methodology, dissemination and management tools were improved.

Purpose

The goal of Aquastat is to support agricultural and rural development by sustainable use of water and land by providing:

- Systematic descriptions on the state of agricultural water management by country
- Up-to-date and reliable data by country
- Predictions of future agricultural water use and irrigation developments
- In-depth analysis for diverse thematic studies, such as the World Water Development Report, Agriculture towards 2015/2030, Global review of water resources by country
- Methodologies and definitions for the water resource and irrigation sector
- Answers to requests from governments, research institutes, non-governmental organisations and individuals.

Methodology

The information provided by Aquastat relies to a great extent on national capacities and expertises. The goal is to provide the most accurate information, presented in a consistent and standardised way. The core information has been acquired through extensive surveys covering Africa (1995), Near East (1996), the countries of the former Soviet Union (1997), Asia (1998) and Latin America and Caribbean (1999). Country profiles are to be updated regularly and currently the African countries are surveyed. The Aquastat information management process is illustrated in Figure 2 and comprises:

- Review of literature and information at country and sub-country level
- Country surveys consisting of data collection and country description through national resource persons by means of a detailed questionnaire, where the source reference and comments are associated with each value
- Critical analysis of information and data processing by the Aquastat Team at FAO Headquarters. Preference is given to national sources and expert knowledge. The data validation and processing is supported by the Aquastat database management system.
- Modelling of data by means of GIS and water balance models for estimating unavailable data and for providing spatial data. GIS data and remote sense data are important input data together with the data acquired trough the country surveys, which are also used for calibration
- Standardisation of information and data tables

- Feed back and approval from national authorities/institutions
- Dissemination on the web, as publications and/or as CD-rom
- Finally, voluntary feedback is acquired from users and through co-operation with other institutions.

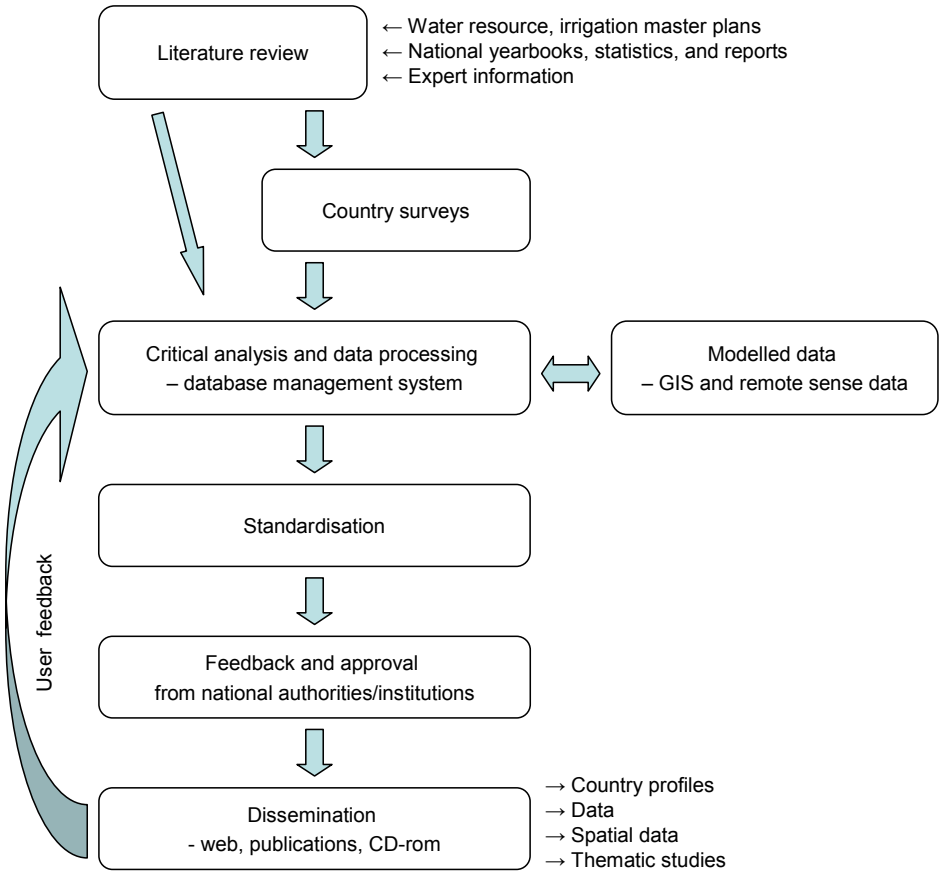

Figure 2. The process through how information is gathered, analysed and provided in Aquastat.

Water and agricultural information sources

All the Aquastat products are available through the internet and as published reports or on CD-rom. Below is a brief description of the different outputs. For further information on the products and description of the methodologies the reader is referred to the Aquastat web site.

Country profiles and regional overviews on the state of agricultural water management: Country profiles and the regional overviews describe the state of agricultural water management

for 150 developing countries and countries in transition and five regions in either English, French or Spanish (FAO, 1995, 1997a, 1997b, 1999 and 2000b). Depending on the importance of irrigation in the country, its size and amount of information available the descriptions vary from three to ten pages. The country profiles have been standardised and provide information on geography, climate and water resources, agriculture, economy, food security, irrigation and drainage development, water policies, environment and health and summarise the perspectives in agricultural water management. In addition, standardised tables holding key data are included in all the country profiles. Added value information on the key data is provided in the text profile, which allows for further description of the origin and particularities of the value. The regional overviews provide analysis by a grouping of countries which are similar in terms of geographic and socio-economic conditions and include tables and maps.

Databases: Around 150 variables on water and agriculture by country can be accessed through the internet on the Aquastat database query system, which will also be made available on a CD-rom in the future. Data can be queried online or downloaded as a comma separated value file (CSV). The query allows for multiple selection options, were the user can a) select a country, a number of countries, or a continent, for b) one variable, a group of variables, or selected variables, for c) one time period or several time periods. Due to the problems of acquiring time-series data, one value for each five year period is aimed at for the moment. Data can be queried for every five year period back to 1965, but the time-series are far from completed. A complete time-serie of yearly values from 1961 onwards exists for the variable on irrigated land, which is made available through the Faostat database, on the basis of the Aquastat data. To allow for further analysis the user can type the variable and country codes and define their own display of the data table in the Aquastat database. The variables are classified in the following five major categories, each containing several sub-categories:

- geography and population
- climate and water resources
- water use
- irrigation and drainage development
- environment and health

In addition to this database, there are four other databases on, a) addresses and links to around 300 institutions in the field of agricultural water resource management, presented by country, b) a glossary, containing definitions for around 250 terms in the field of water resources and agricultural water management, including terminology, origin, comments and typology in English, French and Spanish, c) detailed calculations of renewable water resources for around 200 countries, including an inventory of reference sources by country, d) a geo-referenced database of large African dams holding information on the year of completion, size, capacity, rate of sedimentation and purpose of use of dam.

Spatial data: The digital spatial resources are mainly the Global Map of Irrigated Areas and the Atlas of Water Resources and Irrigation in Africa.

The Global digital map of irrigated areas (Siebert et al 2002) is an ASCII grid map with a resolution of 5 minutes (about 10 km at the equator) showing the percentage of areas equipped for irrigation around 1995. The map has been created in co-operation with the Center for Environmental Systems Research of the University of Kassel and several improvements since the first version have been carried out (Döll and Siebert, 1999 and Siebert and Döll, 2001). The methodology includes a variety of steps depending on the type of data available for the respective country and includes tools to allow for inclusion of new information and quick updates of the global map. The location of areas equipped for irrigation within each country is determined by digitizing irrigation maps and by mapping non spatial data sources such as databases and reports holding information on location and size of irrigation projects. Additional information such as interpreted satellite images and land cover datasets are used to identify the most likely locations of irrigated land. Due to the methodology, which depends very much on the availability of input data per country, the map has no uniform quality.

The Digital Atlas of Water Resources and Irrigation in Africa is published on the internet and on a CD-rom (FAO, 2000c). It and contains mainly a set of spatial data and tables on annual averages on water resources and water use by major river basins and sub-basins in Africa. Natural and actual water resources and runoff, actual evapotranspiration and soil water storage has been modelled on a spatial resolution of 10 square km with a simple steady state, water balance model with monthly time steps in a GIS environment. The spatial data include, digital elevation model (USGS, 2000), precipitation (Leemans and Cramer, 1991), reference evapotranspiration, rivers, dams and waterbodies, soil moisture storage properties (FAO, 1998) and irrigation cropping pattern zones. The model results were calibrated against natural and actual annual water resources by country from the Aquastat data, and by river runoff from major rivers by river basin from the global discharge database (UNESCO, 1995).

Thematic studies: In-depth studies based on the Aquastat information resources described above have been carried out, contributing to publications on a) irrigation potential in Africa, b) global water resources by country, c) Agriculture towards 2015/30 and d) World water development report. All reports are available as published reports and in html format.

The study on "Irrigation potential in Africa, a basin approach" (FAO, 1997c) assesses the land and water that are available for irrigation development by major river basins. The approach is based on the physical constrains of land and water, including variations between wet and dry years and highlights the environmental issues in relation to irrigation developments. The study is particularly useful for researchers and planners at national and regional levels working with sustainable water resources development in Africa.

The "Review of the world water resources by country" (FAO, 2003a) has been undertaken to improve the quality of the knowledge of the state of the world's water resources. The study comprises, a) detailed data on internal and external generated surface water and groundwater resources in the country and its components, e.g. flow reserved by treaties, b) the countries dependency on water from other countries, c) calculation spreadsheet with rules and guidelines

for accounting the water resources and d) regional overviews of the water resource situation. The methodology for assessing renewable water by country was first described by FAO/BRMG (1996) and is based on a water accounting approach.

Within the framework of the study "World Agriculture: towards 2015/2030" (FAO, 2003b) an assessment has been made of the present and future agricultural water use and irrigation efficiency. This publication is the latest FAO assessment on possible long-term developments in world food, nutrition and agriculture, including forestry and fisheries. To provide a comparable coverage the current and future water use for agriculture has been estimated for 93 developing countries. The estimations are based on a spatial water balance calculation approach by applying a simple hydrological model in a GIS environment with a spatial resolution of 10 square kilometres and with monthly time steps. The main outputs of the study are an irrigation cropping calendar and irrigation water use per country for the year 1998.

As part of the "World Water Development Report" Aquastat has prepared a chapter on Agriculture, Water and Food (FAO, 2003c). It addresses questions like: What is the status of food production in the world? How can it be more efficient without compromising the environment? What is the connection between food security and poverty?

EXPERIENCE AND LESSONS LEARNED

The experience and lessons learned in global water information management show the importance of national capacities, systematic data and information collection, harmonised definitions, metadata, support for data handling in the database management system, website properties and, last but not least, a good team.

To acquire reliable data and information the importance of cooperating with national resource persons working in the field of water and agriculture, with good networking capabilities and sense of responsibility, has shown to be vital. To be able to have access to and to collect information from various sources and to discuss the contents with the people in the respective fields, Aquastat is relying to a major extent on experts in the country and the collaboration with FAO representatives and institutions.

Country surveys in Aquastat have shown the difficulties in acquiring data on national and sub-national level for several variables, such as private or 'informal' irrigation, the use of groundwater, water use efficiency, cost of irrigation developments, area salinized by irrigation and water related diseases. Attempts have also been made to collect data by river basin which has shown to be almost inexistent. Efforts are now undertaken to deal with these issues through thematic studies.

Experience also shows that water scarce countries have more reports describing the state of water use and water resources, but, often these analyses are based on a limited number of basic data and the computing methods behind vary from one country to another. In countries where water is abundant very limited information on irrigation and water resources is existing. Moreover, acquiring data on natural river flows, i.e. without major water withdrawals for agriculture, has

shown to be very difficult for the regions where water withdrawals for irrigation are significant since long times.

To be able to provide comparable datasets and descriptions of agricultural water management by country it is important to critical analyse them and to standardise them. Variables on for example arable land, water resources, irrigation, water withdrawal, have different meanings in different countries and therefore imply major uncertainties when used for global analysis. In addition, when calculating transboundary water resources it is very important to apply the same rules based on physical approaches to ensure consistency between the countries and regions and to avoid double counting of water resources. Therefore it is important to have clear definitions, typologies and calculation rules.

The importance of associated metadata, i.e. bibliographical reference and comments associated with each value, becomes clear when processing data. Each value in the Aquastat database is stored with a bibliographic reference, the actual source year of the value and a comment. This is a way to keep track of the data and to select the most reliable information. This comment field provides additional information, such as methodology used, uncertainty range, or expert opinion.

The functions and support of the internal database management system has shown to be very important for secure handling and validation of data. The data collected is going trough a critical review by the national resource person hired and by the Aquastat Team, further supported by the database management system through a set of functions. Before data is uploaded to the query database it has to pass a set of actions, involving evaluation and calculation rules and relationships between the different variables to avoid non-logical values. All the changes in the database are kept full record of in a journal history.

GIS, remote sensing and models have proven to be valuable tools for providing spatial data and making projections on key indicators. The availability of global quality spatial datasets on land cover and base data has made it possible to make predictive modelling studies for indicators such as river runoff, agricultural water withdrawal and irrigated areas for those areas where data exist for calibration and evaluation. As water resources are not divided by administrative boundaries, the use of GIS and models for processing data by river basin and or smaller spatial units are applied for water balance calculations, as described in the previous chapter. The use of these tools and spatial data also provides a powerful instrument showing the degree of water stress by river basin, which illustrates where conflicts may arise due to the claim of water by different countries or areas.

For information dissemination the internet has shown to be a quick and dynamic way of publication. To be able to guarantee a quick access for as many internet users as possible the Aquastat website follows the World Wide Web consortium standards and the layout is made as simple as possible to enable quick loading times and printer friendly formats. The website is available in English, French and Spanish and uses style sheets to allow for simple editing and coherent layout changes. Methodologies and descriptions of the information provided are all easily accessible in html format. The website has also shown to be an important media for feedback from users.

However, information dissemination through the web is not the only media as the web site is difficult or even non-accessible for many of the FAO targeted users. The digital divide between information-rich and information-poor countries is very much illustrated through the monitoring of the Aquastat users. For example, in June 2003 the Aquastat website had around 850 hits per day, 70 visitors per day, where the number of users from Africa was less than one percent.

CONCLUSIONS

Agriculture will continue to be the main user of water and to ensure people's access to water for food, health and hygiene, actions and investments are necessary. FAO is devoting considerable efforts in providing its users with access to information on the state of world agriculture, fisheries, forestry, nutrition and the environment in support of agricultural and rural development, in addition to actual working on development assistance, advising governments and providing a neutral forum. Although the access to information will not in itself lead to reaching the goal of equitable and sustainable development, reliable and standardised information on key variables is necessary to raise awareness and to make well-informed decisions on investments and cooperation on integrated water resource management. In doing so quality check, metadata and standardised information have shown to be the major requisites for the work of the Aquastat Team. In addition, the dissemination and sharing of information, data and tools provides decision-makers, media, researches, non-governmental organisations etc. with information resources for improved water resource management. Finally, as the internet is not yet accessible to all, other information media such as printed information remain important along with strengthening of information and knowledge management capacities.

REFERENCES

Dean, J., 2000. The Role of Knowledge in Development Cooperation. *Information Development 16 (4): 239-240*.

Döll. P. and Siebert, S., 2001. A digital global map of irrigated areas. - An update for Latin America and Europe. *Kassel World Water Series. Report Number 4*. Center for Environmental Systems Research, University of Kassel, Germany.

FAO, 1995. Irrigation in Africa region in Figures. *FAO Water Report 7.* Rome. 336 p.

FAO, 1997a. Irrigation in the Near East region in Figures. *FAO Water Report 9.* Rome. 281 p.

FAO,1997b. Irrigation in the countries of the Former Soviet Union in Figures. *FAO Water Report 15*. Rome. 226 p.

FAO, 1997c. Irrigation potential in Africa - a basin approach. *FAO Land and Water Bulletin 4*. Rome. 177 p.

FAO, 1998. Digital soil of the world and derived soil properties. *FAO Land and Water Digital Media Series No 1*. Rome.

FAO,1999. Irrigation in Asia in Figures. *FAO Water Report 18. Rome*. 228 p.

FAO, 2000a. *1st consultation on agricultural information management, working document*, Rome 5-7th June 2000, Improving access to Agricultural information.7 p.

FAO, 2000b. Irrigation in Latin America and the Caribbean in Figures. *FAO Water Report 20*. Rome. 348 p.
FAO, 2000c. Atlas of Water Resources and Irrigation. *Land and Water Digital Media Series no. 13*. FAO, Rome.

FAO, 2002. *The state of food insecurity in the world*. FAO, Rome.

FAO, 2003a. Review of world water resources by country. *FAO Water Report 23*. Rome. 110 p.

FAO, 2003b. *World agriculture: towards 2015/2030, an FAO perspective*. Ed. Bruinsma, J. Earthscan Publications Ltd. 432 p.

FAO, 2003c, *Agriculture, Water and Food*. FAO, Rome.

FAO/BRMG, 1996. *Les ressources en eau, manuels et méthodes*. FAO. Rome.148 p.

Leemans, R. and Cramer, W. 1991. *The IIASA database for mean monthly values of temperature, precipitation and cloudiness on a global terrestrial grid. Research Report RR-91-18*. November 1991. International Institute of Applied Systems Analysis, Laxenburg, Austria.

Parker, S., 2000. Knowledge is Like Light - Information is Like Water. *Information Development 16(4): 233-238*.

Siebert, S. and Döll, P., 1999. A Digital Global Map of Irrigated Areas, Kassel *World Water Series. Report Number 1*. Center for Environmental Systems Research, University of Kassel, Germany.

Siebert, S., Döll, P., and Hoogeveen, J., 2002. *Global map of irrigated areas version 2.1*. Center for Environmental Systems Research, University of Kassel, Germany / Food and Agriculture Organization of the United Nations, Rome, Italy.

UNESCO, 1995. Discharge of selected rivers of Africa. *Studies and Reports in Hydrology 52*. UNESCO Publishing, Paris.

USGS, 2000. *HYDRO1k geographic database*. Developed by the US Geological Survey's EROS Data Center in cooperation with UNEP/GRID Sioux Falls.

World Bank, 1999. *World Development Report 1999/2000*: entering the 21st Century: the changing development landscape.

World Bank, 1998. *World Development Report 1998/1999*: knowledge for development. Published for the World Bank by Oxford University Press, 1998.

World Water Development Report, 2003*, Water for people, Water for life*. UNESCO Publishing and Bergham books. 576 p.

INTERNET ADRESSES

Aquastat: http://www.fao.org/ag/AGL/aglw/aquastat/

FAOSTAT: http://apps.fao.org/default.htm

FIGIS: http://www.fao.org/fi/figis/

FIVIMS: http://www.fivims.net

GEONETWORK: http://www.fao.org/geonetwork

GIEWS: http://www.fao.org/giews/

GTOS: http://www.fao.org/gtos/

Water and Food Security country profiles: http://www.fao.org/countryprofiles/water/

Water Resources, Development and Management Service: http://www.fao.org/ag/agl/aglw/

Waicent InfoFinder: http://www.fao.org/waicent/search/

WWAP: http://www.unesco.org/water/wwap/