WaterFigures

Research for Development

July, 2012

Making Water Data Work for Development

A twenty-first century combination of satellite remote sensing and mind-expanding computing power has created a golden age of data acquisition and processing for land and water management scientists and practitioners. However, many challenges remain. As we grapple with increasing amounts of data and ever-more complex digital models, this issue of *Water Figures* looks at how scientists at the International Water Management Institute (IWMI) and partner organizations are using these new resources to benefit sustainable agricultural development. **Read more …**

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IWMI is a member of the CGIAR Consortium and leads the: CGIAR Research Program on Water, Land and Ecosystems

EDITORIAL

WATER FIGURES JULY, 2012

The Data Revolution

The United Sates began its earth-mapping Landsat program in 1972. The first three satellites each had a ground resolution of around 80 meters (m), which was enough to be able to recognize a sports field, but not really enough to see the detail in a landscape. Over the next few decades many other countries put up satellites and technology raced on apace. By the time I began my career in Geographic Information Systems (GIS) and Remote Sensing (RS) in the mid-1990s, satellites orbiting the earth could send back images with a resolution as high as 10 m. Now I can turn on my computer and view images with a resolution of half a meter. I can clearly see individual trees and groundwater wells. The progress has been truly astonishing.

However, the boom in GIS and RS has created a challenge: huge amounts of data. We need ever-increasing computer processing power to cope with this. We also need the time and the resources to catalogue and organize a never-ending stream of information. Not only do we receive complex satellite images, we interpret and model the data we get, generating even more material. The International Water Management Institute (IWMI) has 25 years' worth of scientific data. Until recently it was a major challenge to keep track of all this information and make sure scientists could get the data they needed. Something had to be done.

Last year, IWMI upgraded its GIS facility to give more and more researchers access to state-of-the-art geospatial tools and techniques. IWMI's online **Water Data Portal**, which unifies our data resources and allows us to keep everything up-to-date, is a fantastic resource for researchers. Where possible the information we hold is available publicly. The richness and diversity of the data is a treasure trove for water specialists everywhere. The quantity and quality of the data are increasing fast but past data has also been made available. Historic continuity is important for both researchers and resource managers for time series analysis, a technique that can track how land and water use has changed over time. Knowing this can inform effective policy decisions on long-term water management.

We truly live in an age of data abundance. The internet has made information resources global and, in many instances, freely available. In this issue of *Water Figures*, we have highlighted some key areas where improved access to data is driving cutting-edge research into water management. However, if we are not to drown in this digital downpour, we need to make continued investments in effective data management. The challenge is only just beginning.

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Front cover photograph: Installation of water level boards, Jeldu, Ethiopia (Photo credit: Birhanu Zemadim/ILRI)

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Solving the hydrology data dilemma

Interview with Vladimir Smakhtin

It is the dream of every water scientist: freely available data on river basin discharges for the entire world, wherever they are needed. Not only would this ensure informed water management, but it would also allow climate modelers to detect changes and improve their predictions of future shifts in rainfall. If it can be made a reality such a system would surely contribute to improved food security for the entire planet. Yet, the availability of accurate water-related data has been declining in recent years. Many nations are reluctant to share what they already have even within their respective countries, let alone internationally. New technologies may offer a partial solution, but in a rapidly changing world data is urgently needed now.

These are some of the conclusions of Vladimir Smakhtin, leader for IWMI's research theme on Water Availability and Access, derived from an analysis of the availability of global hydrological and climatic data. Vladimir suggests that, while our understanding of hydrological systems has significantly improved in the past 20 or 30 years, the current level of hydrometeorological data gathering is insufficient to meet current and future demands. "There's a misunderstanding of just how important data are," says Vladimir. "The truth is that you cannot properly manage what you do not measure. To know how much water you have in a river or aquifer, you have to measure it over time and at many different locations to capture its variability in time and space. If you do not have that information you cannot set up meaningful mathematical models of water flow. All models are imperfect reflections of reality and they need to be calibrated or tuned, like you tune your receiver to a radio station in a car. This tuning is done by comparing simulations with observations. Un-calibrated models are like untuned radios: impossible to understand and confusing to listen to.

The global demise of data collection is alarming. In the USA, some 2,200 flow stations, maintained by various organizations, closed down between 1980 and 2005. In Australia, although the number of active flow-monitoring stations increased from 1,870 to 1,960, since then the number of stations have remained static. Russia hosted 7,083 gauges in 1980 but by 1991 this number had dwindled to 3,053. The situation in most developing countries is even worse. In addition, conflicts have led to major data losses in Afghanistan, Bosnia-Herzegovina and some other countries. Also, there are still more gaps in our knowledge. "On the global scale," says Vladimir, "We measure river flow from only some 55% of the land mass and even that is done inconsistently. As for groundwater, we hardly know how much of it exists in different parts of the world. We just drill!"

There are political, technical and financial reasons why hydrological data gathering has not kept up with demand, particularly in developing nations. Data gathering is a long-term process, with data series ideally spanning at least 30 years so they reflect natural variability. However, many politicians are not interested in supporting long-term programs that will exceed the length of their political careers. Collecting data is neither viewed as a vote-winner nor as a 'sexy' subject for students and academics, so it does not attract funding and interest as easily as more engaging projects. This translates into a number of problems ranging from the absence of trained technicians, lack of equipment maintenance, and poor quality control and archiving.

No one really knows how many flow-gauging stations are required for current needs. "The density of stations should be related to variability in hydrological processes and rainfall," explains Vladimir. "And because of climate change, we may need to revise the international guidelines on what constitutes an adequate number of flow gauges to properly measure variation. We need to send a clear message to policymakers about what is required.

Even if there are enough data-recording devices, sharing that data still remains a huge challenge. In some cases, particularly in the developing world, this is simply because data exists in hard copy format and there are no facilities to digitize it. However, there are many situations where governments are reluctant to share their data with other nations, because they feel that doing so constitutes a security risk. "Nepal freely shares its data," explains Vladimir. "If India and Bangladesh opened up their datasets on the Ganges River to each other they would probably find it much easier to manage the water resources for their mutual benefit. There is no merit in secrecy. There should be fully accessible databases for all transboundary rivers. Globally, almost all major rivers flow across national boundaries."

There have been many attempts to remedy the lack of data, but with mixed results. For example, in 1993, the World Meteorological Organization (WMO) set up the World Hydrological Cycle Observing System (WHYCOS). The aim of this was to install automatic observing stations on major rivers and transmit data via satellite to research laboratories. Although several regional Hydrological Cycle Observing Systems (HYCOS) were established as part of WHYCOS, overall progress has been slow. Moreover, the project has demonstrated that applying technologies from developed countries to developing countries does not always work.

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In southern Africa, for example, only seven of the 48 data collection platforms installed between 1998 and 2001 were still operational by 2006. Elsewhere, progress is encouraging. The Global Runoff Data Centre (GRDC) in Germany, for instance, has succeeded in establishing data streams from 8,000 stations on the world's major rivers. For the time being, this is the best global water data archive we have. Yet, it contains only a fraction of the globally available data.

"In this age of information overload, many seem to think that we are swimming in an ocean of data," says Vladimir. "But what kind of data are these? It is true that various climate and hydrological models now generate googols of data of almost any kind. However, this is simulated, synthetic data. We are designing methods to evaluate modeling uncertainty to cope with this, but it is not a satisfactory substitute."

According to Vladimir, a rethink is needed. One possibility could be to stop looking for data on-the-ground and start looking to the skies. He suggests that there are ways in which satellite remote sensing, for example, could help solve the data crisis. It is already fairly common for researchers to use available remote sensing data on land use, precipitation, topography, etc., to help simulate hydrology. This still requires some calibration with observed data but can help overcome gaps where data is sparse. The more radical approach is to do away with field measurements completely and redirect efforts and funds into improving the accuracy of remote sensing. Vladimir is hopeful that this may eventually become as accurate as measurements from gauging stations on-the-ground. "Remote sensing is already so accurate that you can read a car number plate from low Earth orbit; and some techniques can now penetrate right through water and soil to identify what is underneath. So, let's put these to work on a large-scale in the water world," he says. "If remote sensing could be used to collect primary data, it may influence some nations to make their existing data available. Also, if observed, accurate and accessible data comes from a universally accepted source such as accurate satellite measurements, there will naturally be no restrictions to data sharing."

If good quality hydrological data sharing is to become a reality, an internationally agreed framework is needed to ensure that scientists can access that data easily and cheaply. A central repository and backup will also be essential to avoid unnecessary loss of data through conflicts or environmental disasters. "I am looking forward to the day when the entire world's available hydrological data will be stored at, say, WMO headquarters, and be available on request," says Vladimir. "So, if I need daily flow data for Turkey, or Manitoba, it will be delivered directly to my desktop. Realizing this dream will be difficult but if we spent only 1% of the money spent globally on water infrastructure to address this issue, then it's possible that the dream might just become a reality."

Getting the measure of farm wells in northern Sri Lanka

Satellite image showing locations of farm wells in Jaffna Province, Sri Lanka.

Groundwater use is increasing across South Asia at a dramatic rate. Cheap pumps and low energy costs have made extraction of groundwater an attractive proposition to many farmers. However, overexploitation can create severe environmental problems. In Sri Lanka, wells are proliferating in many areas but nobody really knows just how many there are.

To better understand the potential impacts of this trend, GIS/RS experts at IWMI are using remote sensing to analyze changes in the number of wells in northern Sri Lanka. The five-month study focussed on three agricultural areas lying in the dry zone of the country: Kalpitiya in the west, Anuradhapura in the center and Jaffna in the north.

"In the last few years the number of agricultural wells in these areas has increased drastically," explained Salman Siddiqui, Manager of the GIS/RS/Data Management Unit at IWMI. "However, there wasn't much data available on this because these areas, particularly Jaffna, were affected by the recent civil war. According to a

rough estimate there may be as many as 100,000 wells in Jaffna alone – that is one every 100 meters (m) or so."

"If too many new wells have been dug this could have serious consequences on the quality of groundwater," says Salman. "Lower groundwater levels can lead to increasing problems of salinity as it encourages seawater intrusion. Ultimately, this can permanently damage the shallow freshwater aquifer, which makes the water useless for agriculture or drinking purposes."

The scientists acquired 0.5-meter resolution satellite imagery from the IKONOS and QuickBird satellites to home in on one 'Divisional Secretariat' (an administrative subunit) in each district. They then analyzed the satellite images from the years 2000 and 2010 to see how the number of wells has changed over this time in each area.

"We found an increase in the number of wells of just over 37% between 2003 and 2009. At the same time, the area used for agriculture only increased by around 6%," says Salman. "Next, we want to establish if there is a relationship between the number of wells and farm production or yields. If yield is not increasing, we could introduce an awareness programme to tell people that simply sinking more wells is not going to help them produce more crops and that it could be damaging to the environment to do so."

Salman Siddiqui
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Calculating the water needs of pilgrims and dolphins

Defining optimal flow requirements for a complex river system is always a challenge, but when the river is also a 'holy goddess' the process requires some innovative approaches.

It is not often that scientists are asked to quantify the 'holiness' of a river. However, this was what was required when World Wide Fund for Nature (WWF)-India asked IWMI to calculate 'environmental flows' for its 'Living Ganga Programme'. The term 'environmental flow' generally denotes the flow regime required to keep a river in an acceptable ecological condition while also providing water for agriculture, industry and domestic uses. Since Hindus consider the Ganges River to be a 'goddess', not only did scientists have to calculate the seasonal volumes of water required to nurture 230 species of fish and amphibians but they also had to define the water needs of thousands of pilgrims who regularly practice rituals along the river's banks.

"Although IWMI was one of the first organizations to introduce the concept of environmental flows in India, this was the first time a *comprehensive* environmental flow assessment of this kind had been applied there," says Luna Bharati, Senior Researcher and Head of IWMI's Nepal office, who led IWMI's role in the Living Ganga Programme.

Photo Credit: Luna Bharati, IWMI

The Ganges is India's holiest river and shrines, such as this Shiva Lingam, are found right along its length.

The team began by delineating the Upper Ganga Basin using digital data collected using a unique radar system carried by the Space Shuttle *Endeavour* just over a decade ago. The total area covered was 87,787 square kilometers (km^2), with the main river channel spanning 800 kilometers (km) between Gangotri and Kanpur. The elevation of this section ranges from 7,500

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Data, models, tools and maps available on the IWMI website

Data and maps

Water Data Portal
Website: waterdata.iwmi.org

WaterData is the new easy-to-use integrated portal providing access to all data stored in IWMI's archive. A 'one-stop-shop' for anyone who might find IWMI's data useful. Researchers, water management practitioners and policymakers will all find this an invaluable resource. Both special data, such as maps and GIS records, and non-special data, such as social surveys and flow records, are supported. Models can also be accessed.

Ultimately, all IWMI's publicly available data will be accessible through this site.

The system also supports data management in IWMI's research projects. Access to data is provided in compliance with copyrights, intellectual property rights and data agreements.

Access: free access to 'public' datasets. Requests can be sent to the relevant owner to access a restricted dataset.

Global Irrigated Area Mapping (GIAM)
Website: www.iwmigiam.org

Updated in 2007, IWMI's Global Irrigated Area Mapping (GIAM) is the best resolution that is presently available for irrigated areas at global level (10 km). Area calculations are made for each season and the map has the capability of calculating by month. There are a suite of associated products including snapshots, photos and animations. Disaggregated class images can be downloaded and a more refined map can be created for specific local areas. Twenty-year animations can be created so that one can spatially recreate the history of an irrigated area. The user can derive crop calendars, sowing-peak-harvest dates, and determine single, double or continuous crops.

Related products include:

- Global Map of Rainfed Cropland Areas (GMRCA)
- Global Map of Land Use/Land Cover (LULC) areas (GMLULCA)

Access: Free online access.

World Water and Climate Atlas
Website: www.iwmi.org/WAtlas

The World Water and Climate Atlas provides irrigation and agricultural planners with rapid access to accurate data on climate and the water available for agriculture. The atlas includes monthly and annual summaries for precipitation, temperature, humidity, hours of sunshine, evaporation estimates, wind speed, total number of days with and without rainfall, days without frost and Penman-Montieth reference evapotranspiration rates. The core of the atlas consists of data assembled from weather stations around the world between 1961 and 1990. Data can be extracted in summary, manipulated using the software of the atlas or exported in a standard format for use in other applications. Users can also include their own local data for a more detailed picture of a particular area.

Access: Free online access.

Global Wetland Mapping Project
Website: wetlands.iwmi.org

The overarching goal of the Global Wetland Mapping Project (GWMP) is to map, characterize and classify the wetlands of the world at various scales or pixel resolutions through a wide range of partnerships including the Ramsar Convention on Wetlands. The project evaluated remote sensing wetland-mapping methods *using freely available high-resolution satellite data* at three locations: the Limpopo River Basin in Southern Africa; the Ruhuna River Basin in Sri Lanka; and two inland valleys in Ghana.

Access: Free online access.

Global Map of Rainfed Cropland Areas (GMRCA)
Website: www.iwmigiam.org/info/gmrca/default.asp

IWMI's Global Map of Rainfed Cropland Areas (GMRCA) is derived from IWMI's Global Map of Irrigated Areas (GMIA). The world's total rainfed croplands were estimated at 1.132 billion hectares at the end of the last millennium, using the GMRCA products. This is 2.78 times the net irrigated area of the world (407 million hectares). The GMRCA area provided here is for the June to October period only.

Access: Free online access.

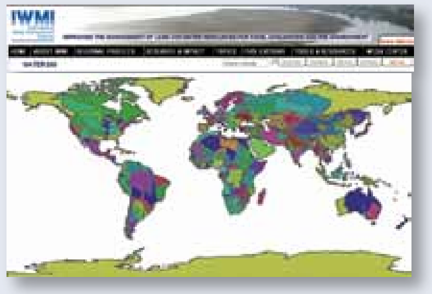
Tools and models

Global POlicy DIalogUe Model (PODIUM)
Website: podium.iwmi.org

IWMI's Global POlicy DIalogUe Model (PODIUM) is an interactive policy-planning and scenario-analysis tool, which explores future demand for water resources on a national scale, along with the potential trade-offs between them. It is intended to foster dialogue and stakeholder participation, and provide a basis for multi-sectoral planning and analysis. It is not designed to be used as a quantitatively reliable predictive tool, but is provided to raise awareness and explore the complex interactions of water scarcity, food security and environmental needs, in light of increasing populations and changing national diets. The model was developed by IWMI as part of the World Water Council's vision for 'Water and Life in 2025'. It computes current and future food and water demands for the year 2025, based on trends derived from statistics in the FAOSTAT database of the Food and Agriculture Organization of the United Nations (FAO), and user-definable scenarios of population growth, changing diets and improvements in agricultural productivity and/or water efficiency.

How to gain access: Free online access.

WATERSIM
Website: www.iwmi.org/Tools_And_Resources/Models_and_Software/WATSIM



WATERSIM is an integrated hydrologic and economic model designed to help planners:

- understand the key links between water, food security and the environment; and
- develop scenarios for exploring questions related to food, water provision and environmental security at the global, national and basin scales.

The model estimates food demand as a function of population, income and food prices. Crop production depends on economic variables such as crop prices and subsidies on the one hand, and climate, crop technology (whether rainfed or irrigated) and water availability on the other. Irrigation water demand is a function of the food production requirement and management practices, but is constrained by the amount of available water. Water demand for irrigation, domestic purposes, industry, livestock and the environment are estimated at basin scale. Water supply for each basin is expressed as a function of climate, hydrology and infrastructure. At basin level, hydrologic components of water supply, usage and outflow must balance. At the global level, food demand and supply are levelled out by international trade and changes in commodity stocks. The model iterates between basin, regional and global level until the conditions of economic equilibrium and hydrologic water balance are met.

Access: Please contact Aditya Sood (a.sood@cgiar.org)

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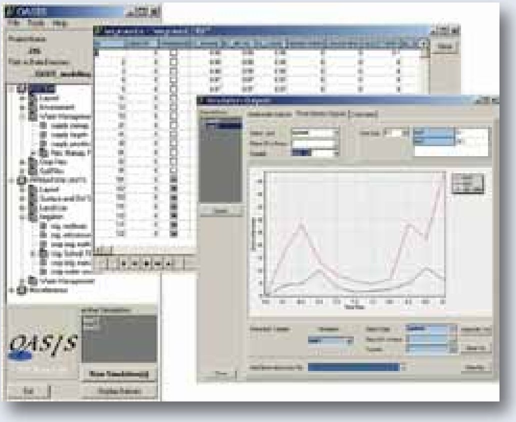
Tools and models

Options AnalysiS in Irrigation Systems (OASIS)

Website: www.iwmi.cgiar.org/Tools_And_Resources/Models_and_Software/OASIS

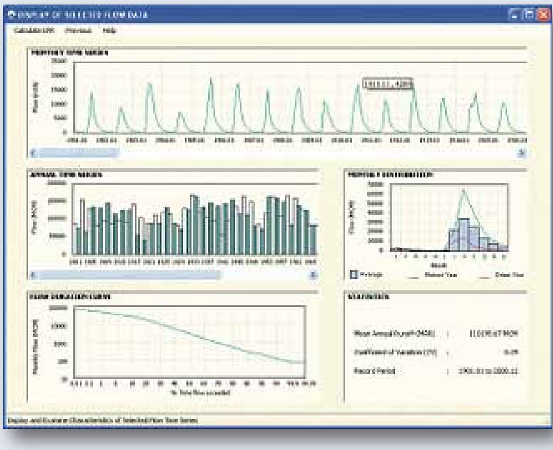


OASIS is a planning model for medium- to large-scale canal irrigation systems, typically several thousand hectares. It specifically takes account of surface water-groundwater interactions to assess the impacts of a broad range of actions in irrigated agriculture on water use, depletion and productivity. Examples of such interventions include: lining of canals, development of storage, introduction of alternative cropping patterns, water deliveries and on-farm irrigation practices. The model can be used to provide guidance to irrigation system managers and water policymakers to make more efficient and productive use of limited water resources in agriculture in the context of rising food demand, competitive water use from other sectors and the uncertainties brought about by climate change.

Access: The model with a basic user manual is available for free and can be obtained from Dr. Xueliang Cai (X.Cai@cgiar.org)

Global Environmental Flow Calculator

Website: www.iwmi.cgiar.org/Tools_And_Resources/Models_and_Software/GEFC



The Global Environmental Flow Calculator (GEFC) is a software package that is used for making rapid desktop-based assessments of environmental flows (the optimal amounts of water required by river systems to function effectively). The technique used to estimate environmental flows in GEFC uses a monthly time-step series, reflecting natural or unregulated flow conditions, and the corresponding flow duration curve. The aim is to help planners maintain an ecosystem in, or upgrade it to, some prescribed or negotiated condition, termed the Environmental Management Class (EMC). The higher the EMC, the more water is needed to maintain the ecosystem and more variability in flow needs to be preserved. Six EMCs are used in GEFC, ranging from the ‘unmodified’ class to the ‘critically modified’ class.

Access: Free access. Contact Nishadi Eriyagama (n.eriyagama@cgiar.org) and the relevant DVD will be sent to you.

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m in the Upper Mountain Region to 100 m in the Lower Plains. Presently, the river is highly regulated by the Tehri and Ramganga dams and multiple barrages. Three canal systems take water from the river to irrigate some 2 million hectares (Mha) of farmland.

Modeling flows

For security reasons, the Indian Government does not permit outsiders to access data on its transboundary rivers. The scientists, therefore, used hydrological models to estimate natural flows that had existed before dams and barrages were installed, as well as present-day flows. For this purpose, they used the Soil and Water Assessment Tool (SWAT), a computer-based modeling tool developed by Texas A&M University (TAMU). When the scientists compared the SWAT simulation of natural flows with observed water volumes at three sites on the river, they found that flows had shrunk by up to a quarter. Together with WWF-India and a team of Indian experts with a range of specializations, they then undertook a comprehensive ecological assessment which considered a variety of water needs.

WWF-India formed a working group comprising experts in a range of fields and invited them to attend a workshop, at which IWMI scientists explained the hydrology and introduced the concept of environmental flows. The experts were given one year to research the water requirements for their respective specialization and report back the results. The aim was to recommend flows for dry and wet seasons, for both average and drought years, that would fulfil the various non-agricultural needs. “The idea in maintaining environmental flows is to mimic the natural variability of the river while taking into account the diverse requirements of flora, fauna, livelihoods and human culture,” explains Luna. “So it’s not simply about maintaining minimum flows.”

For the fluvial geomorphologists, for instance, sufficient flow depths, velocities and river widths were of prime importance to ensure that habitats would remain connected along the length of the Ganges River. Floods were also considered vital, even in drought years, to link habitats laterally. The geomorphologists concluded that without the recommended flows, the movement of creatures could be severely restricted, with additional adverse impacts on supplies of nutrients and the health of habitats overall.

Safeguarding species and spiritual needs

The key criteria for the biodiversity specialists was the survival of flagship species, such as snow trout, otters and dolphins. Fish, invertebrates and diatoms (a type of algae) were also taken into account. The biodiversity experts agreed with the geomorphologists that floods were important, as these events helped to distribute nutrients and silt onto floodplains, in turn helping to maintain and restore biodiversity.

The cultural and spiritual requirements were identified somewhat differently from the biophysical needs. For example, one local community indicated that the Temple of Brahma at Bithoor ghat should ideally be inundated in the monsoon, interpreting this as the washing of Brahma’s feet. At Kaudiyala and Rishikesh, waist-high water was seen as optimal, as this would wash away debris and sediment on the lower steps of the ghats, enabling locals to access the river for bathing and worshipping. Local inhabitants felt it was important for the river to have sufficient water to complete cremation rites and wash away ritual offering of flowers. However, people accepted that in drought years, when crops were parched, water just covering cow hooves was acceptable. The religious and ecological needs matched quite well. “It’s probable that religious rituals started at a time when the river had its natural flow,” explained Luna. “As a result, they were based around natural variability, just as biodiversity and geomorphology evolved under unmanaged conditions.”

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Photo Credit: Luna Bharati, IWMI

A Sadhu (holy man) praying in the Ganges. The river has a deep religious significance for many people living in the region.

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Instigating change

IWMI scientists took the experts' inputs, along with the modeled natural flows, and calculated the monthly optimum environmental flows required for low-flow and high-flow years. Freeing up water in the dry-season months to promote biodiversity, for instance, will mean that less water is available for agriculture. IWMI scientists are, therefore, now turning their attention to addressing agricultural water use. If agriculture can be made more efficient, then it should be possible to take less water from the river, leaving more water for important environmental and cultural needs. The Indian Government has responded positively to the Living Ganga Programme. It has set up the National Ganga Basin Authority and engaged the same stakeholders to rerun the initiative using real, rather than modeled, data. "The fact that the government has embraced the environmental flow concept and launched a major project as a result is a great outcome for us," says Luna. "We are now constantly getting requests for information on the methodology we used and how we ran the project, so I believe we have successfully established the concept of environmental flows within India."

For project information go to www.iwmi.cgiar.org/Projects/ShowProjects.aspx?C=052-01-01-WWF or contact Luna Bharati (l.bharati@cgiar.org) or Vladimir Smakhtin (v.smakhtin@cgiar.org)

Forecasting flows and food production in the Mekong River Basin

Modeling the effects of future infrastructure developments and climate change on the Mekong River has revealed that the region should be able to remain food secure if common adaptation strategies are implemented.

Second only to the Amazon Rainforest in terms of biodiversity, the waters and ecosystems of the 795,000-km^2 Mekong River Basin feeds 300 million people and provides livelihoods to 70 million people. However, the area is undergoing rapid change as a result of population increases, urban developments, hydropower and irrigation schemes, and climate change. A major challenge for water planners, therefore, is to find ways to promote economic growth and produce sufficient food for the Mekong's future people while nurturing the environment and coping with the uncertain impacts of climatic changes.

Photo Credit: Kim Geheb, CGIAR Challenge Program on Water and Food (CPWF).

Mekong fisherfolk may find their livelihoods affected by climate change.

Understanding how climate change and water-related developments will affect flows, flooding and salinity in the Mekong River Basin is key to defining how much water will be available for agriculture and fisheries, and what impacts any changes will have on food production and livelihoods. Scientists from IWMI and the Mekong River Commission (MRC) used hydrological modeling to provide forecasts of future flows under different development and climate change scenarios. The findings were published in a report by Mainuddin et al. 2010[1].

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[1] Mainuddin, M.; Hoanh, C.T.; Jirayoot, K.; Halls, A.S.; Kirby, M.; Lacombe, G.; Srinetr, V. 2010. *Reducing vulnerability of water resources, people and the environment in the Mekong Basin to climate change impacts.* Commonwealth Scientific and Industrial Research Organisation (CSIRO): Water for a Healthy Country National Research Flagship.

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Consulting the planners and climate change models

The researchers used an existing 20-year Basin Development Plan to show how possible future developments could affect flows in the river. This included the building of Chinese dams in the Upper Mekong Basin, 11 proposed dams on the mainstream channel, together with various diversions and developments for irrigated agriculture, flood mitigation and industrial or domestic water supply.

Six model run scenarios were analyzed by the project team by combining the development options under 'without climate change' and 'with climate change' conditions projected by the global and regional climate models.

Higher rainfall forecast

The Mekong is currently a wet basin with an abundance of water. The climate projected data suggested that, overall, the future rainy seasons would be wetter. Future dry seasons were also projected to be wetter. The model suggested that the temperature in the region will rise by 0.023 °C per year.

When the scientists studied the projected outcomes of future developments combined with climate change, they found that, at times of high water flow, the two counteracted each other. For example, the likely impact of future developments alone, was to decrease flows by 5-18%. The impact of the planned developments combined with climate change, however, would be to decrease flow by almost exactly the same amount.

At times of low water flow, climate change and development were both forecast to bring about increases in flow. Under the forecast future climatic conditions, planned developments would likely bring about an increase in river discharge of 20-40%. Climate change alone would increase water flow by about 20-30%. The combined effects of climate change and development could increase discharge by anything from 40-76%.

Food security outlook

A team from Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) took the above projections to see how these might impact on the region's food-growing capabilities. They used the model, AquaCrop, to assess the impact of climate change on the productivity of major crops. The results suggested that the productivity of rain-fed rice, the predominant crop, could increase eightfold in parts of Laos and Thailand. In Cambodia and Vietnam, however, productivity could vary, increasing in some areas but decreasing in others. These variations in productivity are mainly due to changes in rainfall and increased concentration of carbon dioxide in the atmosphere.

The scientists suggested that decreased yields in Cambodia and Vietnam could be offset by adopting adaptation methods such as shifting planting dates and using supplementary irrigation. They concluded that food security in the Mekong Basin was unlikely to be threatened by either a population increase or climate change, and noted that the region could potentially maintain levels of rice exports in the future. The study did not consider the direct impacts of rainfall, floods, drought, dry spells, sea-level rise or the impact of natural disasters such as cyclones. However, despite these limitations, the study represents significant progress in understanding how future developments and climate change may affect water flows, yields and food security in the Mekong Basin.

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New working group unites data experts

A new working group on modeling and spatial analysis aims to help resolve similar issues faced by scientists working in different river basins. Researchers from the CGIAR engaged in modeling the Mekong, Ganges, Volta, Limpopo and Nile basins, together with representatives from invited external organizations, attended an inaugural meeting of the group in Ethiopia in November, 2011. The workshop comprised field visits, presentations and targeted discussions.

The working group aims to address issues such as: how to obtain and share quality information; how to integrate biophysical and socioeconomic data; the best methods for filling data gaps and encompassing different scales; how to select the most appropriate models from the plethora available; how to link different models and build feedback loops; and how to transfer these tools and technologies to partners with limited means.

Delegates attending the inaugural meeting visited Ethiopia's Blue Nile River Basin and discussed hydrological models, optimization and spatial analysis. The idea is for the scientists to learn from each other's experiences of working within different basin contexts. Funding came from the CGIAR Challenge Program on Water and Food (CPWF).

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IWMI researchers mapping Sri Lankan wetlands using GIS remote sensing.

Photo Credit: Aminul Islam/IWMI.

The International Water Management Institute (IWMI) is a non-profit research organization with offices in Sri Lanka (headquarters), India, Pakistan, Nepal, Laos, Vietnam, Ghana, Ethiopia, South Africa, Syria and Uzbekistan.

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