IWMI
INTERNATIONAL WATER MANAGEMENT INSTITUTE
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RESEARCH Update

News of the Progress and Impact of IWMI's Research • April 2000

# IWMI AND THE WORLD WATER VISION

As partners in the World Water Vision process, scientists from the International Water Management Institute have contributed analysis and research thinking to the Vision's report, *Water for Food and Rural Development.* This research offers new perspectives on water scarcity and its links to food security; the productivity of water in irrigated agriculture; strategies for water storage and groundwater; and gender, water, poverty issues.

### New research thinking supports international water policy

Over the past five years, the science program of the International Water Management Institute (IWMI) has generated new research thinking on water management and its relationship to poverty and food security in developing countries. Some of these concepts are included in the World Water Commission's, *Vision of Water for Food and Rural Development,* which was published as input to the World Water Forum and inter-ministerial conference held in The Hague, in March 2000.

The report is one part of the Commission's comprehensive *Long Term Vision on Water, Life and the Environment in the 21st century.* The Vision is an assessment of the world water situation. It is also a call to action, which aims to mobilize governments and other actors in society, to ensure the sustainable management of water resources for the benefit of all people.

Over the past year, IWMI scientists have been active partners in the international team of water specialists—composed of research institutes, universities and international organizations—that have elaborated the *Water for Food* vision.

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IWMI's Water Scarcity Study and Podium research team: David Molden, Charlotte de Fraiture, Upali Amerasinghe and David Seckler (Director General).

## HOW IWMI'S RESEARCH SUPPORTS WORLD WATER POLICY

- **Water scarcity/food security**
  IWMI's Podium software model is used by developing countries to develop their policy visions for 2025.
- **Global water scarcity**
  This IWMI research gives a picture of where the water shortage hot spots will be, and which countries will require food imports.
- **Irrigation performance**
  Contrary to popular belief, significant new water supply will not come from improved irrigation practices. This research shows why; and where more water is likely to be found.
- **Groundwater**
  The real water crisis is the uncontrolled depletion of groundwater in many countries. IWMI's research asks: "Why do more policy makers not recognize this fact?"
- **Water storage**
  Reservoirs—big and small— along with effective aquifer management provide efficient solutions for conserving water and increasing its productivity. The research shows a combination of groundwater recharge and surface water facilities is vital to meet the water demands.
- **Gender, water & poverty**
  The research aims at poverty alleviation by endowing poor women with irrigation assets and water for their own farm business.

# Satellite Imaging Tools help Poor Countries Bridge the Technology Gap

IWMI is completing its implementation of new satellite remote sensing tools that will give agricultural planners and water managers in developing countries more precise information about water use and about the interaction between water and crops. These are among the first satellite remote sensing technologies that will be freely available to developing countries.

### A powerful new tool helps see available water and plan food security

These remote sensing tools use publicly available satellite images and analyze them to provide agricultural planners with new strategic information. They help determine: where there is available water in a river basin at various times of the year; where water is reaching—or not reaching—crops in an irrigation system; and the interaction between the water and the plant, in natural vegetation and agricultural areas.

For water resource management, this type of satellite imaging has a decided advantage over traditional measurement methods. Classic practices to evaluate performance of irrigation systems collect data on inputs such as stream flow, and estimate water use. "It is difficult to measure every part of a system at regular intervals, so the end result of these measurements is an average or an approximate figure. Other variables, such as farmer practices and maintenance levels of irrigation canals, cannot be quantified by manual assessment, so the potential variation of using classical techniques is quite large," according to Wim Bastiaanssen, the IMWI scientist leading the development of these new tools.

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(Continued from front page)

# Satellite Imaging Tools for Poor Countries

When the final version of these remote sensing tools are complete they will give planners a new view of a country, region, or a large irrigation system and show them how effectively it is functioning. "Data can be displayed by the day, week or month, showing the evolution of a crop and water situation. This type of comprehensive time-series view would be virtually impossible to compute using manually collected data," says Baastiaansen.

If publicly available satellite images have existed for years, skeptics might ask why no one has thought of this before? Many have, but few have had the persistence or continuity of funding to develop a tool that fits the precise needs of poor countries. "Similar software tools exist," says Ian Makin, Program Leader for Applied Information and Modelling systems at IWMI. "But they have been created for the needs of the large-scale commercial farming market in wealthy countries. These user needs are quite different. Even if these tools were suitable for the needs of poor countries, the cost would be prohibitive. Certainly, one real innovation of this research is that it brings state of-the-art water management technology within the reach of developing countries," he says.

To achieve clear and simple interpretations of satellite data, high-performance software and specially developed tools are required to do the calculations. Baastiaansen has been studying this problem for the past decade.

Today the IWMI remote sensing team is close to finalizing generic procedures that will give developing countries a bird's eye view of their water and agricultural resources at a very low cost. "Using these tools, we can analyze a satellite image from anywhere and give planners new insights to the details of their water resources and crop water interactions," he says. A comprehensive view of satellite images showing areas ranging from hundreds of sq. km. down to small areas can be analyzed in a matter of hours.

A number of successful trials have been completed by IWMI, among them are analyses of the water and crop production situations in Pakistan and Sri Lanka.

Today, IWMI has identified five applications that will benefit planners in developing countries:

## Where is a country's water being used –daily, monthly, by seasons?

Satellite maps are analyzed to measure the total available water that runs out of a country's watershed into the sea or into groundwater aquifers, in millions of cubic meters per month. Combined with rainfall data this analysis clearly shows where water enters a system, and how it leaves, through evapotranspiration and run-off.

*Using this data, planners can see where available water resources lie. Using this data they can plan a water resources strategy based on the most accurate figures available.*

## A new view of irrigation performance

This analysis gives a detailed picture of the performance of an irrigation system that cannot be obtained by currently used methods. Irrigation performance is traditionally measured by recording the flow rate of water. This is compared to the number of hectares in the irrigated area to determine how much water is utilized. This type of measurement gives an average view of the situation and does not account for variations in farmer practices or conditions in every corner of the field.

Using satellite data–which can be gathered monthly, weekly, or daily–the IWMI system allows planners and managers to zoom into a 1x1 square kilometer area to see where the water is being evaporated.

Using lower resolution imaging, planners can see where water leaves the plant in an irrigation system, on a given day, and where it does not. An irrigation system may have adequate flow to cover the area to be irrigated but it is poorly distributed. These new techniques allow us to see this quickly–before yields are reduced.

*Where is the crop receiving enough (or too much) water? Is the water reaching the crop in all areas? These are the questions that IWMI research helps irrigation and food security planners answer, for the first time. These tools allow irrigation planners to see where there is water stress in an otherwise 'sufficiently irrigated' area.*

## Measuring the productivity of water in agriculture

Maps generated from satellite weather and crop data give a picture of the photosynthesis–amounts of light absorbed and water evaporated –in all crops and plants in natural areas in any country or region.

*This information gives countries an accurate view of what kind of harvest they can expect from their crops in a given year. It is a powerful new tool to address poverty issues and food security planning.*

## Malaria risk mapping

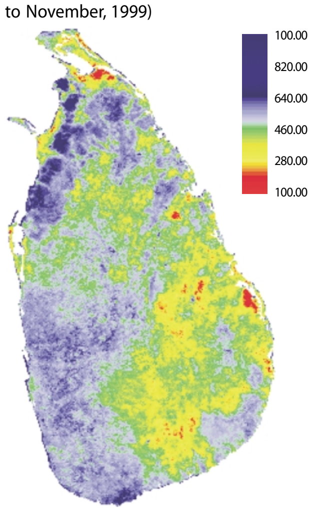
By combining satellite data of high-moisture areas with other known risk factors helps health authorities anticipate the incidence of malaria in a region or country.

## Environmental monitoring

By using these techniques to systematically map a country's water availability and plant growth, planners can evaluate factors such as land use change or degradation, to measure whether or not environmental damage is happening.

### Total Evaporation

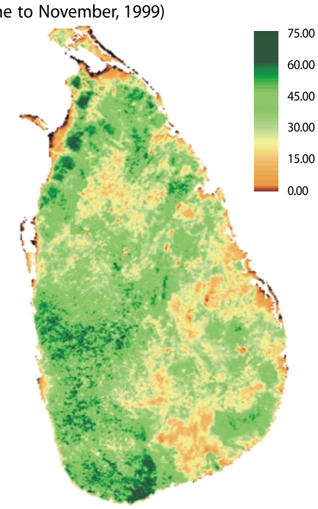
(Total mm). 1km resolution
(June to November, 1999)




**Where is water being consumed?** This type of map helps water resource planners allocate water and manage its distribution.

### Average Plant Growth

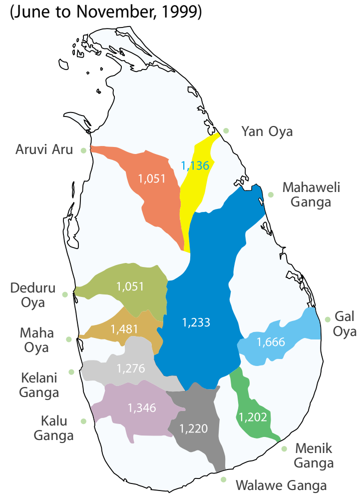
(kg/ha/day)
(June to November, 1999)




This type of map helps water resource planners monitor the productivity of water and direct water resources to the locations where they have the greatest impact.

### Water Resources Evaluation

($kg/m^3$)
(June to November, 1999)




Combining satellite estimates of water use with ground-based rainfall data enables a rapid evaluation of available resources. The volume of water leaving the ten major river basins in Sri Lanka is shown here.

For updates on IWMI's activities see the Remote Sensing page at www.iwmi.org

# Supporting Pakistan's Water Sector Reform

Pakistan's water sector reform was created in the mid-1990s to inject more efficiency and accountability into irrigation management and to link farmers and water institutions through an ongoing dialogue. IWMI's research work and advice to the government since 1995 have helped local authorities manage change and have prepared farmers to take a hands-on approach to managing their water resources.

### Understanding the problem

The initial problem water reformers faced is that farmers did not have the skills to take on their new responsibilities. A history of inadequate management, combined with an increasing demand for water from different sectors has resulted in low, inequitable and unreliable water supplies.

Beginning in 1995, IWMI Pakistan ran six pilot projects at the Hakra 4-R Distributary and the Shapur and Mirwal Small Dams in the Punjab Province, and at the Bareji and Heran Distributaries, and Dhoro Naro Minor in the Sindh Province. The objective of this work was to test the viability of FOs and their capacity to participate in the canals were rehabilitated with farmers' participation and Irrigation Department staff to minimize losses and ensure water supply to their extremities. This successful conflict resolution galvanized the divided community of irrigators into formally organizing themselves as a water user association.

Organized support for canal maintenance.

The 1997 Provincial Irrigation and Drainage Authority Acts paved the way for the creation of three new institutions Provincial Irrigation and Drainage Authorites (PIDA), Area Water Boards and Farmer Organizations (FOs). Open and more frequent dialogue is the central strategy of this reform. Through these new structures, agency personnel and farmers cooperate in the joint management of irrigation resources. But there was a major practical obstacle to this well-laid plan. Farmers were neither organized to become effective partners in managing the irrigation and drainage infrastructure nor sufficiently skilled to take responsibility for operation and maintenance. To build these skills, international donor agencies and the Government of Pakistan launched social mobilization pilot projects, to organize farmers into water user organizations, provide them with training in essential skills, and involve them in operation and maintenance activities at distributaries or small dams.

management of their irrigation systems at the local level.

In 1998, IWMI Pakistan's project activities generated several significant impacts on the progress of the irrigation-sector reform. About 800 farmers of the Water Users' Federation (WUF) of the Hakra 4-R distributary carried out a five-day maintenance campaign to desilt and repair its distributary. The formation of the Hakra 4-R WUF was publicly recognized by the oath-taking ceremony of 121 farmer leaders representing 4,600 water users from 41 villages in the command area of the distributary.

### Helping in conflict resolution

Persistent conflicts over the inequitable distribution of irrigation water were experienced among water users from two branch canals at the Shapur Dam. IWMI's mediation efforts led to the acceptance of the sanctioned command area principle and the recalibration and modification of the structure. The branch

### Policy impact: Punjab irrigation and drainage authority

The newly formed Punjab Irrigation and Drainage Authority appointed the former legal consultant to IWMI Pakistan and high-level local law academic, as its General Manager, Legal Affairs. He reviewed the existing irrigation laws in Pakistan and devised a model legal framework, based on close consultations with farmers in Hakra 4-R and IWMI Pakistan's research staff. This model is the basis for the evolution of Punjab's new regulatory framework in the irrigation sector.

### Moving reforms forward

Pilot Area Water Boards were established in the four provinces, and farmers were mobilized to create FOs. IWMI Pakistan will continue to support the reform process by providing policy advice to the PIDAs. It will facilitate and monitor the formation of FOs at the Hakra Branch Canal in the Punjab and the Jamroa/Nara Canal in Sindh.

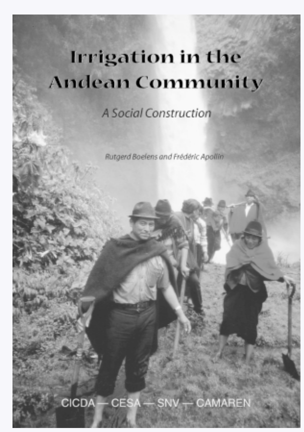
## Andean Farmer-Managed Irrigation: An Example for the World

A community irrigation project in the Andes provides a unique practical example of how farmer-managed irrigation can best be organized. This is a true participatory approach, whose concepts can be used by organizations designing this type of projects.

The Andes Community Irrigation Project was developed by the Netherlands Development and Cooperation Service (SNV) and the Ecuadorian Agricultural Service Central (CESA). Recognizing this as a useful practical example that could benefit planners and policymakers across the developing world, IWMI has translated and is disseminating an information kit describing this process to all interested people.

The kit explains the main points of this community approach to irrigation. Visual and hands-on models to make the process farmer friendly were employed. A democratic approach was taken in making men and women aware of their rights to irrigation water by participating in the design, construction and management of the system. Involving women farmers actively was one of the major achievements.

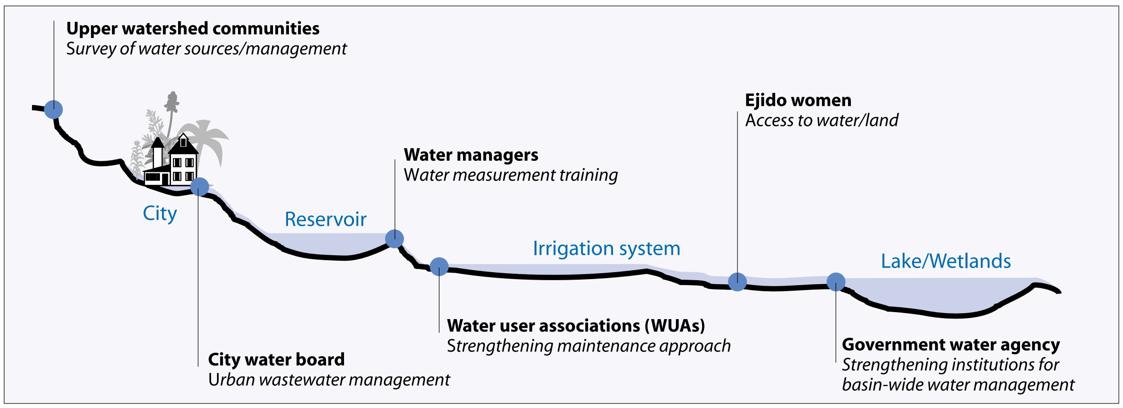
*Interested in sharing the experience? Read and download the document on www.iwmi.org*



# Managing Water in a 'Closed' Basin: A Case Study in Mexico

Research in Mexico's Lerma-Chapala basin helps water authorities understand and manage this water-short river basin.

IWMI's research activities in Mexico over the past three years have centered on problems faced by the people living around the water-short Lerma-Chapala river basin. The situation here has reached a crisis point, as intense competition for water between the farming and industrial sectors has resulted in alarming declines in the levels of groundwater and of Lake Chapala.




IWMI-Mexico Capacity Building, based on a Watershed Approach.

The Institute is running a series of projects from its Irapuato field office, located at the heart of the basin. This work combines action research with capacity building. The goal is twofold. First, to transfer new methods and tools to local authorities and water managers to help them manage their water resource as effectively as possible. The second objective is to gather knowledge about water management practices in the Lerma-Chapala, that will help planners in other developing countries deal similar situations in their 'closed' river basins (*A closed basin is where there is no excess water flowing out of the basin; all water resources are committed to use).*

The most important activity of IWMI is the application of its water accounting system to measure the water allocation and productivity of Lerma-Chapala's water resources. IWMI is working with the National Water Board and a local university, the Colegio de Postgraduados, to assess how much water the basin has, where it goes and how it is used, and to identify the scope for water savings.

Several smaller research projects complement the Lerma-Chapala research. These include a cost-benefit analysis of using wastewater for irrigation; an examination of alternative livelihood strategies on communal farms—especially by women; and an assessment of the institutional changes needed to support sustainable management of irrigation.

## Helping farmer-managed irrigation work better

Another research project is examining the impact of the Irrigation Management Transfer, as the responsibility for irrigation systems is devolved, from national to local authorities. Here the Institute is helping local water user associations better organize their maintenance schedules, to increase the quality of service given to farmers.

The recently formed Water User Associations (WUAs) in Irapuato have become effective managers of their water resources, but they have difficulties keeping up with maintenance requirements for the infrastructure that they have inherited.

When the Irapuato WUA approached IWMI for help, this association had limited funds, and some pressing maintenance work to keep its irrigation system flowing.

"The association faced many difficulties in delivering water to its users, says IWMI irrigation scientist, Flip Wester. "At the far end of the canal system, users hardly received any water. The chief reason for this was that, in the six years since transfer, the WUA had been unable to do the required maintenance and rehabilitation work," he adds. Wester believes that the primary cause of these maintenance delays is a lack of administrative, not agricultural expertise. These irrigation managers have a general lack of expertise in planning and budgeting.

## Technology vs. local knowledge

To help build more method and expertise into the WUA's actions, IWMI researchers introduced MARLIN, an irrigation management software tool and track maintenance imperatives. By completing a simple 'yes/no' questionnaire on the computer, the user can easily assess the current condition of each of the irrigation infrastructure's components (canal reaches, gates, siphons, aqueducts, measuring devices, etc.) The software analyses the manager's answers, compares this information with the location and function of each component, then ranks the work to be done in terms of its importance to the system's performance.

Using MARLIN, the WUA rapidly produced an inventory of the irrigation system's 326 structures and 64 canal reaches. The inventory gave a complete picture of the work required, and helped generate a maintenance workplan and cost estimate of the funds needed to accomplish the work.

This work in Irapuato enabled IWMI to field-test MARLIN's usefulness as a tool for other sites. The model's designers, the UK-based Hydraulics Research Institute (HR-Wallingford) participated in this process.

## Reaping the results

Armed with this new view of their irrigation system, WUA members were pleasantly surprised to find that their situation was not as dire as they thought. Much of the system proved to be in reasonable shape and all crucial maintenance work could be done within their budget. The canals required more attention. They were found to be in such a poor condition that they could not be improved by maintenance alone. This will require the rehabilitation funds promised by the government.

The results of this work were presented at a regional workshop, attended by government officials and all involved WUAs. Impressed with the results of this work, four additional associations in Irrigation District 11 have requested IWMI's help to implement MARLIN.

### Learn about IWMI's research in Latin America

The IWMI Spanish language publication series, Serie Latinoamericana, details research work completed in Latin America. These publications are currently sent to over 200 policy makers, researchers, universities and IWMI collaborators throughout Latin America and are available to others on request.

# Improving the Productivity and Understanding of Tank Cascade Systems

IWMI's water management methods for tank cascade irrigation give a rapid analysis of a system's water resource. National data is enriched with farmer knowledge, and fed into a water balance computer model.

A lack of understanding of tank and cascade irrigation systems has resulted in many failures in small tank rehabilitation projects. Previous research that focussed on individual tanks did not give a clear picture of whether additional water was available to increase the cropped area and cropping intensity of agriculture. IWMI's research on tank cascade irrigation systems has generated two useful tools: a method for tank rehabilitation planning, designed specially for cascade systems, and the *Cascade* computer simulation model.

These tools combine to help planners develop water management scenarios that bring the maximum productive use of water in tank cascade systems. The results of this work can benefit farmers in developing countries that use tank cascade irrigation. This approach will improve the effectiveness of government investments and the overall performance of the irrigation system.

**Table 1.** The indicators to evaluate the potential of a tank system to benefit from rehabilitation investment.

| Indicators | Description |
|---|---|
| 1. Cascade water surplus ($WS_c$) | The ratio of the outflow per unit area ($R_e$) to the mean annual rainfall ($R_{50}$).<br>*If Wsc>0.05, the cascade has surplus water.* |
| 2. Tank water supply adequacy | The extent to which the effective runoff ($R_0$ ) *can meet the irrigation requirement ($I_t$) in the main season.*<br>*If $R_0/I_t > 1$, the tank has adequate water supply to meet the irrigation requirement.* |
| 3. Tank storage capacity ($S_t$) | ($S_t$) measures the extent to which the tank is capable of sharing the runoff water and releasing it to meet the irrigation requirement ($I_t$).<br>*If $S_t/I_t \geq 0.3$, then the tank has sufficient capacity.* |
| 4. Cropping intensity (Main season cropping intensity, $CI_t$) | It is the average of the past 5 years of main (maha) cropping intensity. |

## Rehabilitating cascade tank systems: A practical, participatory approach

The IWMI method for rehabilitating small reservoir irrigation systems (also called tank systems) was applied in Sri Lanka's dry zone. This approach is innovative from two perspectives. It helps planners rapidly assess the water availability situation in a system, and it directly involves farmers in the collection of detailed local hydrological and agro-ecological knowledge. Some indicators, which could be used to make recommendations on tank system augmentation and expansion were used to evaluate the potential of a tank system to benefit from rehabilitation investment *(see tables 1 and 2)*.

In many countries, stream flow monitoring is done in locations where only rainfall data are available and groundwater data do not exist. This approach uses farmer's knowledge of the local situation to enrich the meager data available at the regional or national level.

R. Sakthivadivel, the IWMI scientist running this project, says that the generation of fast, reliable results is the primary advantage that the Cascade method has over standard approaches to small-scale water resources monitoring and development. "Planners can now come into an area where few hydrological monitoring data exist, quickly gather local knowledge produce an accurate picture of what is happening in the system," he says.

In its research in Sri Lanka, the IWMI team estimated flows for some 700 tanks in 50 cascades, in a six-month period. As a part of this work, farmers and planners worked together to define and evaluate proposals for water development for each of these tank systems. Involving farmers ensures that each individual project will be of real benefit to the local community and will not harm other irrigation systems.

Sathivadivel explains that this participatory method can benefit many other developing countries that have cascade tank systems. "It can help improve small-scale irrigation development on any small or medium sized basin," he says.

### HOW DOES THE CASCADE MODEL improve productivity of water in irrigation schemes?

The Cascade model helps planners:

- Predict water availability over a specific time period, in small reservoir systems.
- Simulate the hydrological process of a system using standard weather and water data
- Compute daily water balance figures for each individual tank
- Rapidly and clearly see the processes that determine tank water balance

## The Casade computer model

The local knowledge collected from farmers in this area was combined with rainfall and other standard data and fed into IWMI's Cascade water balance simulation model. Cascade calculates the water flow as it passes through the tank system and measures the amount of water leaving the watershed.

Cascade helps planners predict tank water availability for crop growth over a specific period of time. It uses standard meteorological data, water release requirements–and information on the system's physical layout–as input to simulate the hydrological process of each individual tank. Cascade also computes daily tank water balance figures to determine the amount of water that is available.

This tool provides planners with valuable new insight into the processes that determine tank water balance. It clearly shows the relative magnitudes of the tank water balance components and their temporal variations. After further validation, Cascade will be a very useful tool to help water management authorities achieve maximum productive use of the water available in a tank cascade system. "We believe that this new approach has significantly increased the effectiveness of government investments to reduce poverty through the improved productivity of water," concludes Sakthivadivel.

News of the method's effectiveness is spreading in the developing country water community. A nongovernmental organization in Tamil Nadu, India, (DHAN) is using the IWMI method on a 58-tank cascade irrigation system. DHAN is publishing a journal called *Tank Cascades* to inform others of the usefulness of the IWMI Cascade method and its application in various agro-ecological settings.

Contact: r.sakthivadivel@cgiar.org

**Table 2.** The evaluation of tank system conditions.

| Cascade water surplus | Tank water availability | Tank storage capacity | Cropping intensity | Recommendations |
|---|---|---|---|---|
| No | — | — | — | No expansion/augmentation |
| Yes | Not adequate | — | — | Tank water augmentation |
| Yes | Adequate | Not adequate | — | Tank capacity expansion |
| Yes | Not adequate | Not adequate | — | Augmentation and capacity expansion* |
| Yes | Adequate | Adequate | High | Command area expansion** |

*Capacity building is recommended only if tank augmentation will actually be carried out.

**Command area expansion is recommended only if appropriate land is available.

# West Africa: Making Water Management More Effective

West Africa's rice irrigation systems face problems maintaining productivity and sustainability. The root cause of the problem is inefficient water management and high levels of alkalinity and salinity in the soil and water. IWMI researchers are working to review the problem and offer a solution to this pressing issue, with assistance from its sister research center, the West African Rice Development Association (WARDA). Research is progressing in Côte d'Ivoire and Mauritania to pinpoint the specific problems faced in these countries.

### Côte d'Ivoire: Producing rice with a scarce water resource

Water shortage is the primary issue in this region. The lack of adequate water supply eliminates the possibility of a second cropping cycle for rice, a crop that is generally cultivated in two cycles. IWMI's work is based on one of its core research views: *that the productivity of water can be increased if it is managed more carefully.*

The first step toward devising a water management strategy that will improve this situation is to understand the scope of the problem. Using the IWMI Water Accounting System, researchers can determine who is using the water and where there is unused water that could be tapped for irrigation. The farming systems and production processes are then analysed to make farmers aware of the constraints. This input suggests several options, says IWMI scientist, Wilfried Hundertmark: "The possible strategies include improved reservoir management and making better use of rainfall during the first cropping cycle," he adds.

The human factor—more specifically, gender—is another area where changing current irrigation practices will help improve the performance of water management. In these communities, most of the field labor is done by women. But all planning, implementation, monitoring and evaluation of activities are made by different committees elected by the farmers, none of which has any female member.

### Dealing with alkalinity and salinity in Mauritania

The area being studied here is facing severe degradation of land and water resources due to alkalinity and salinity. This research is asking three specific questions: *Can current soil productivity losses be attributed to inadequate water management? What are the long-term implications of inadequate water management on the potential soil productivity? What sort of water management interventions can be recommended that stop resource degradation processes?*

A long-term increase of salt inside the reservoir which can hold 500 million cubic $m^3$ of water is another problem caused by high evaporative losses from a large surface. IWMI scientists are testing controlled flushing or surface protection to reduce the evaporation losses to maintain an acceptable salt concentration. IWMI's water balance framework is employed at the scheme level. This framework permits a simple validity check of basic assumptions of the internal consistency of the water flow system.

In addition, a scheme level salt balance will be established allowing a better understanding of salt transfers from the reservoir to the various systems levels. Water management strategies at the irrigation system level may include both improved water rotation and improved drainage. Eventually, a set of management interventions will be recommended integrating improved cultural practices, including field irrigation, improved management of the water distribution system as well as improved reservoir management at basin level.

(Continued from front page)

## IWMI and the World Water Vision

IWMI's contribution addresses five themes that will be central to the question of water, poverty and food security in the coming 25 years. They are: global water scarcity; understanding and increasing the productivity of water in irrigated agriculture; water storage options; the groundwater situation and potential strategies for developing countries; and questions relating to gender, water, and poverty. Each of these topics is a research area in IWMI's science program.

"We were pleased to be a partner in the World Water Vision process," comments David Seckler, Director General of IWMI, and the architect of the Institute's strategic research into water scarcity. "There is an interesting complementarity between the Vision's goals and the work we have done on water and poverty questions over the past five years. It is good that some of these scientific results can be useful to help shape world water policy."

The IWMI global water scarcity study, launched in 1997, presents water supply-and-demand scenarios for 118 countries. It gives a vision of the world water scarcity and food security situation in 2025, based on country data from the Food and Agriculture Organization and other sources.

*(From left)* R. Sakthivadivel: (water storage strategies); Barbara van Koppen: (poverty, gender & water); Tushaar Shah: (groundwater issues) led these IWMI research contributions to the World Water Vision.

Upali Amerasinghe, a scientist on the IWMI water scarcity research team, summarizes the Institute's vision of water scarcity in 2025: "Our basic scenario for water scarcity and food security projects that, for the world to feed itself in 25 years, irrigated agriculture will require 17 percent more water supply. The 17 percent scenario is considered by IWMI researchers to be the most realistic view, given the many economic and social variables involved in making global forecasts of this magnitude."

An important research activity for IWMI is the creation of tools and methods that help agricultural and policy planners better understand and measure the productivity of water in irrigated agriculture. Armed with this knowledge, developing countries can see where water savings in agriculture are possible, and devise strategies for more effective water management.

Seen in the context of IWMI's global water scarcity findings, any water savings in irrigated agriculture can be transferred to benefit other water users, such as the environmental and domestic sectors. The Institute's work in this area, gives planners a micro-to-macro view of their water resources, from the farm, irrigation system, and river basin levels. This basin-level perspective gives a clear picture of the multiple uses for water and the interactions between the different users.

Taken together, IWMI's contributions to the *World Water Vision* provide new analyses that place water management as a central issue for agricultural development and environmental concerns in poor countries. These findings will support the creation of future international water policy. They will also help identify priority areas for research, where the international water and development communities can focus their resources for best results.

See the full report of IWMI's contribution to the World Water Vision on www.iwmi.org

# Arsenic in Groundwater: Forming A Clear Picture of the Causes

Is there a link between water used for agriculture and arsenic contamination in Bangladesh?

Arsenic contamination of the groundwater in Bangladesh is a major public health problem that is currently being addressed by a number of institutes and international development agencies. These efforts are making some headway in reducing the contamination among poor communities, by encouraging low-cost water filtering techniques.

While the extent of the problem is relatively well understood and suitable remedial measures are being addressed, there is no agreement on the causes of arsenic contamination. To better understand the situation, and present a clearer picture, IWMI recently launched a fact-finding study, which aims to present a clearer picture of the situation. In the Bangladesh geological environment, arsenic is released when anoxic conditions (lack of oxygen) prevail in the soil and water . This is different to the situation, in other locations, where arsenic contamination has been linked to fluctuations in the level of water in aquifers.

The IWMI researcher leading this effort is environmental specialist, Liqa Raschid. Her starting point was to look behind the generally accepted perceptions to see where actual causes of arsenic contamination are documented. "One of the common theories put forward is that arsenic contamination is a direct result of the overuse of groundwater, particularly for agricultural uses. The focus of IWMI's research was to determine the validity of this theory which, if proven, could have a serious impact on the agricultural sector."

A comprehensive review of the existing research literature was done, supported by interviews with researchers working on the problem in Bangladesh and elsewhere. A further reason for this exercise, explains Raschid, is to gather sufficient facts to decide what IWMI's potential role could be in searching for solutions to the root causes of the country's arsenic problem.

A parallel perception highlighted by IMWI's investigation is that many outside observers think the arsenic problem is being taken care of and that no further action is needed. "There are many organizations working on the problem, some think too many," she comments. The remedies offered today are to encourage people to switch from tube well water-use to city water supplies—where feasible—or to adopt filtering techniques using chemicals, which absorb arsenic. As is often the case, the poorest people are the hardest hit, as they use tube-wells to draw water for drinking and growing crops, as treated mains water is too expensive or simply not available, eespecially in rural areas.

IWMI's review revealed a large body of useful documentation on arsenic contamination in Bangladesh, which has established this situation as a problem of international concern. Many initiatives are underway, to the point where it seems like 'everybody wants a piece of the action', causing some observers to question whether there is duplication of some of these efforts. "To our knowledge, there is no one working to strategically address the causes, and prevent the continued large-scale arsenic contamination," says Raschid.

Another aspect of the arsenic problem that has not yet been examined is the institutional and policy options that governments can use to avert this type of crisis. "Strong policies are as important as good technical solutions, because they help governments devise strategies to manage contamination, over-depletion and other types of groundwater problems," says Tushaar Shah, research leader at IWMI who is specialized in groundwater issues in South Asia.

The Bangladesh study complements IWMI's larger groundwater research initiative, which plans to look at groundwater from various perspectives, including policy options, recharge and water resource management, income generation, potential of groundwater and overall groundwater strategies.

*Read the full study at www.iwmi.org*

## Opening Turkey's Research to the World

New review highlights research on water sources, agriculture, health and environment.

A new IWMI Working Paper compiles a wealth of information on the health and environmental aspects of water resources development in Turkey, presenting some of the country's research outputs to the international community for the first time. The paper reviews existing literature on four topics: irrigation, health and environment and the production and consumption of pesticides.

Dr. Eline Bolee, the IWMI scientist leading this review, cites areas where clarification of the research directions is needed: "Detailed studies have been done on water use in agriculture and its impacts on people's health and the environment. But there is limited insight into the link between the different health and environment impacts," she says. Another area where she sees a need for further research and data, is the occupational exposure of farmers in irrigated agriculture.

### Some highlights of the review:

### Plans for future

Agriculture is the country's largest water user. According to IWMI's Global Water Scarcity Study, Turkey has little or no water shortage. But increasing water demands from the domestic and industrial sectors may change this picture in the near future.

Despite this Turkey's strategy for developing its water resources looks promising. It considers a range of issues, ranging from environmental protection and control, to health and hydro-power generation. GAP, the country's largest regional development plan aims to ensure easy access to water for all users, to create new opportunities for emerging agro-industries.

### Health challenges

Schisostomiasis and malaria are two major diseases that are directly related to water use in agriculture. Malaria is the most widespread of the two, largely due to the carrier mosquitoes' increasing resistance to insecticides. The disease is kept in check using larvae control and spraying of chemicals. Some new methods are currently being tested. Biological control using bacteria, predator fish and growth hormone inhibitors are good candidates, as they attack only the target mosquito population and do not lead to environmental pollution.

### Ensuring water quality

Several government bodies and NGOs are concentrating on protecting water resources and ensuring a high level of water quality. Drinking water standards are set by the Turkish Institute of Standards.

### Preserving wetlands

Turkey has many wetlands. Some are under a direct threat caused by the drainage of swamps and marshes for malaria control and pollution from upstream cities.

# Welcome to www.iwmi.org


The refreshed IWMI web site is now on-line. It offers a wealth of practical information such as rapid access to all of IWMI's research data and publications; easy downloading of IWMI's software tools; a direct link to the worldwide scientific library of water resources; and reports on international water policy topics.

# Update.... New projects

### 'Hidden' water use innovations can help millions of poor

IWMI has launched a new research initiative to identify and validate the most innovative water management practices at village and community levels in South Asia that can benefit poor people in this region and also in other countries. The project is gathering information on reported innovations across South Asia and shortlisting the most transferable ideas. This project is funded by DFID, the UK Department for International Development.

### Ph.D study support for South Asian women

A new research associate program launched by IWMI with the Ford Foundation aims to improve the skills of women active in water resources management. Under this scheme, women from South Asia can receive funding to support their Ph.D studies. The successful candidates will participate in IWMI's research programs. Eligibility criteria are: South Asian citizenship; 22–34 years of age; must be full-time student. *For details see www.iwmi.org*

### Preventing malaria with water management

An upcoming research study will test whether management of water flow in Sri Lanka's Yan-Oya river can effectively reduce breeding of the major malaria carrier mosquito in this region. This work will identify water management scenarios that regulate water depth to decrease the mosquitos possibilities to breed. An important factor in this project is to ensure that new water management techniques are integrated into current irrigation practices. This study is funded by Health and Environment section of the World Health Organization and the World Bank.

# Annual Report

The latest IWMI Annual report reviews IWMI's science program, documenting examples of recent research projects. Particular attention has been given to highlighting the generic aspects of the Institute's research findings that can benefit water managers and policy makers in many developing countries.

# IWMI appoints next Director General

Dr. Frank Rijsberman has been selected to succeed Dr. David Seckler as Director General of IWMI from September 1, 2000. Rijsberman, Dutch citizen, is currently Deputy Director of the World Water Vision Unit of the World Water Council, and a part-time professor in the water resources and environment group at the International Institute for Hydraulic, Infrastructure, and Environmental Engineering(IHE) in Delft, The Netherlands. Rijsberman says that he will help IWMI build on its strong scientific work, to make the Institute an international center of excellence for integrated water resources management with a special focus on the scientific aspects of water for food and rural development in poor countries.

# Recent Publications

### Research Reports

Renault, D.; Makin, I. W. 1999. *Modernizing irrigation operations: Spatially differentiated resource allocations.* Research Report 35.

Bandaragoda, D. J. 1999. *Institutional change and shared management of water resources in large canal systems: Results of an action research program in Pakistan.* Research Report 36.

### Latin America Series

Bos, M. G.; Chambouleyron, J. L. (Eds.) 1999. Parametros de desempeno de la agricultura de riego de Mendoza, Argentina.

Levine, G. 1999. Entendiendo el Comportamiento del Riego: La Disponibilidad Relativa del Agua como Variable Explicativa.

Garces-Restrepo, C.; Guerra-Tovar, J. 1999. Consideraciones sobre impacto ambiental por efecto de las obras de regadĩo en el distrito de riego Chancay-Lambayque, Per.

Monsalvo-Velèzquez, G. 1999. Sostenibilidad institucional de las asociaciones de riego en Mexico.

López, F. J.; Scott, C. A. 1999. Simulaciòn de alternativas del manejo del agua en la cuenca del Rio San Juan, Mèxico.

Hernandez, M. F.; Alhers, R. 1999. Naturaleza y extension del mercado del agua en el D.R.017 de la Comarca Lagunera, Mexico.

Levine, G.; Garcés-Restrepo, C. 1999. El desempeño de los sistemas de riego y sus implicaciones para la agricultura Mexicana. [Irrigation systems performance and its implications for Mexico's agriculture].

### South Africa Working Papers

Pardeller, L.; de Lange, M.; Magadlela, D.; Smal, S.; Sugrue, A.; Stimie, C.; van Koppen, B. 1999. Rural women's association: An assessment of the success factors and sustainability.

Lahiff, E. P. 1999. Land tenure on the Arabie-Olifants Irrigation Scheme.

Mpahlele, R. E.; Malakalaka, T.M.; and Hedden-Dunkhorst, B. 2000. Characteristics of smallholder irrigation farming in South Africa: A case study of the Arabie Olifants river irrigation schemes.

# IWMI Papers in Internationally Refereed Journals

- Brewer, J. D.; Sakthivadivel, R. 1999. Maintenance management process. *Irrigation and Drainage Systems* 13(3): 207–227.
- Droogers, P.; Kite, G. 1999. Water productivity from integrated basin modeling. *Irrigation and Drainage Systems* 13(3):275–290.
- Kolavalli, S.; Brewer, J. D. 1999. Facilitating user participation in irrigation management. *Irrigation and Drainage Systems* 13(3):249–273.
- Meinzen-Dick, R.; Bakker, M. 1999. Irrigation systems as multiple-use commons: Water use in Kirindi Oya, Sri Lanka. *Agriculture and Human Values* 16(3):281–293.
- Renault, D.; Vehmeyer, P. W. 1999. On reliability in irrigation service preliminary concepts and application. *Irrigation and Drainage Systems* 13(1):75–103.