IWMI
International Water Management Institute
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RESEARCH Update

News of the Progress and Impact of IWMI's Research • Issue 2, 2005

CA begins work on Assessment report...

The end of its initial research phase sees the Comprehensive Assessment on Water Management in Agriculture moving into the next stage—multidisciplinary teams are now fully engaged with the task of synthesizing a wealth of knowledge and experience into the final Assessment report.

Lessons from the past—and looking ahead

The CA is a multi-institute international initiative that explores innovative responses to the challenges in water management facing communities today. The Assessment is founded upon a retrospective analysis of the costs, benefits and impacts of the last fifty years of water development. It will assemble a much needed overarching picture on the water-food-livelihoods-environment nexus to guide investment and management decisions in the near future–taking into account their potential impact over the next 50 years. This will enhance food and environmental security in support of the Millennium Development Goals.

The Assessment report is developed along the lines of the Millennium Ecosystem Assessment and the Intergovernmental Panel on Climate Change (IPCC) reports and has formal linkages with the International Assessment of Agricultural Science and Technology for Development. It differs from the above in providing in-depth analysis of water and food issues that are inadequately addressed in other global exercises and benefits from the research of its first project phase. Over thirty projects were developed in this phase to fill knowledge gaps and a publications process was initiated to disseminate project results. Work on compiling the Assessment forms the second stage of the CA.

A market place at Godino village, near the Godino irrigation scheme in Ethiopia—good extension services are key to reaping benefits from farming

The Assessment looks at a broad spectrum of subjects including rainfed agriculture, irrigation, groundwater, low-quality water, fish, rice, land, and basins, knitted together by four cross-cutting chapters discussing water productivity, policies and institutions, ecosystems, and poverty. It will also include a section on future scenarios and a summary for policy makers.

The CA has brought together hundreds of practitioners and researchers in a dynamic and iterative process of discussion, debate and review on the above issues. More than 90 international and national research institutes; local, regional, national and international organizations active in water, agriculture, and environment have contributed to the CA through specific research and development projects. They include the CGIAR's Future Harvest agricultural research system, universities, NGOs, and the

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Minimizing human cadmium disease from contaminated rice

Rice containing toxic levels of cadmium (Cd) poses grave risks to human health. IWMI Southeast Asia has developed and tested a risk-assessment model to identify high-risk fields...

Since the late 1980s, mass poisonings in Bangladesh, China, Vietnam and West Bengal caused by naturally excess levels of arsenic in groundwater have garnered much attention. Arsenic poisoning (medically referred to as *arsenocosis*) is recognizable by the thickening of palms and soles of affected individuals (a condition known as *palmoplantar keratoderma*) and hyper-pigmentation of the skin.

An unseen hazard

In contrast, except in extreme cases such as Itai-Itai Disease (a form of *osteoporosis*), there are no visible symptoms of human cadmium-disease. The long-term consumption of cadmium contaminated rice results in this condition, manifested primarily by proximal tubular kidney dysfunction, which is irreversible and progressive even with decreased exposure.

To date, reports of the health effects of cadmium in populations dietarily exposed to cadmium have centered on Japan and China, where rice systems are contaminated with cadmium from the use of irrigation waters that receive natural runoff and/or uncontrolled discharges from non-ferrous mines and smelters.

Research has also shown that inadequate dietary zinc and iron sig-

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Itai-Itai Disease

This strange disease first made its appearance in the downstream basin of the Jinzu River around 1912. It received its name because of the way victims cried out "*itai-itai*" under the excruciating pain they endured, ("*itai*" being what Japanese people say when in pain). In severe cases, victims suffered broken bones when trying to move on their own.

However, because the disease was first taken as an endemic sickness, it wasn't until the 1950s that outright research began.

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CA begins work....

CA co-sponsors–the Food and Agricultural Organization (FAO) and the RAMSAR Convention.

An interactive learning process

Apart from online discussions, which stimulate debate and ensure the inclusion of several perspectives, CA chapter teams have met to prepare chapter outlines. June 2005 was a particularly active month for the teams, with nearly 90 authors and contributors gathering in their respective writing teams in parallel workshops, to develop Assessment chapters by debating and discussing key messages. Currently, first drafts of chapters are undergoing a rigorous process of scientific review and feedback, in preparation for a workshop in late September, which will integrate findings across topics and distill the central themes.

Next, the CA team plans to draft a technical assessment volume containing all the chapters, as well as a synthesis overview with the Assessment's main lessons. The rest of the year will be devoted to consultations with stakeholders, before the report is subjected to a second review.

A preview of some chapters

Irrigation

The last 50 years have seen massive investments in irrigation, which have brought the world food system to a position where it can satisfy the needs of a growing population. In spite of these gains, 850 million people, most of them in rural areas, still suffer from hunger, while a billion people worldwide continue to live in abject poverty. Water can play an important role in solving this problem but different means are required.

Researchers concede that the paradigm of heavy investment to increase food production, which justified investments in irrigation in the past, is no longer valid. Irrigation faces new challenges: how to produce more food of better quality, while using less water; how to provide rural people with resources and opportunities to live a healthy and productive life; and apply clean technologies that ensure environmental sustainability. This chapter reviews the conditions and trends in irrigation, providing guidance on investments and management options for irrigation in the forthcoming decades.

Compiling the Assessment report

The process so far:

- Outline developed by author teams
- Chapter outlines subject to intense online discussion, by a broad network
- Key messages and detailed outline of each chapter finalized by the chapter teams in workshops
- First drafts by lead authors now being evaluated by an independent panel of reviewers
- Drafts to be reviewed at Synthesis meeting this month

October to March, 2006

- Second and final drafts, and second and final review
- Development of overview for policy makers

The benefits of a consultative approach:

- Harvests a diversity of perspectives and ideas
- Enhanced credibility
- Promotes greater ownership and outreach

The Assessment will be launched in the latter half of 2006.

Rice paddies in the Uda Walawe region in Sri Lanka—finding a balance between water needs for food, livelihoods and the environment

Dealing with the realities of low quality water in agriculture

The Assessment identifies the extent, significance and strategies of using marginal-quality water in agriculture, as well as different options for its use, which balance environmental and human health concerns, livelihood support and agricultural productivity.

Recognizing that the use of untreated water is on the rise since treatment is financially difficult in a low income context, this chapter focuses on ways to use marginal-quality waters in sustainable crop production, which do not compromise human health; the possible options of improving the quality of low-quality waters; the policy and institutional aspects of its use in agriculture; and the regulatory framework for its use.

Rice, food and water

Rice feeds three billion people in Asia. Irrigated rice areas receive 40-50 percent of all water diverted to agriculture in the region. However, total rice production needs to increase to feed a population that continues to grow (especially in urban areas). Furthermore, the productivity and profitability of rice cultivation need to increase to alleviate rural poverty and keep the price of rice low, boosting economic development.

Water shortages have encroached upon Asia's rice baskets, endangering the yield and sustainability of lowland rice paddies, while contributing to an increase in negative environmental impacts. Climate change will lead to an increase in flooding and salinity intrusion, particularly in the low-lying deltas and flood-prone inlands where rice is produced.

In response to this situation, there is a large technological scope in some Asian countries to close the yield gap in irrigated systems through integrated crop management technologies, which increase rice output per unit of water. Moreover, the CA examines potential water-saving technologies to realize high yields under decreasing water availability.

Tools and resources for researchers and practitioners

Along with the Assessment report, the CA is also developing a unique knowledge base on water-agriculture-environment. This includes a book and report series, tools and methods (including the GMIA featured in this issue), which will be an invaluable resource to researchers and practitioners.

The CA is supported by the Governments of the Netherlands, Switzerland, Sweden, Taiwan, Japan, Austria, World Bank support for CGIAR System Wide initiatives, as well as the FAO, OPEC, Water and Food Challenge Program, the CGIAR Gender and Diversity Program, and the Rockefeller Foundation and in-kind controbution from assessment participants.

Please visit the CA's website at http://www.iwmi.cgiar.org/Assessment_html/About/

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Minimizing human cadmium disease....

nificantly increases the accumulation of cadmium in the target organ, the kidney. The health risks associated with the long-term consumption of cadmium contaminated rice grain are complicated, therefore, by the fact that the iron and zinc content in rice grain is insufficient for human needs. Further, IWMI research has demonstrated that in soils significantly contaminated with both zinc and cadmium, the rice plant–irrespective of total or bio-available soil zinc concentrations–effectively controls rice grain zinc. In contrast, the rice plant is unable to control the translocation and accumulation of cadmium to grain.

A timely intervention

Rice is the staple of millions throughout South and Southeast Asia. However, limited research has been conducted outside of Japan and China to quantify the extent and magnitude of rice food chain cadmium contamination and determine its negative impacts on public health, food security and livelihoods.

IWMI collaborative research has identified significantly elevated levels of cadmium in soils and crops in an isolated 2000 ha area of intensive rice production in Northwestern Thailand that are a potential health threat. Researchers developed a simple but effective risk-assessment model (called *Irr-Cad*) that predicts cadmium distribution within a cascading irrigation system. Using the *Irr-Cad* model, IWMI and its Thai partners identified and zoned high-risk fields within the affected communities.

The study outcomes have underpinned the Thai government's response to the crisis and led to the development of comprehensive action plans. For the long term, adjusting cropping patterns and growing non-food crops are among the practices being promoted in the affected areas. These measures are aimed at eliminating the potential long-term health risks associated with cadmium contamination.

Confronting the threat of cadmium contamination across the region

Similar situations are suspected throughout South and Southeast Asia and research proposals have been developed to address this issue. However, appropriate management options cannot be implemented on a regional basis, unless populations exposed to elevated levels of dietary cadmium are systematically identified and the health risk accurately evaluated.

The decision support tools developed by IWMI and partners, coupled with detailed epidemiological and dietary studies, will be invaluable in rapidly evaluating areas of concern, so that management options to reduce the threat to public health may be implemented.

For further information on the subject, please contact Robert Simmons at r.simmons@cgiar.org

Mae Sot, Thailand: Rice grain cadmium concentration in 65 percent of fields exceed the maximum permissible level for the 'safe' lifetime consumption of rice

Mae Sot, Thailand: Preparing rice for transplanting in cadmium contaminated fields

Sources

1. Simmons, R.W.; Pongsakul, P.; Saiyasitpanich, D. and Klinphoklap, S. 2005 Elevated levels of cadmium and zinc in paddy soils and elevated levels of cadmium in rice grain downstream of a zinc mineralized area in Thailand: Implications for public health. Environ. Geochem. Health (In Press)

2. Chaney, R.L.; Reeves, P.G.; Ryan, J.A.; Simmons, R.W.; Welch, R.M. and Angle, J.S. 2004. An Improved Understanding of Soil Cd Risk to Humans and Low Cost Methods to Phytoextract Cd from Contaminated Soils to Prevent Soil Cd Risks. BioMetals, Vol. 17 (5) 549-553.

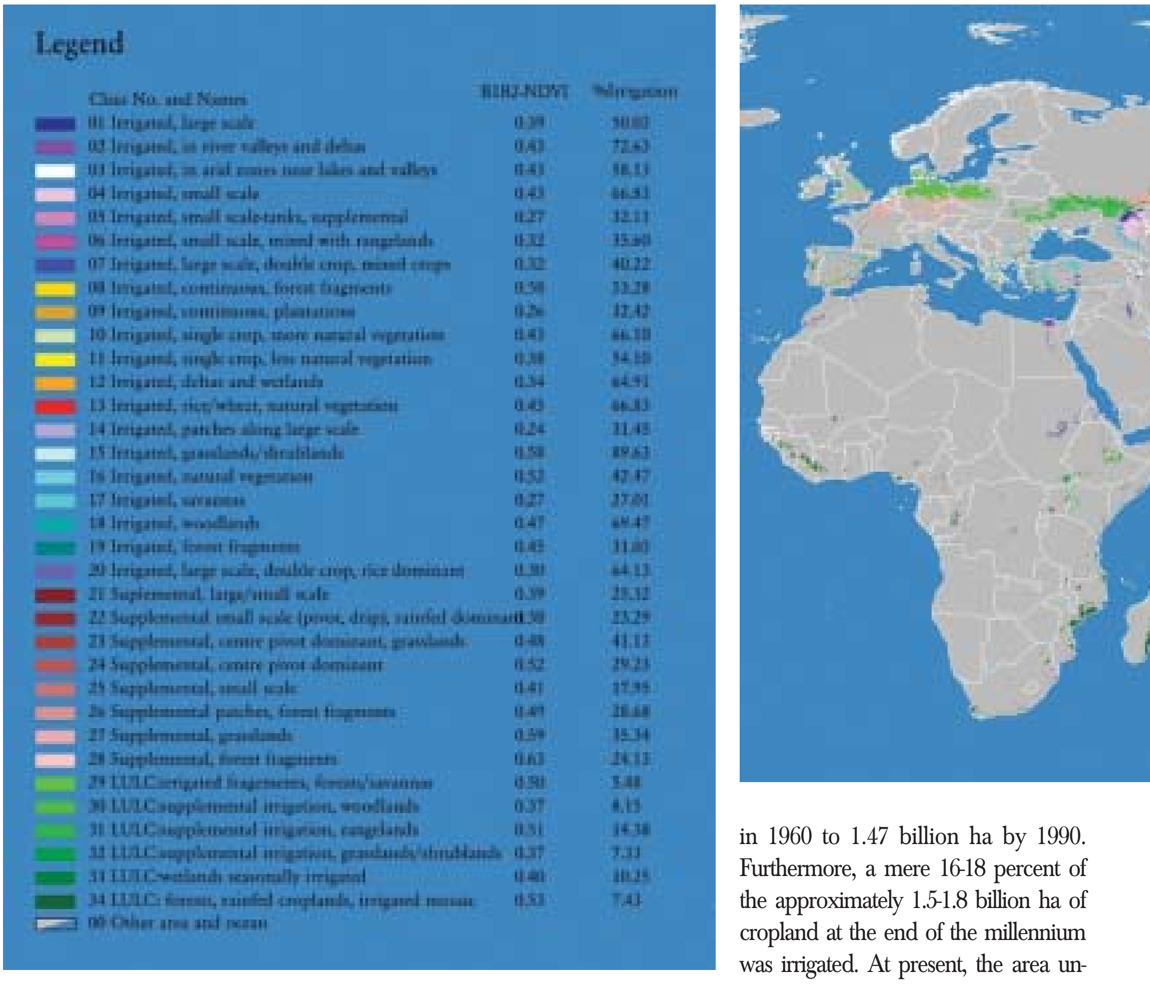
3. Simmons, R.W.; Pongsakul, P.; Chaney, R.L.; Saiyasitpanich, D.; Klinphoklap, S. and Nobuntou, W. 2003. The relative exclusion of zinc and iron from rice grain in relation to rice grain cadmium as compared to soybean: Implications for human health. Plant and Soil. 257 163-170.

Mapping irrigation: Food security now and in the future

How much irrigation do we have today? And how much will we need in the future to meet the goal of food security for a burgeoning world population? What are the impacts on the environment of such water demands?

A project of the CA's research phase, IWMI's *Global Map of Irrigated Areas* (GMIA, See Figure 1) released recently is the first attempt to use multiple satellite sensor data to try to quantify the area and geographical extent of irrigated agriculture across the world.

Figure 1. IWMI's Global Map of Irrigated Areas (GMIA) [Source: www.iwmigmia.org]



Previous attempts to calculate the amount of irrigation are not thought to be very accurate, since they relied on secondary data, which can be misleading. An example is India, where 60 percent of irrigation now uses groundwater, most of which has been privately developed and is not always accounted for in government statistics. There are many other sources of systematic over and under-reporting, depending on context. The GMIA attempts to explicitly account for the number of crops grown per year in each location (at each pixel). Previous estimates using secondary data and GIS have determined equipped area, which is the area designed and developed, largely as surface irrigation. At a global scale, secondary statistics rarely provide sufficient information on cropping intensity over the year, which can vary considerably between farming systems and within irrigation systems themselves.

By using time series satellite data at different resolutions coupled with groundtruth from various sources, it is possible to estimate the gross irrigated area in the world, which is roughly the sum of crops grown over 1-3 seasons in a year, depending on location. IWMI estimates area under irrigation at the end of the last millennium to be 318 Mha during the main season, and when irrigation intensity is considered, the area is 637 Mha. This very significantly outstrips other estimates where only the area equipped for irrigation is considered. This major increase in estimated area is mainly due to multiple cropping and mapping of much of the extent of informal (private and community developed) irrigation.

Why map irrigation?

Although inequalities in distribution and access mean that malnutrition and starvation is a grim, everyday reality for countless numbers of people, the world currently produces enough food to feed itself. A large part of this success, such as it is, is due to the rapid increase in irrigation in the last half-century, particularly during the peak period from 1950 to 1990. From a meager 95 Mha in the early 1940s, the boom in construction of dams in the aftermath of World War II saw the area of irrigation worldwide almost triple to between 250 and 280 Mha by the 1990s.

Irrigation is conventionally thought to provide about 40 percent of the world's food from around 17 percent of the cultivated area, based on existing statistics. This estimate may have to be revised in future in light of the gross annual irrigated area estimated in GMIA. Nearly seventy percent of diverted water resources in Asia, where irrigation development has mainly been concentrated, goes to irrigation which was at the centre of the "Green Revolution", meeting food needs over the past forty years, especially in staple grains.

In contrast, the expansion of cropped land (rainfed and/or irrigated) has been modest, from 1.36 billion ha in 1960 to 1.47 billion ha by 1990. Furthermore, a mere 16-18 percent of the approximately 1.5-1.8 billion ha of cropland at the end of the millennium was irrigated. At present, the area under irrigation is increasing at a much slower pace of about 1.3 percent per year, compared to its heyday.

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State of the art technology

Remote sensing offers a relatively cheap way of undertaking global assessments of land use, and in particular of irrigated area. Time-series of freely available public domain data from NASA allow the spatial extent and dynamics of irrigation to be captured at different resolutions. However, all remote sensing requires appropriate groundtruth to verify and refine classifications and the more that this is done, the better the product.

Remote sensing approaches therefore need to be disseminated broadly to regional and national agencies with the capacity and interest to improve on classifications in their specific settings. A major output of the GMIA work is the development of a methodology and a suite of image analysis and statistical techniques at different scales, including the forthcoming All-India Map of irrigated area at 500m x 500m resolution.

While it is almost impossible to assess the absolute accuracy of a global map, it is possible to do so in comparison to secondary statistics and more precise high-resolution images at national and local levels. IWMI and FAO/University of Kassel are working together to compare the estimates derived from remote sensing and GIS to allow further improvement in global estimation.

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Cropping intensities

How then do we explain the situation of global food abundance described above? As the GMIA reveals, irrigated areas have expanded, must be confronted today. A large part of the solution to global and regional food problems is likely to be found through irrigated agriculture. Researchers anticipate that cropping intensities will increase in

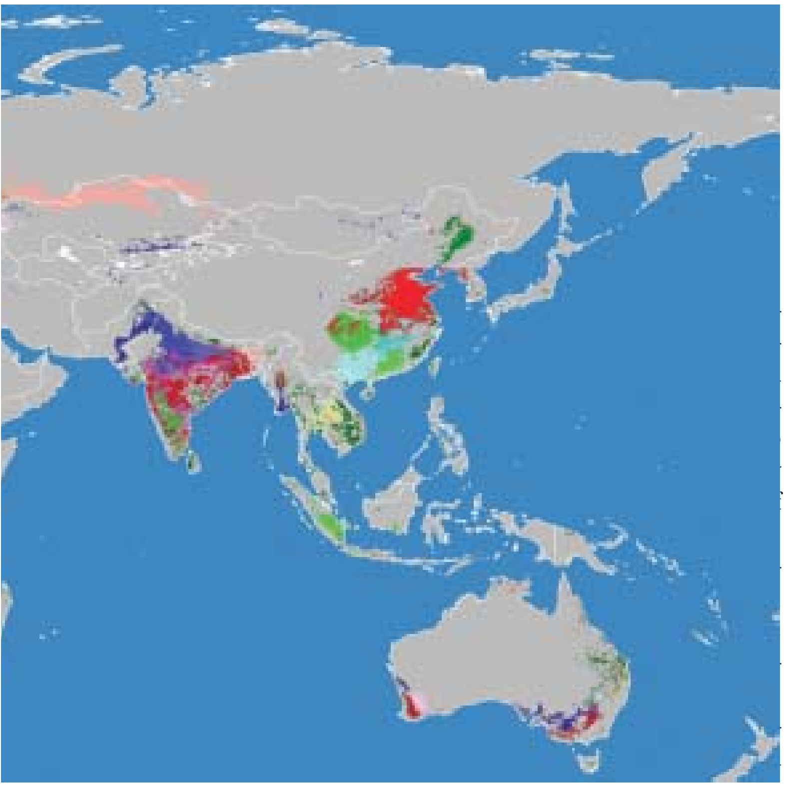
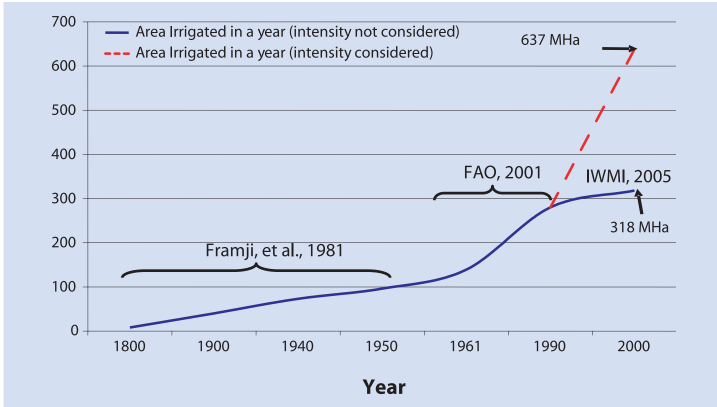


Figure 2. Historical development of global irrigated area, with and without cropping intensity expressed in Million Hectares.



response to the growing demand for food, placing tremendous pressure on water resources.

In these circumstances, the IWMI GMIA is the first step to fulfilling the urgent need for more precise estimates of the actual area and spatial distribution of irrigation, in addition to the extent of multiple cropping.

Remote sensing techniques enable an internally *consistent* estimate, which can be studied over time and space. Satellite sensors offer increasingly well-understood platforms and data characteristics, while updates are relatively easy and meet similar or improved scientific standards. With high quality data freely available on the internet, the GMIA thus represents a cost-effective tool for researchers, planners and decision makers in managing water for food and environmental security.

The map and its related products include area estimates, crop calendars and their dynamics–derived for each characteristic agricultural system around the world (e.g., long season winter sown cereals in the north-

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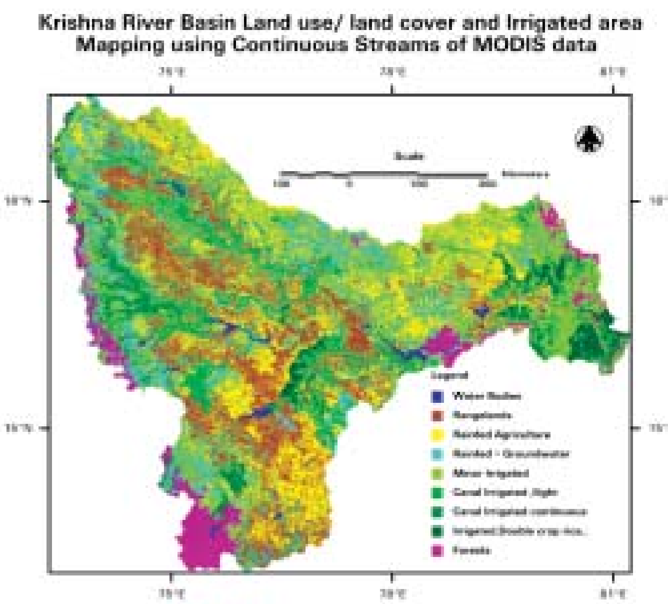
The Krishna River: More production and less poverty in a closing basin

Decades of agricultural growth in the Krishna Basin have drawn heavily upon its water resources. How will this affect the region's economy? What steps can be taken to reverse the harm caused to the environment? How can remaining water supplies be managed to support livelihoods, reduce poverty and develop the economy, while protecting vital ecosystems in the basin?

The Krishna Basin, India's fourth largest river system, is home to one of the most important rice, cotton, milk and sugarcane regions in the country. Between the 1950s and the 1990s, the Green Revolution saw an expansion of irrigation, which increased food production to feed a growing population. However, the success in food production had a flipside–the near complete depletion of runoff to the ocean.

The development of major dam irrigation caused runoff to the ocean to decrease dramatically, from 28 percent of rainfall in the first 60 years of the 20th century to a mere 10 percent by the 1990s. Simultaneously, agricultural production in the downstream states has stagnated. IWMI is continuing investigations into the water resources of the Krishna, designed to frame the key issues facing the basin and alternatives that could be pursued to minimize the consequences of basin closure.

Figure 1.



The impacts of basin closure

-on water productivity

What are the implications of this kind of stream flow depletion? First and foremost, it will require smarter water use and cooperation among different users to support an *equitable* and *sustainable* agricultural growth–a shift from an emphasis on "hardware" development, such as new dams, to "software", such as wise and efficient

[1]Moderate Resolution Imaging Spectroradiometer

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The Krishna River.....

management of existing water supplies at the basin scale.

While there is currently much enthusiasm for “mini-hardware” projects (like check dams for water harvesting), in a closed basin like the Krishna, water harvesting or groundwater development in one area is likely to deplete water already utilized by downstream users. The Krishna has a rich mosaic of irrigation of different types and intensities, all interrelated in unknown ways through the hydrologic cycle and any intervention must be understood and carefully evaluated for its impacts on other users in the basin.

Crop yields in the basin still average less than half their potential, presenting opportunities to improve water productivity. Other agricultural activities, such as livestock, may also contribute towards increasing water productivity. For example, preliminary calculations suggest that the milk industry dominates the market for agricultural produce, generating more gross value than rice and cash crops combined. Such assessments provide the start for a full understanding of where value originates in the basin and how it might be further enhanced through better water management.

-on regional politics

Basin closure has also resulted in interstate conflict, as three states share the shrinking water resource. The downstream state, Andhra Pradesh, has experienced a state-wide stagnation in agricultural production, including acute water shortages in its major irrigated commands, while the upstream states, Karnataka and Maharashtra, have large dry regions and want to continue developing their water resources to maintain their agricultural growth and reduce poverty.

Urban water demand and wastewater irrigation

Along with agriculture, the region’s rapid urbanization also makes demands on water supplies. Hyderabad city, for example, now has 7 million people and consumes 380 million m^3 of water annually. Much of the urban water supply returns to the local Musi River as wastewater and is used for irrigation, which has important consequences for human health, soil salinity and the environment.

A new project called “Ensuring Health and Food Safety from Wastewater Irrigation in South Asia” by IWMI, ILRI (International Livestock Research Institute) and local partners in Hyderabad, India and Faisalabad, Pakistan, will focus on vegetable and fodder production to recommend concrete measures to mitigate the risks to farmers and consumers.

Figure 2. Stream flow depletion and river development stages of the Krishna Basin.

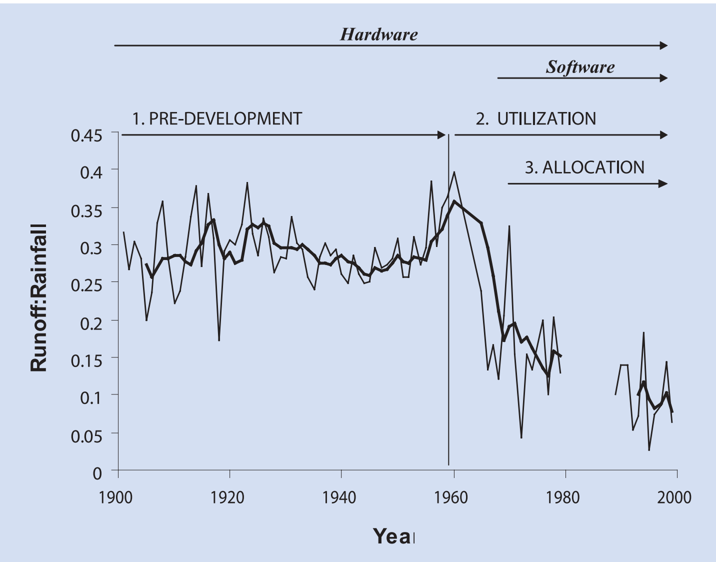
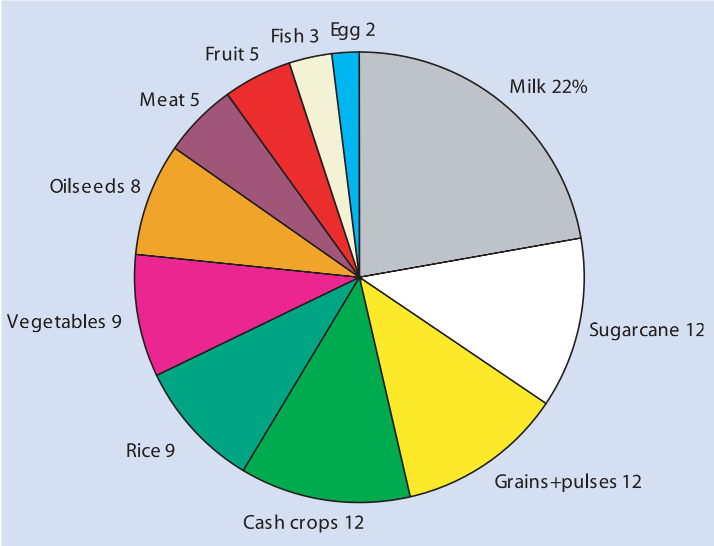


Figure 3. Share of different agricultural products in total output of the Krishna Basin, 1998. Numbers indicate the percentage of total Ruppee output contributed by different agricultural products



Water poverty mapping

Remote sensing shows that cropping patterns in some parts of the basin change quickly in response to water scarcity. In particular, large areas of downstream irrigated areas change from double cropped rice-rice to single cropped rice or no cropping at all during years of water stress. These changes may cause income shocks to farmers in the affected areas. Other parts of the basin have naturally low rainfall and high incidence of water stress, and potentially high poverty rates.

A major IWMI research project, in the Andhra Pradesh part of the basin, aims to map and link poverty to problems related to water, in collaboration with the State irrigation department.

Environmental impacts

The rapid decline of inflows to the Krishna Delta also has implications for environmental stability; salt water intrusion into aquifers already affects part of the Krishna Delta and may become worse as inflows decrease and groundwater extraction continues. The Delta also houses some unique mangrove ecosystems, whose species composition depends crucially on the balance of salt and freshwater. Changing that balance may alter these ecosystems, perhaps irreversibly.

The Krishna Basin closure occurs in the wider context of other basin closures in southern India. The Cauvery and Penneru basins have also experienced near total basin closure; nearly all of southern India, starting at the northern border of the Krishna Basin, is closing, with wide-ranging effects on agriculture, ecosystems and the regional and national economy. IWMI’s work continues in the hope that by understanding how basins close, and by devising innovative, basin-wide strategies for managing water, agricultural development can continue while alleviating poverty and protecting the environment.

For more information, please contact Trent Biggs at t.biggs@cgiar.org

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Playing the 'trust' game in India–Investigating the dynamics of successful WDPs

Why do Watershed Development Programs flourish in certain villages and not others? What conditions at grassroots level boost the success of community based resource management?

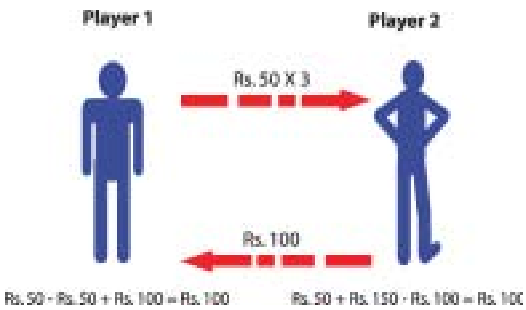
In February this year, researchers in India used an unconventional approach to explore why some village communities had more successful watershed development programs (WDPs) than others. Surmising that the degree of social cohesion might influence a community's management of its natural resources, researchers used a *game* to measure how trust and reciprocal behavior in a village influence the individual household's contribution to soil and water conservation.

Village meeting place, Kadampally in Andhra Pradesh

Personal gain or mutual advantage?

The 'trust' game is played by two people who are from the same village but unaware of the other's identity. Both Players receive Rs. 50 (US$1.15), the equivalent of a day's wages, which they can increase through a process of exchange with the other person. Player 1 first decides how much of the Rs 50 to send to the opposite Player. This amount is tripled in transit by the research team. Player 2 has to decide in turn how much of this to transfer back to Player 1. Researchers had participants play the game twice to allow each person to experience the set of options built into each standpoint in the game (i.e., sender and recipient or investor and trustee). At the conclusion of the game, the Players keep the money earned.

The most mutually beneficial strategy would be for Player 1 to send the full Rs 50 and Player 2 to return Rs 100, so that they go home with Rs. 100 each. On the other hand, both Players could simply decide to keep the Rs. 50 they received at the beginning of the game intact and not gamble upon the other person's goodwill. Solving the game backwards, since Player 2 has no incentive to send back any amount s/he may receive, Player 1 does not send any money. Thus, how much Player 1 decides to send depends largely on trust: if Player 1 trusts Player 2, s/he will send a larger share of her/his Rs 50 than if each person acts purely out of self-interest.



A fresh perspective in development and resource conservation

The "trust" game provides an insight into the dynamics of social interaction and cooperation at a time when many conservation and local development projects visualize an increased role for communities–a trend confirmed by the US$ 7 billion World Bank budget for community-led initiatives. Communities may succeed in situations where both governments and markets fail to make an impact, as they take advantage of the peculiar features of small groups. Apart from the low costs of disseminating information and monitoring progress, for instance, the social norms and peer pressure within a community are highly effective in mobilizing individuals towards a common goal.

In India, watershed development (WDP) depends on this participatory approach. The whole village is required to cooperate in planning, implementing and maintaining local soil and water conservation. With an annual budget of approximately US$ 500 million, it is one of the country's main rural development programs. Nevertheless, several studies show that while community governance is certainly more effective than a top-down conservation strategy, it does not guarantee sustainable resource management in the long term. It goes without saying that if the performance of a particular village in a WDP can be forecast before the program gets underway, then resources, both human and financial, could be committed where they are likely to produce the best results.

Strategic discussions before the game, in Bicchiwara, Rajasthan

Results of the "trust" game

In results remarkably similar to those of earlier 'trust' game experiments held in USA and Zimbabwe, on average, people sent a little over half of their initial amount and returned a little less than what they received, contradicting economic theory, which predicts that self-interested individuals will neither send nor return anything.

Comparing the results with the household survey conducted before the experiments, the research team found that socially homogenous communities with higher income levels are more cooperative than villages with greater caste diversity and inequality, signaling a dynamic of inclusion/exclusion–where a greater probability of interacting with a person of the *same caste* prompted more trust in the Players. As researcher Jetske Bouma explained, 'Including the data on trust and reciprocity in the analysis of the household survey showed that the villages with higher levels of trust and reciprocity invested more in the operation and maintenance of WDP investments. Awareness of the degree of trust and reciprocal behavior thus becomes significant in explaining a household's participation in conservation efforts. This is an important indication that investments in social interaction, community building and communication can contribute to community resource management in the long term'.

If you wish to obtain more information or the full paper with analytical results, please contact j.bouma@cgiar.org.

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Mapping irrigation....

ern hemisphere; triple rice cropping in SE Asia; wet monsoon season (Kharif) and dry winter (Rabi) systems in the Indian sub-continent). It summarizes the statistics for three seasons in a calendar year: 318 million ha from June-September (including single long season crops harvested in this period), 194 million ha from October to February, and 125 million ha from March to May. The sum from the three seasons, (as mentioned below) at the end of the last millennium, amounted to 637 million hectares. The development of global irrigated area is summarized in the chart, with and without estimates of cropping intensity.

Among the many features of the GMIA are its 34 unique irrigated area classes (see Figure 1), with 20 pure irrigated classes, 8 supplemental irrigated classes and 6 other land use/land cover classes with some irrigation. The areas derived from the map are determined on the basis of the proportion of irrigated area within each pixel within a class.

A range of products and data are freely available to the global community on a dedicated web site (at *http://www.iwmigmia.org)*. It features three other global agriculture and land use/land cover products, the *Global map of Rainfed Cropped Areas (GMRCA)*, the *Global map of all land use/land cover areas* and the *Global IWMI generic 628 class map*. The site also contains maps, images, class characteristics, area calculations, snap-shots, animations of time series area development and methodological and background documentation. The primary satellite sensor data, secondary data and the groundtruth data can also be downloaded by users.

The IWMI GMIA is the second step in quantifying irrigation at a global scale and the first attempt to explicitly account for cropping intensity. Further refinement and development is required, but it will strengthen efforts to make agriculture more productive and sustainable, manage crucial environmental resources better and reduce hunger. It sets a benchmark and framework for a consistent mapping of global irrigated areas, which will be continually refined and increasingly devolved to the global research community.

For more information, please contact p.thenkabail@cgiar.org

Recent Publications

For on-line access to IWMI Research Reports and Working Papers, see www.iwmi.org/pubs

IWMI Research Reports

Kurian, Mathew; Dietz, T. 2005. *How pro-poor are participatory watershed management projects? An Indian case study.* Colombo, Sri Lanka: IWMI. v, 25p. (IWMI research report 92)

Lesterlin, G.; Giordano, Mark; Keohavong, G. 2005. *When "conservation" leads to land degradation: Lessons from Ban Lak Sip, Laos.* Colombo, Sri Lanka: IWMI. v, 25p. (IWMI research report 91)

Mccartney, Matthew Peter; Masiyandima, Mutsa; Houghton-Carr, H. A. 2005. *Working wetlands: Classifying wetland potential for agriculture.* Colombo, Sri Lanka: IWMI. v, 35p. (IWMI research report 90)

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