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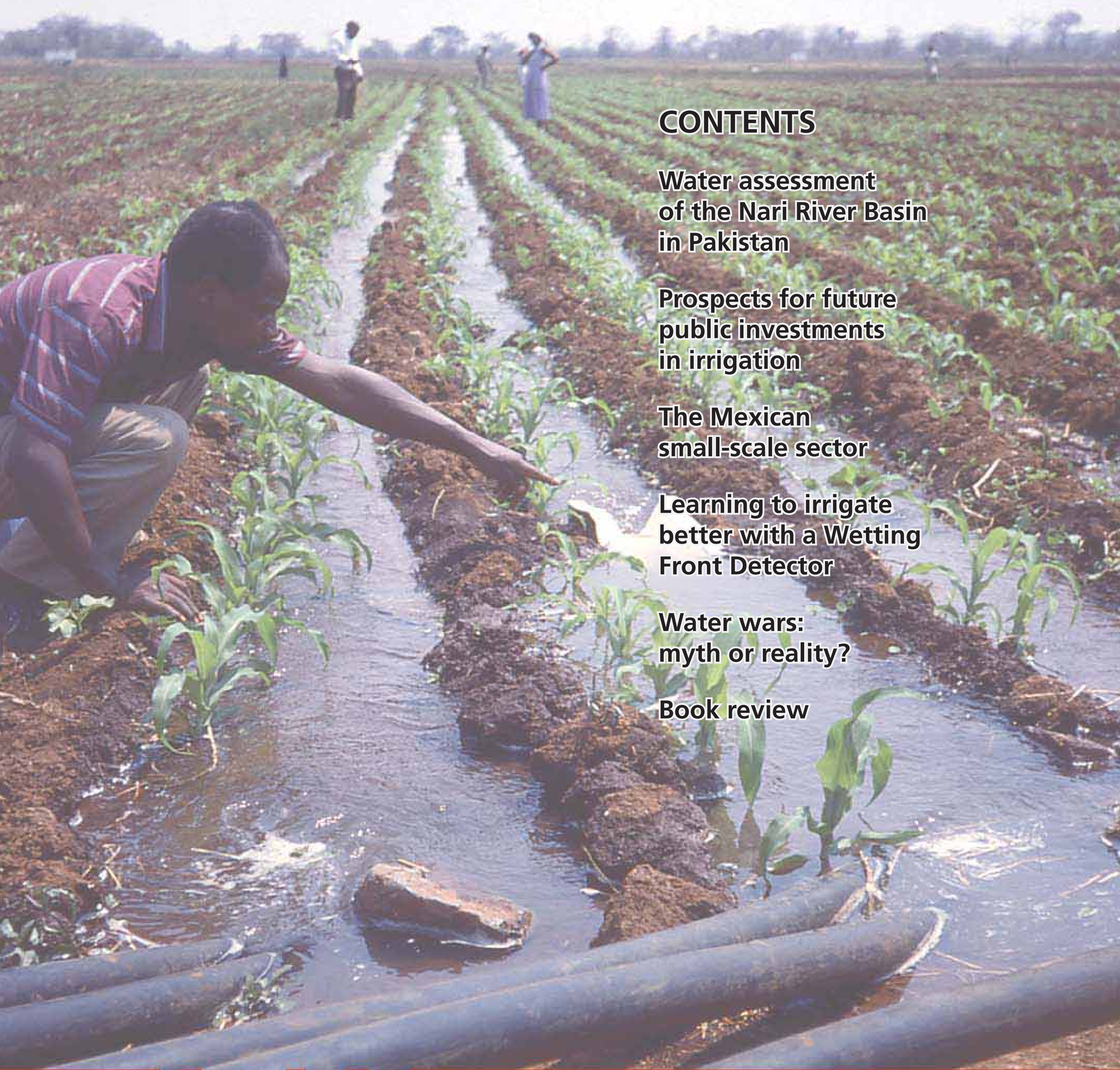

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GRID invites short written contributions, principally for the Diary and Forum sections. They may include photographs or drawings, which must be of high quality and suitable for reproduction at reduced size. Contributions should be sent to: International Programme for Technology and Research in Irrigation and Drainage (IPTRID), Land and Water Division (NRL), Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, 00153 Rome, Italy.

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Furrow irrigation with siphons in Nyanyadzi, East Zimbabwe. *(HR Wallingford Ltd)*

Aim and scope

GRID is published to assist communication between researchers and professionals in the spheres of irrigation and drainage. It informs readers about IPTRID activities and about research and development in irrigation and drainage with a view to stimulating international debate on these issues.

GRID is produced for professionals working or having an interest in irrigation and drainage projects in developing countries. It covers all relevant disciplines including engineering, agriculture and the social sciences.

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A welcome from the Programme Manager

Dear Reader,

Concerning this issue

Our GRID 27 is the second issue of 2007. I invited our Associate Professional Officer, Ms Virginie Gillet, to be a Guest Editor for this issue, and as such she has done an excellent job in bringing together all the contributions you now have in your hands. Unfortunately, this particular issue can only be published in English, as the required funding for other languages was not forthcoming. This new version of GRID will tell you about multiple use schemes in Nepal, it provides an overview of Mexico's small-scale irrigation sector and the view from France on how irrigation systems allow provision of multiple water services. You can also read about FAO's new approach to irrigation modernization.

Our interviewee this time is the Senior Water Adviser of the World Bank (WB), Mr Salah Darghouth, who has been a strong supporter of the Programme for many years. He provides his views on how the Bank is re-engaging in the agricultural water management agenda and how IPTRID may link with his Organization on joint efforts in Africa. Our main article is tied to our agreement with ICID to promote the Country Policy Support Project (CPSP). In our last article under this arrangement an IPTRID Secretariat staff member summarized and provided an overview of those activities undertaken in Pakistan in the Nari River.

Under our Research and Technology section we bring you a very interesting case of research that is ready to be taken to farmers fields: The Wetting Front Detector, a joint effort from Australia and South Africa. In our Forum, a contribution from the United Kingdom argues on the myth or reality of the water wars and the Chairperson of our Consultative Group, Peter Lee, proposes a debate on the Ten Top Technologies capable of revolutionizing food production using less water, where we would like to have your feedback. Finally, we draw your attention to our Review section where we present one new book touching on water policy.

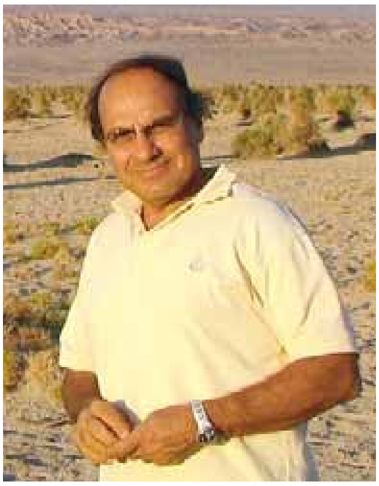
In relation to our activities

A considerable amount of our efforts during the past six months were spent on dealing with two key issues: Organizing a Donors Meeting on behalf of the Programme and looking towards the future after the present hosting arrangements with FAO comes to an end on 31 December 2007. As we went to press, the first activity had taken place on the 6th of July 2007, with the presence of both donors and partners. There was a broad consensus that support for the IPTRID shall continue and it was agreed that the Programme will present a mid-term work plan by November 2007 that will allow donors to further commit their support. On the second issue, negotiations have started with FAO to shape the future of the IPTRID-FAO relationship; this after the Director-General reaffirmed FAO's interests for a continuation of support to host the IPTRID Secretariat.

Finally, and with respect to other activities, the Programme continued its involvement and support in a various ways: we continued to work in North and West Africa within the framework of the CISEAU project; we move forward on the evaluation of the Swiss Concrete Pedal Pump in India and Tanzania under Swiss financial support; IPTRID conducted evaluations of the French-supported projects: "Improving the performance of irrigation in Africa (APPIA)" for East and West Africa, and "Mission régional eau–agriculture (MREA)" in the Middle East region; and we expanded our ESPIM work (institutional mapping) to Thailand, in collaboration with the FAO Water Development and Management Unit (NRLW).

Carlos Garcés-Restrepo
IPTRID Programme Manager

Interview with Salah Darghouth



On the World Bank

Where does water for agriculture fit into the World Bank's overall development support agenda?

As part of its renewed focus on environmentally sustainable development, between 2002 and 2003 the World Bank issued new corporate strategies on Rural Development, on Water Resources Management and on Environment. All three strategies recognized and confirmed the importance of irrigated agriculture and called for the Bank to reengage in the sector. Because of the complexity of the issues at stake and the interconnections between them, the strategies stressed that irrigation and other agricultural water issues should be addressed in the broader context of water resources management, rural development and environment.

Since then, we have been working to implement these strategies by developing a new reengagement agenda for agricultural water management and translate that into concrete development activities within and outside the Bank.

You have been instrumental in this Bank agenda for reengaging in agricultural water management. Could you describe the main components of this agenda?

Following an extensive and broad consultation within and outside the Bank, we have devised the main strategic support for this agenda, presented in "Reengaging in Agricultural Water Management: Challenges and Options." This report demonstrates that agricultural water management (AWM) has been and will continue to be crucial to economic growth, food security, and poverty alleviation in the developing countries. The agenda revolves around a central message: "How to meet the ever-rising demand for food while at the same time increasing farmer incomes, reducing poverty and protecting the environment, all from an increasingly constrained water resource base?"

The report identifies specific policy, institutional and incentive reform options for accelerating improvements in productivity and pro-poor growth in the AWM sector. It also articulates priorities for investments and indicates options for adjusting the roles of the public sector and stakeholders.

What are the main program messages of this reengagement agenda?

To meet these challenges, the program calls for a major shift towards the following:

- AWM should be recognized as being extremely diverse. For example, what is referred to most often in the global debate on irrigation – the publicly funded and managed large-scale irrigation schemes – cover no more than a third of the world's irrigated land.
- AWM has to be placed, treated and analyzed within an integrated water resources management and environment contexts.
- A special focus is required on ways of increasing water productivity rather than simply water use efficiency.
- It is essential that we recognize and integrate the technological aspects of AWM. This is important because irrigation technology underpins the manageability of systems, on which institutional change, operation and maintenance and charging for water can be successfully built leading to improved performance and long-term sustainability.
- New institutional arrangements should give farmers more responsibility to truly empower them, engage the energy of private stakeholders and reduce the role of government. "People, Public and Private Sector Partnerships" (PPPPs) would be the result.
- At the local level, any investment in agricultural water improvement and/or expansion should be economically viable for the concerned country, financially sound for the beneficiary farmer and based on assured market opportunities.
- Closer attention must be given to factoring more poverty and gender concerns systematically into agricultural water programs.

Of course, these messages need to be adapted to regional and local situations through a process of careful study, consultation and dialogue leading to action programs.

There seems to be a mismatch between the importance given to water for agriculture by the water community and the funding allocated to it by international donors. Do you agree with this perception?

As a matter of fact, both the water and donor communities as a whole have, until recently, focused almost exclusively on the equally pressing and urgent needs to expand access to water supply and sanitation and to deal with the broader issues of water resources management. This is a well-justified move, considering the urgency of reaching the Millennium Development Goals (MDGs) on access to drinking water. Only in the last two or three years has the importance of agriculture and AWM been recognized for resolving the persisting worldwide problems of food security and attaining the MDG on reducing hunger. This trend in awareness building has largely been driven by demand from client-country governments.

We know the Bank's lending for irrigation-related project is on the rise. What can you tell us about this?

World Bank lending for AWM has indeed picked up in the last four years. After hitting the record low of US$ 220 million in fiscal years (FY) 2000–2003, its annual average loan and credit commitments to irrigation and drainage (I&D) components of dedicated and nondedicated projects more than quadrupled in FY2004–2007. Lending in FY2007 (ended 30 June 2007) was close to the US$ 1 Billion mark.

A large proportion of this lending was for the South Asian countries, but the good news is that lending in the sector is picking up in Sub-Saharan Africa. The most recently approved projects were for Madagascar (improvement of irrigation and watershed management over 80 000 hectares) and for Ethiopia (development of new irrigation schemes over 20 000 hectares). The Bank is now preparing sector strategies, reviews and investment projects in AWM in several other African countries. These include Nigeria, Zambia, Niger, Kenya, Mozambique, Tanzania, Mali and Sudan.

In the context of aid harmonization, is the Bank developing new partnerships for the irrigation sector?

As part of our reengagement agenda, we are following a two-step approach. Under the first step, our partnership has focused on building closer collaboration with research/development organizations active in AWM. First we wanted to make sure that the wealth of Bank sector policy and project-related work is available to our partners in these organizations. At the same time, we wanted to ensure that our work to develop the new reengagement agenda is based on and consistent with these organizations' analytical work. These organizations are FAO and IPTRID, ICID, INPIM, IWMI and IFPRI. One practical example of this partnership is our collaborative program with FAO, IWMI, IFAD, and AfDB for the recently completed regional strategic study on challenges, options and tradeoffs of promoting sustainable investments in AWM in Sub-Saharan Africa.

The second step is to strengthen our partnership with the donor community in the irrigation sector. This initiative began recently with preliminary contacts with valued partners. Our plan now is to deepen and expand this partnership. The Bank has been part of a vibrant donor partnership in water supply and sanitation for the last five years. We intend to forge a similar partnership for AWM.

On IPTRID

IPTRID was established in 1990 with World Bank support. You have long been an IPTRID supporter. What opportunities are there for IPTRID to develop further?

Indeed, IPTRID was hosted and financed by the Bank for several years before this role was passed on to FAO. In assuming my role as the Bank representative on IPTRID's management committee, I have done my best to provide any support needed to strengthen the development of this program that I believe is central to achieving the reengagement agenda objectives.

Beyond some CGIAR crop research institutes, no organization but IPTRID has the mandate to focus on the AWM-related technological matters. Almost all water research and development organizations concentrate on analysis, planning, and development policy for institutional and environment water-related matters. The technology-related aspects have been and still are the bailiwick of the private sector and some nongovernmental organizations especially when it comes to smallholder, low-cost irrigation technologies. A program like IPTRID is vital for the identification of water-efficient irrigation technologies and their worldwide dissemination and promotion, and for training people to use them. Special efforts should go into promoting the most suitable and affordable technologies for small to medium-size farmers.

IPTRID's recent effort to return to a concentration on the technology aspects of irrigation is a timely and welcome initiative. Similarly, I applaud FAO's decision to continue hosting and supporting IPTRID beyond 2007.

In terms of the activities of the Bank, how and where do you think IPTRID could support you?

In addition to developing some global and regional strategic programs for promoting irrigation technologies and research results, IPTRID can indeed provide specialized services for the design, preparation and implementation of irrigation technology and research-related components of AWM projects. These services can be provided not only to the World Bank but also to any other multilateral, regional or bilateral development organization involved in supporting such projects. Among these are IFAD, AfDB, ADB and, within FAO, the services of the Investment Center. I am convinced that there is demand for such services. However, the only way to access this demand is for IPTRID to develop specialized technical assistance "products" in the irrigation technology and research field that it can "sell" competitively to potential users.

Would you like to see IPTRID based in a developing country or remaining under its current set up?

This question deserves careful study, and the answer will depend on the proposed new location and the arrangements entailed in any move of IPTRID outside Rome. From my own experience, I would like to say that moving IPTRID to a developing country would be an interesting option if it could cut both the fixed and variable operating budgets of the program. Cost cutting was the main reason for moving the central office of INPIM from Washington, D.C., to Islamabad, Pakistan. Apart from that, keeping the IPTRID Secretariat in FAO headquarters in Rome offers many advantages, considering the great positive synergies and collaboration potential that exist between IPTRID and the various FAO and IFAD services engaged in agricultural water policy, institutional and project preparation, and implementation aspects.

On technical matters

Do you feel that participative irrigation management has already run its course? And if so, what should come next?

Participative irrigation management (PIM) has been adopted all over the world. It is becoming a central component of irrigation/water policies, for example, in World Bank irrigation management projects. And, there is a general consensus that further promotion, strengthening and expansion of PIM reforms is needed in the I&D sector across countries.

We should recognize, however, that experience with PIM so far has been successful in some countries and regions but less so in others. Global and regional reviews have demonstrated that — if properly implemented — the PIM approach delivers a number of positive outcomes and impacts for stakeholders. However, the extent of PIM reform success and sustainability and the magnitude of such outcomes and impacts have varied from locality to locality. Success has hinged on a number of factors such as the clarity and strength of the institutional and legal framework, strength of political will and local leadership, availability of financial and technical resources, access to support services, and existence of incentive systems, capacity building and training.

All such issues were debated openly and candidly during the 10th International Seminar on PIM, organized by INPIM and the Iranian Commission for I&D in Tehran in early May 2007. The outputs of this seminar as well as the results of the studies conducted by FAO and other development/research organizations should help us come up with a useful toolkit on the conditions for the sustainable establishment and management of PIM and Irrigation Management Transfer experiences in different parts of the world. The World Bank has just started to do this as part of our FY08 work program. ■

Water assessment of the Nari River Basin in Pakistan: issues emerging from a national consultation

This article is derived from a Country Policy Support Programme (CPSP) related activity undertaken in Pakistan, where the Nari River Basin was selected for assessment. The Nari River flows in the Balochistan province and terminates in the Kachhi plains, on which the waters of the Nari and other hill torrents discharge. The ICID facilitated a National Level Consultation in Lahore to present and discuss the results of the Nari River Basin study (see Table 1). The consultation was organized by the Pakistan National Committee on Irrigation and Drainage (PANCID) with the help of the National Engineering Services of Pakistan (NESPAK). Participants, representing different regions and disciplines, discussed policy interventions emerging from these studies and their implications for addressing country level problems in water management at length.

Storage dam sites in the Nari Basin

Eighteen sites have been proposed for the management of floods in the Nari Basin. The proposed plan consists of Delay Action Dams, Detention/ Storages Dams and Dispersion Structures with Diversion Channels. While recommending a diversion structure the main consideration is the perennial flow in the streams and the existing irrigation of the area. With the proposed diversion structures it is intended to divert additional and ensured supplies

The purpose of a delay action dam is to enhance groundwater recharge and moderate flood peaks through reservoir routing and controlled releases thanks to low level outlets provided to meet local crop water requirement conditions. The flood peaks can destroy downstream storage, diversion structures and can fill the structures with sediments. Any development in the Nari Basin could affect the downstream Kachhi plain, which utilizes its water. Construction of storage reservoirs and their effect on sediment movement and morphology of the hill torrents downstream of the reservoir need to be studied.

Watershed management and sedimentation

The major watersheds in Pakistan cover about 24.5 million hectares and are located mainly in the northern areas in the North West Frontier Province (NWFP) and mountainous area of the province of Punjab; with a few watersheds in Balochistan. The rate of soil erosion in the watershed/catchment areas of almost all the river basins in Pakistan is accelerating due to over-grazing, deforestation, and cultivation of marginal lands and inability of people to undertake proper soil conservation measures and manage water effectively. There is an estimated 1.2 million hectares of eroded land in Pakistan. It is further estimated that 76 percent of Pakistan's land is affected, in varying degrees, by wind and water erosion. The soil erosion and sedimentation load can be reduced through proper development and efficient management of watersheds/catchment areas. In the Nari Basin, afforestation and watershed management in the upper areas can provide a strategy, which is complementary to the creation of storages for flood control. This needs to be further studied.

Groundwater depletion

The groundwater recharge in Pakistan is estimated to be about 67.85 billion cubic meters (BCM). It is being exploited through installation of 15 443 large public capacity (3-5 cubic feet per second or cusecs) and 469 546 small capacity (0.5-1.5 cusecs) private tubewells. The groundwater abstraction in Pakistan has increased from 4.12 BCM in 1959 to 59.21 BCM in 1996-97. To meet ever increasing demand of water for agriculture, and water for domestic use and industry (people sector), more and more groundwater is being pumped. This is causing the groundwater level to fall rapidly in many fresh groundwater areas. The mining of water is causing intrusion of saline groundwater into fresh groundwater areas resulting in deterioration of groundwater quality in many areas. In addition, pumping cost of groundwater increases as the water table goes down.

In the Nari Basin, a few sub-basins have already been over-drafted as discharge exceeds recharge. Some basins do not have any groundwater resources. So the need is to identify the sites having development potential

Table 1: Organization-wise break up of consultation participants

Federal Government	10
State Government	20
Consultants (public sector)	20
Consultants (private sector)	5
Academics and Institutes	8
NGOs and other individuals	15
TOTAL	**78**

in the basin. One sub-basin is over drafted having about 11 million m^3 more extraction than the recharge to the groundwater system. Any surface and/or groundwater development within the Bain could reduce the amount of base flow entering the other sub-basins as a link and/share resources.

Water quality

Country-wide the indiscriminate and unplanned disposal of agricultural drainage effluent (polluted with fertilizers, insecticides, pesticides) and untreated sewage and industrial waste effluent loaded with Biochemical oxygen demand after 5 days (BOD5), heavy metals and poisonous material into rivers, canals and drains cause deterioration of water quality in the downstream waterways and water bodies. According to a rough estimate, in 1995 some 9 000 million gallons of untreated wastewater having 20 000 tonnes of BOD5 loading was daily being discharged into river, canals, drains and water bodies. The polluted water of rivers, canals, and drains which is also being used for drinking downstream is responsible for numerous water-borne diseases.

The extensive use of groundwater in some parts of the Nari Basin would result in higher return flows to surface and groundwater bodies due to the higher gradient, thus resulting in deterioration of water quality. It is important that base flow leaving the downstream end of the Nari basin should be preserved to ensure continued supply to extensive surface water-fed schemes and other supplies from the Nari River Head works on the edge of the Kachhi plain. However, development of groundwater in the Nari Basin should not result in reduction of downstream base flow.

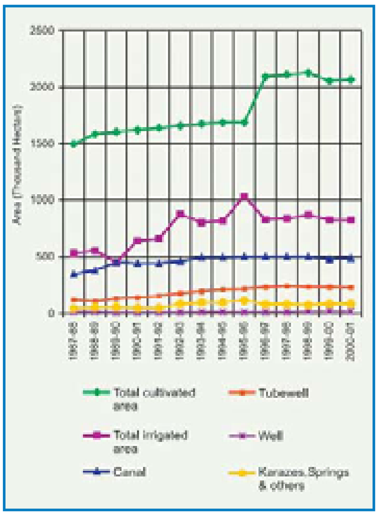


Figure 1. Area irrigated by different sources in Balochistan

CPSP studies and application of the BHIWA model: Suggested policy options

In regard to application of the Basin Wide Holistic Integrated Water Assessment (BHIWA) model, the participants in general, agreed with the overall results of its application. However, it was noted that there is room for improving the results. For example, in such low and highly variable rainfall regimes, a weekly step both for calibration and in simulation for assessment of scenarios would be appreciated.

In regard to results from the various scenarios studied, the need for building additional storage at the proposed multi purpose use dam site in the Nari Basin was recognized. Specifically, as brought out in the "Business As Usual" (BAU) scenario, groundwater use under present conditions is unsustainable. The construction of additional storages, which would facilitate additional use of surface water, could remove the present imbalance between surface and groundwater uses.

Reforestation and management of watersheds in upper reaches of the basin can be one of the strategies which could be complementary, or an alternative, to the strategy of creation of storage for flood control purposes.

The water discharging on the Kachhi plains can cause damage in this area, and can also damage the irrigated areas between the plains and the Indus River. Even though flood control is an important policy objective, slightly different strategies may cater for: i) Flood control in the basin; ii) Flood control in the Kachhi plains; and iii) Flood control in canal commands.

However, the ecological problems of the three areas above would have to be addressed separately. For example:

- While many participants supported mechanized (pumped) irrigation to allow maximum use of the waters, concerns about the groundwater regime were also expressed.
- While the need to eliminate flood damage was recognised, the need for maintaining the water regime and ecology of the Mancher-Indus system was also recognized.
- In the National context, the need for properly estimating the environmental flow requirements (EFR) of the Delta was seen as high priority. This is a subject of study and debate and should be pursued vigorously.

Extrapolation and applicability of Nari Basin studies to other basins

The Nari Basin does not depict a typical sample of other river basins of the country. The extrapolation from the Nari Basin study at national level is debatable at this stage. The study has been carried out mainly by relying on secondary data. The characteristics of the Nari River Basin present large variations from other basins in Pakistan. The Balochistan province consists of varying physiographic features and hydrological characteristic condition (see Figure 1 for different sources of irrigation water). Prior to extrapolation to country level, more hydrological basins should be studied in detail.

Hydrologically, the province has three basins namely, Indus Basin, Kharan Closed Desert Basin and Mekran Coastal Basin. These basins could be further subdivided into 73 sub-basins, with the Nari Basin being one of these. The Nari River Basin is a groundwater deficit basin; although the surface water resources of the basin are sufficient to meet the demands of the area, their occurrence and non availability of storage reservoir make it impossible to fully utilize this precious resource throughout the year. The precipitation usually occurs during monsoon months; besides a winter rainfall and little snowfall are other inputs.

For extrapolation to country level, two or three different types of basins (representing water surplus and water deficit) should be selected for detailed study and then their results could be successfully extrapolated to other basins in the country. The smaller basins should be grouped into few larger basins to represent province and/or country level results for comparison with the extrapolated results.

Summary

The study has indicated that there is development potential of surface water resources in the Nari River Basin. For an average condition, the outflow to the basin outlet is 1 050 million m^3. A considerable part of it can be stored by constructing delay action dams, diversion structures and storage dams to fully utilize the potential water resources. It was also felt that there is strong need to extend this study to the Indus River Basin to identify desired interventions in the national policies related to water resources development and management. ■

For further information contact ICID at: icid@icid.org

An assessment of multiple use schemes for smallholders in Nepal's mountainous districts

Introduction

Small water sources provide promising opportunities for serving the multiple water needs of poor communities. Compared to conventional technologies serving either irrigation or domestic needs, several new technologies are now available for catering to the multiple needs simultaneously. The application of such combined new technologies is referred to as "Multiple Use Systems (MUS). This article summarizes the potential effects of multiple use systems to determine prospects and constraints for their expansion in the hills of Nepal. The MUS technologies studied included a Thai Jar of 3 000 liters for drinking water and an underground tank of 10 000 liters for irrigation. The water is collected for drinking water first and the overflow from this jar is collected in the tank. The irrigation water is distributed through off-takes at farmers' fields.

Methodology

A study was conducted in a total of nine schemes, three in each of the hill districts of Syangja, Palpa and Surkhet. A survey directly related to MUS set ups was undertaken by administering a set of questionnaires to 69 sample households. The assessment was done based on the response for "before" and "after" situation as baseline information was not available. Other project related information was collected from key informants through focus group discussions.

The schemes studied comprised both new irrigation and drinking water schemes as well as improved ones. Existing drinking water schemes were upgraded with the addition of a Thai jar. Also, there were schemes where only an underground tank was built, both for irrigation and drinking water.

Results and Discussions

Participation. User committees were formed for the implementation of the project. The majority of the respondents participated actively during the project cycle. However, women users were not actively involved in the decision-making process. They reported that the work was planned by male members of the group and thus only provided suggestions on needs and problems.

Economic intervention. The use of existing facilities reduced costs to projects and users. On an average, household investment for system development varied from NRs 1 113 in *Syangja* to NRs 2 937 in *Surkhet* (the exchange rate utilized for the study was: US$1 = 71.8 Nepalese Rupees [NRs]). The difference was due to the design of the schemes. The farmers were able to recover the cost in one year. The analysis also indicates that the first priority was given to drinking water.

General benefits from introduction of MUS. The majority of farmers responded that they had benefited from the introduction of MUS. The realized benefits indicated were, among others: 68 percent of respondents mentioned increase in household income; 77 percent of respondents reported water saving, and 70 percent of respondents reported time saving in water collection. The time saved was used for vegetable production by 54 percent of the respondents; while 44.5 percent mentioned other income generating activities such as weaving at home.

A time saving of 22 minutes per round trip fetching water was one of the important contributions of the drinking water provision under MUS (See Table 1). For a household making three trips in a day, the saving would be thus more than one hour per day which translates into over 50 working days per year (8- hour working day). This saving was worth NRs 3 306.9 per year (US$ 46). Mostly, it was the women who benefited from the time saving and reduction of drudgery, as they bore the brunt of 75 percent of the household activities; with males having the remaining. Interestingly, female respondents reported that men had started fetching water and managing livestock due to the nearness of the water tap. Previously, women had to fetch water including that used by men.

Water use pattern. After the introduction of the technology the major source of water use came from the MUS tap; yet households were using traditional sources like river and spring to wash clothes. Tap water was mostly used for cooking, drinking, utensil washing, bathing, house cleaning and for livestock. This shows the importance of the tap water when quality of water is essential. In almost all the schemes, users reported that tap water was supplied in the morning for 2-3 hours. During the lean (high-demand) season drinking water was supplied for even less time in order to balance the supply to irrigation. Therefore, the tasks requiring more water were carried out in the nearby streams. One important change due to the MUS was the construction of latrines by most of the households. Thus, improved household water availability also led to improved sanitation and hygiene, though no quantitative estimates are available.

In most of the schemes, households pooled NRs 10 per household for the maintenance of the system and some groups transformed this arrangement into a saving and credit mechanism. The operation and maintenance of the systems was carried out by the local person who was trained by the implementing agency.

On MUS technology, irrigation and area served. Land under MUS was mostly rainfed upland where maize or "*finger*" millet was being cultivated before the intervention. The average area covered by MUS was only 0.0125 hectares per household (see Table 2). The total area irrigated under MUS was 0.67 hectares in the three studied districts.

Table 2: Distribution of land under MUS including type of technology used

District	Type of MUS and area coverage (ha)					
	Drip	Sprinkler	Both	Pipe	Surface irri.	Total
Syanja	0.16	0.01	0.01	0.04	–	0.22
Palpa	0.24	–	–	–	–	0.24
Surkhet	0.18	0.01	0.01	–	0.01	0.21
Overall	0.58	0.02	0.02	0.04	0.01	0.67

Source: Field survey 2005

Vegetables were the main crops in MUS plots after the intervention. In sampled households the majority (77 percent) were using Drip/Sprinkler for irrigation. The use of drip irrigation was promoted to enable farmers to use low cost technology for increased benefit from the available scarce water resource. A few households were

Table 1: Users' responses on time saving

Indicators		Sampled districts			Average or total (t)
		Syanja	Palpa	Surkhet	
Time saved	Number of Responses (n)	29	24	16	69 (t)
Round trip time to collect water (minutes)	Before MUS	27	31	27	28.3
	After MUS	3	5	11	6.3
Per day time saved (minutes)	After MUS	72	78	48	66
Origin of time saved in (%)	MUS-related	93.1	91.6	87.5	92.8
	Non related	6.9	8.4	12.5	9.2
% of respondents indicating particular use of time saved (multiple responses, total can add more than 100%)	Weaving at home	0	0	6.2	2.06
	More time in farming	65.6	54.2	81.3	67.03
	More time for rest	41.4	33.3	31.3	35.3
	Regular household activities	34.5	75	31.3	46.9

Source: Field survey 2005

Table 3: Annual income per household from the sales of vegetables from MUS plot

Item	Sampled districts						Overall (US$)	
	Syangja		Palpa		Surkhet			
Crop: Vegetables	Before	After	Before	After	Before	After	Before	After
Total Income in US$	0.79	24.0	0	8.86	0	74.97	0.79	107.83
Average Income in US$	–	–	–	–	–	–	0.26	35.94

Source: Field survey 2005

irrigating directly through polythene pipes and bucket due to their inability to purchase drip kits [NRs 1 000 (US$ 14)] or because the area under irrigation was too small. For the main season the total cropping intensity of MUS plots was above 200 percent (or more than two crops within the lean season) and one crop in the low season. Thus, the total area served by MUS in a year was about 2.025 hectares (or an irrigation intensity of 300 percent). Many households (about 41 percent) were interested in expanding the area for vegetable cultivation but water availability was the constraining factor since the collection tanks had been designed to serve only the designated area. Besides, the available drip technology has a capacity to serve only a fixed area. It was reported that more than 90 percent of vegetables produced were sold (Table 3) which was the main source of cash income to the household.

The farmers from *Surkhet* district were earning more in a year because good vegetable seeds were used, followed by farmers of *Syangja* district. The differences could be attributed to the year of scheme operation, market access, the demand for the vegetables and, of course, the access to better seeds.

Conclusions and recommendations

The multiple use schemes are easily accessible to the poor and marginal households because of their simple technology and low cost. The standardization of MUS design of having two separate tanks for drinking water and irrigation was found to be highly beneficial. The participation of the users was quite high but the females participated in the work planned by the males and were not actively involved in the decision-making process. Therefore, there needs to be gender balance particularly in decision-making processes in order to promote female participation.

For women, who bear the brunt of the household activities, the most important benefit of the MUS was time saving of about 50 days per year. In addition, due to availability of better quality drinking water, the hygiene of household members has also improved.

Some of the MUS irrigators have also opted for water conserving technologies, such as drip and sprinkler technology, while others were yet irrigating directly through polythene pipes and buckets. Vegetable cultivation has become a major source of cash income for the MUS households. When households started earning money from vegetable sales, they introduced fixed time allocation for drinking water during lean seasons to save water for irrigation. Given the importance, the up-scaling of the technology to expand the cultivated area would be beneficial for the farmers. The expansion of this activity to areas where there is food deficit, but markets are accessible, would be beneficial to uplift the economic conditions of the poor households. Development of market linkage is highly needed for the farmers to take advantage of the MUS. ■

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Combination of Thai Jar and underground water tank in a MUS, Nepal.

The Mexican small-scale sector: Irrigation Units overview

What is an Irrigation Unit in the Mexican context?

There are two categories of irrigation systems in Mexico, the Irrigation Districts (ID) or *Distritos de Riego* – as the large-scale irrigation systems are locally known – and the small-scale irrigation sector which comprises the infrastructure of thousands of Irrigation Units (IU) which are locally known as *Unidades de Riego*. Each category accounts for around 50 percent of the irrigated area.

These two types differ in size as much as in organizational structures and level of institutional intervention. The IUs have been managed by the water users since their inception while the IDs were initially managed by the government and in the 1980s were transferred to Water User Associations (WUA). Additionally, within the IU a great variety can be observed based on their information availability in official records, type of irrigation source, land tenure and size (see Figure 1).

The National Official Inventory known as Irrigation Units Information System (SIUR) has a classification based on the level of organization presented in the IU: the "organized" and "unorganized". The former are those that, at the time of surveys (during the 1970s), had the corresponding documentation similar to any well organized ID: WUA constitution act, internal system operation regulations, census of water users, classification of land tenure, location map and plot map with the corresponding land registry. Nowadays, this classification lacks practical meaning since very few of them keep their documentation updated and some of the "unorganized" operate their units in an empirical but effective organized manner. However, this classification is essential to understand the official databases.

The water supply source of the IU determines to some extent its size and cropping pattern; cash crops are generally grown with surface water and high-value crops commonly under groundwater. In turn, the cropping pattern has a direct influence on land productivity; the economic output for vegetable production can be up to six times higher than grain production. Furthermore, there is a relationship between land tenure and water supply source; normally, IU that irrigate with deep wells correspond to privately owned land and IU with reservoirs were normally constructed by the government in an *ejido* land were a major number of beneficiaries could be found. Therefore, the average farm size in community owned land is around 2.9 hectares; meanwhile, privately owned IU, mainly constructed from private investment, have an average farm size of around 8.1 hectares. Thus, it can be said that the IUs are a very heterogeneous group of small-scale irrigation systems controlled by the users. Even though they are essentially independent systems they can be supervised by the government who has invested totally or partially in their infrastructure.

How many IUs are there?

The National Water Commission reports (see Table 1) a total number of 39 492 IUs comprising a total irrigable area of 2.9 million hectares. Although, the number of surface water IU

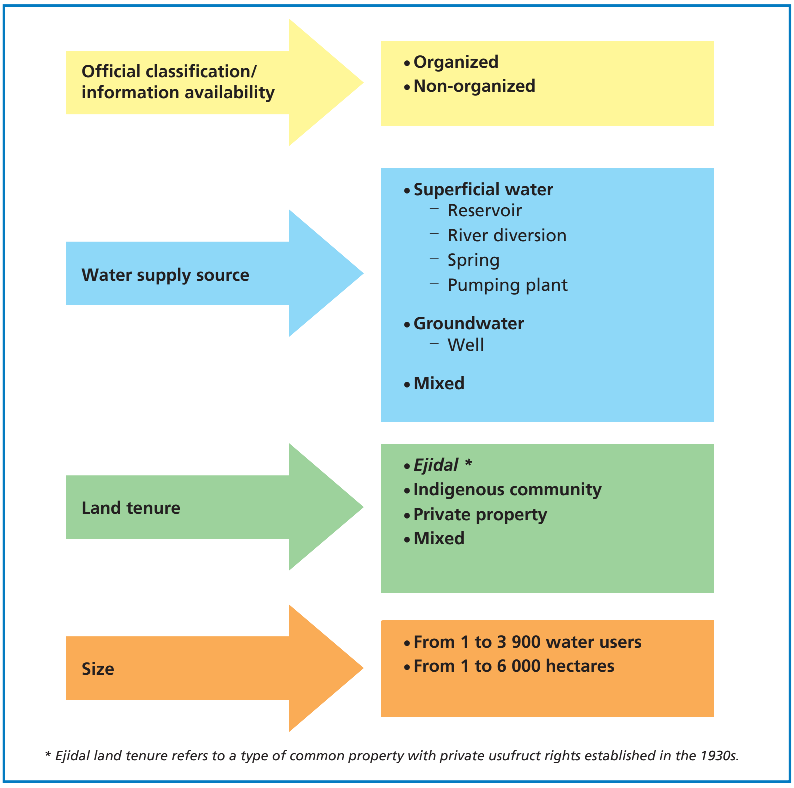

Figure 1. General Irrigation Unit classification.

Table 1: Irrigation Units in Mexico, 1998

	Groundwater	Surface water	Mixed sources	Total
Number of Units	28 576	9 942	974	39 492
Surface (ha)	1 485 659	1 367 897	102 476	2 956 032

Source: CNA/CP, 1998. – Note: see also Figure 1 for water supply sources types.

represent only 25 percent, this type of IU accounts for 46 percent of the total irrigable area.

The content of the official database corresponds in most cases to field data collection from the 1970s. This information has not been updated and discrepancies can be observed with other databases related with the irrigation sector such as the Water Rights Public Registry (Registro Público de Derechos de Agua, REPDA) and the Federal Electricity Commission (Comisión Federal de Electricidad, CFE) related to agriculture users subsidized electricity fee. Although outdated, the IU inventory was still used until recently for the estimation of total water demand required for the elaboration of hydraulic plans and integrated water resources management; the estimation of the demand volume has been done considering an average irrigation depth and the official irrigable surface. However, recently a reform in the water legislation mandates the use of the REPDA records, i.e. the actual water concession titles. This is unrealistic given that in some regions, it is estimated that up to 60 percent of IUs are operating without a proper concession title.

How do IUs operate?

The water users are in charge of the decision making related to the operation and maintenance of the irrigation infrastructure including the existing headwork. There is not an assigned institutional department for the direct supervision for the IU; the governmental oversight takes place only when issuing water concessions and through some governmental support programmes to improve water efficiency and agricultural productivity.

The complexity of the organization infrastructure required to perform these tasks depend on the number of users and type of infrastructure. Groundwater infrastructure, normally owned by a single or small group of farmers, is easily managed given that the well normally works continuously during the irrigation season; water delivery roles are set by themselves upon request and electricity fees, as well as maintenance expenses, are distributed proportionally to the land owned. On the other hand, surface water infrastructure involves more complex organization since water availability varies every season, the number of users is normally above 100 and the headworks operation and maintenance implicates routine activities and more technical skills. Regardless of these differences, the water users are commonly organized under a WUA with no legal status, namely, Civil Association, Cooperative, etc. Lately, the legal constitution of the WUA has gained importance since it is now a requirement for any government support programme application procedure and, most of all, to update and request a water concession title.

The WUA has a board of directors elected every 2 to 3 years and integrated by at least three members: president, secretary and treasurer; ideally, there are also members' substitutes and an oversight committee. These members are honorary positions without salary and usually they are exempted from the payment of irrigation fees. The WUA meets at least twice a year, one at the beginning of the irrigation season and the second at the end. During the first meeting the water allocation is agreed, i.e. number of irrigations per farmer, number of hectares to be irrigated or number of irrigation per hectare; as well as the water fee and the first irrigation date. The execution of the irrigation plan is the responsibility of the ditch man (*canalero*) who is in most cases the only employee of the WUA earning a salary of USD 16 per day (1 USD= 11 Mexican pesos).

The fee collection in surface water based IUs takes place through a single payment at the beginning of the season estimated in terms of hectares or type of crop. On the other hand, when the fee is established in terms of irrigation turns, the farmer usually pays one night before he needs to irrigate. This operational flexibility is possible given that the conveyance network is relatively small and has a water delivery short-time response. In groundwater based IUs, fee collection takes place monthly – when the CFE sends its bill – and the fee amount is determined by the cost of electricity and the irrigated land expressed in terms of $/ha. The possibility of charging water per volume consumed, an incentive for water saving, is far behind since the presence of measurement devices at farm level – and even at main level – is null. However, based on an average irrigation depth a fee in terms of volume can be estimated ranging from 4 to 70 \$USD/m^3.

What are the IUs main constraints?

Small-scale irrigation schemes represent a very important instrument for poverty alleviation, food production as well as economic growth in rural areas. They have an advantage over large-scale irrigation sector in terms of conveyance efficiency, low-cost management and operational flexibility. However, besides the common agriculture related problems, the IUs – especially the ones using surface water – face an increasing deterioration of their hydraulic infrastructure and a lack of funds to conduct maintenance and modernization investments. Most IUs have significant percentages of unirrigated land (in some cases up to 90 percent) and some lack a fixed fee (whether irrigation takes place or not) for general maintenance. Limited access to governmental support programmes is common and representation in basin councils is hardly found. However, the main constraint for the IUs might be organization weakness within the WUA and most important among the governmental institutions involved in the water and agriculture sector. Issues such as institutional oversight, water concession regulation and water accounting represent an enormous challenge given such dispersed hydraulic infrastructure. ■

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Prospects for future public investments in irrigation

In many countries, irrigation has contributed to the development of rural economies and boosted agriculture (Lipton *et al.* 2003), but it has also absorbed large shares of public finances. The paradigm of rapid increase in food production that justified many large scale public investments in the past is no longer valid; with sustained progress in the last decades, agriculture is now in a position to satisfy the needs of its population, and projections indicate no global food shortage in the forthcoming decades. After an initial rise, demand for food crops will stabilize, following downward trends in population growth rates. The predominant trend is for continually decreasing prices of all agricultural commodities, including high value crops.

Projections of developing country irrigation expansion predict much lower rates of expansion of irrigated land over the next 20–30 years. FAO (2003) predicts an average increase of 0.6 percent a year between 1997/99 and 2030 in developing countries, substantially lower than the 1.6 percent a year from 1960 to 1990. Such projections are systematically lower than those given by most national irrigation departments, which generally rely more on past trends than on a careful analysis of demand for agricultural outputs.

In the future, the agriculture sector's contribution to GDP will continue to decrease as countries' economies enlarge (Figure 1). There will be increasing pressure to internalize the true costs of agricultural production.

One major reason to invest in irrigation in the future will be to adapt to changing food preferences and changing social priorities. Rising incomes and growing urbanization in many developing countries are shifting demand from staple crops to fruits, vegetables and "luxury" goods such as wine, as in China, for example (Figure 2). These shifts are typically associated with investment in supply reliability and precision water application but – more important for farmers – they also raise yields and improve product quality. This implies investment in modernizing equipment and in improved water control and

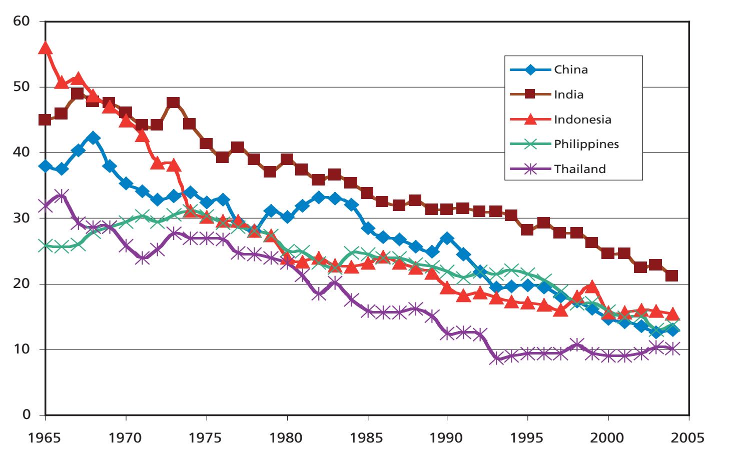

Figure 1. Agriculture in percentage of GDP for selected countries with major large-scale irrigation infrastructure (1965–2004). (World Bank online database).

progressive shift from staple to higher value crops. Other shifts, such as increased meat and milk demand, also require increased grain or feed production. Increased global trade also opens developed country markets to these commodities. Notably, these production shifts also require major investment in the entire post-harvest marketing chain.

Table 1 shows projections of expansion of irrigated land and investments in new development and rehabilitation between 1998 and 2030 based on unit costs provided by various lending agencies. As expected, the bulk of future capital investment will be in modernization/ rehabilitation of existing schemes, while new development will become progressively less important.

However, one of the most striking challenges for irrigation is how it will adapt to increasing competition for public finance. The expanding population, compounded by economic development and rapid urbanization in the developing countries places budget demands for social, housing, infrastructure, education and related programmes to a level that is crippling irrigation funding – a change that will constrain every measure in the irrigation sector dependent on public funding. While some sectors, like water supply and sanitation, continue to attract government's attention in view of their prominence as part of the Millenium Development Goals targets, support to large scale irrigation is increasingly viewed as an excessive burden on public finance. Under such conditions, the reduction of government funding of irrigation and drainage programmes may well be the primary determinant in altering the present support programmes, institutions and financing in these sub-sectors.

As financial resources become scarcer, the issue of cost recovery and associated water charges is becoming critical and will have a major impact on the sector in the near future. A substantial reduction of government funding should be expected for irrigation programmes in many countries. The irrigation landscape will undoubtedly change in response to this pressure, but in ways that are hard to predict, ranging from gradual disuse and disbandment to dynamic self-financing.

The current school of thought in cost recovery for the water sector is well illustrated by GWP (2000): "full cost recovery should be the goal for all water uses". However, assessment of the full cost of water is often out of reach (Figure 3), and GWP (2000) also argues that while all efforts need to be made to estimate costs in order to ensure rational allocation and management decisions, these costs should not necessarily

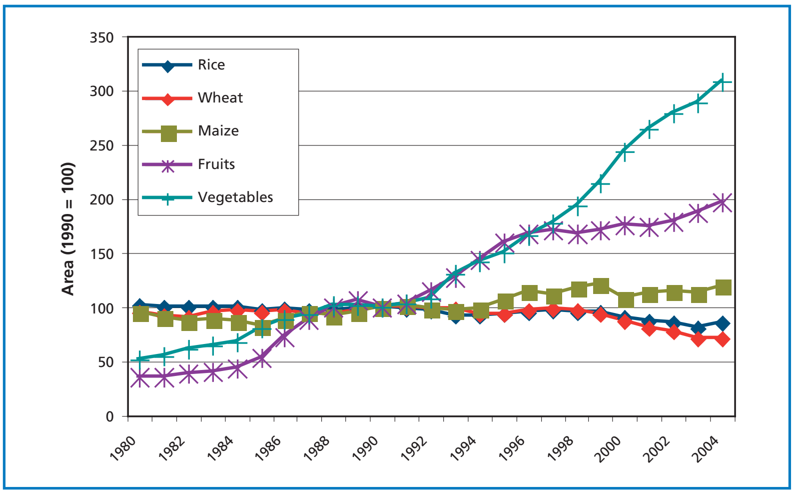

Figure 2. Evolution of harvested area for major crop groups in China, 1980–2004. (CA, 2007).

Table 1: Projections of capital investment needs in irrigation development and rehabilitation in 93 developing countries, 1998–2030

Region	Irrigated area (thousand hectares)			Unit cost ($ per hectare)		Total cost ($ millions)		
	1998	2030	Change (%)	New	Modern.	New	Modernized	Total
East and South East Asia	71 500	85 300	19	2 900	700	40 000	46 400	86 500
Latin America and the Caribbean	18 400	22 000	20	3 700	1 300	13 400	23 900	37 300
Near East and North Africa	26 400	33 100	25	6 000	2 000	40 100	52 800	92 900
South Asia	80 500	95 000	18	2 600	900	37 600	68 500	106 100
Sub-Saharan Africa	5 300	6 800	30	5 600	2 000	8 900	10 500	19 400
TOTAL	**202 000**	**242 200**	**20**	**3 500**	**1 000**	**140 100**	**202 000**	**342 100**

Source: CA, 2007, based on FAO 2003 and Inocencio and others 2006.

be charged to the user. In irrigation, the relevant question therefore is how users (through water charges) and taxpayers (through subsidies) should share the costs associated with irrigation (ICID 2004).

In addition to a thorough understanding of the costs associated with irrigation, information on economy wide benefits of irrigation is critical to efficiently allocate irrigation costs across sectors. Indeed, in many cases society as a whole gets a much larger share of irrigation benefits through induced and indirect benefits than a typical irrigated farmer gets through increased crop productivity (Mellor 2002). This is evidenced by the high multiplier of investment in irrigation —between 2.5 and 4 in India — a factor to consider in setting cost-recovery policies for irrigation.

Contention usually focuses on whether and what to charge: service, operation, and maintenance only, or those plus the full cost of capital investment, either in the past or as future replacement annuity. The answer varies widely according to the role irrigation plays in the country's economy: while some advanced economies may seek full cost recovery from irrigation, others may consider subsidies in irrigation as part of wider rural development strategies. In both cases the concept of sustainable cost recovery, which is gaining increasing attention, remains valid and deserves decision makers' attention: ensuring the sustainability of existing irrigation infrastructure requires that operation, maintenance, administrative, and renewal costs be adequately covered. ■

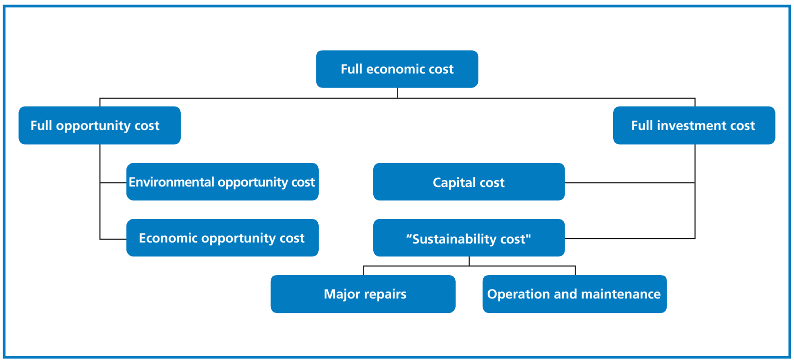

Figure 3. Components of costs associated with irrigation.
Source: Adapted from ICID 2004; Rogers, Bhatia and Huber 1998; FAO 2004.

For more information, contact: JeanMarc.Faures@fao.org. This article is based on some of the work done in preparation for the report "Water for food, water for life, the Comprehensive Assessment of water management in agriculture" (CA, 2007), and in particular its Chapter 9: "Reinventing irrigation" by J.M. Faurès, M. Svendson and H. Turral. (Earthscan, London).

Modernizing the management of large canal irrigation system or chasing the devil with a MASSCOTE!!!

How about chasing the devil?

Although a majority of the irrigation experts, policy makers, donor agencies and practitioners recognize a dire need to bring about drastic changes in irrigation management, unfortunately few know how to proceed in practice. In the past, in spite of considerable efforts and resources, a large number of modernization projects have failed and irrigation institutional reforms have not yielded expected results because of a lack of attention to details. The Regional Irrigation Modernization Programme of FAO in Asia, carried out in over 10 countries and covering more than 30 irrigation systems, reveals that inadequate attention to canal operation is a major reason for disappointing results and under performance of a great majority of the systems.

Whereas, irrigation modernization is often misunderstood and associated uniquely with high technology, costly automation or canal lining on the one hand or institutional reform on the other hand, modern irrigation management – as FAO understands it – basically refers to responding to the current users' needs with the best use of available resources and technologies while anticipating the future needs of users and the scheme. How to translate this concept into very practical and effective technical solutions and management arrangements is a very critical question. It is often said that "The devil is in the details". The more water is debated globally, the less actual managers are provided with practical solutions and tools that could assist them in addressing complex situations. The paradox is that chasing the devil is not attractive.

Where to find high level professionals to cope with increasingly acute needs?

Irrigation has undoubtedly been and will continue to be instrumental in fighting food insecurity which remains prevalent in many rural areas. This situation co-exists with a significant shift towards more productive agriculture and prosperous farming systems. At the same time, attention to the multiple uses and roles of water for improving livelihoods, conserving the environment and managing water resources for sustainable development has also been growing. With increasing water scarcity and growing competition for available water resources from different sectors, irrigated agriculture is expected to do "more with less" water as well as finances, thus freeing up resources (water, money) for other uses. However, irrigation engineers are still trained mostly as civil engineers. This only prepares them to design and construct the infrastructure, and not to manage irrigation systems. Very few training centres and universities (mostly in the western developed countries) provide training in service oriented irrigation management and the necessary modern canal operation techniques.

The MASSCOTE approach for capacity development for modern irrigation management

The MASSCOTE methodology, recently formalized by FAO, is an attempt to break this paradox and to assist technical experts, irrigation managers and more broadly irrigation professionals, in seriously addressing modern needs, issues and challenges, analyzing all the associated details, and embarking upon the difficult road of modernization or re-engineering of irrigation management of medium to large irrigation canal systems, with practical and detailed objectives, plans and solutions.

The entry point of MASSCOTE is canal operation but the scope is modernization and the goal is to promote Service-Oriented Management (SOM) with specific targets that are explicit in terms of cost, use effectiveness of water and other resources, and for the environment.

The methodology builds on many capacity development programmes on modernization in which FAO has been involved in recent years and other contributions from numerous institutions. During the last decade, FAO has trained more than 500 engineers in Asia. Therefore it is fair to say that the approach presented here has largely been developed in close collaboration with irrigation managers in the field, for whom this product has been developed.

MASSCOTE is a systematic methodology to diagnose and embark step by step on modernization planning. The methodology can be used without any specific training but FAO has been using MASSCOTE extensively as a capacity development tool. Present experience suggests that outcomes in terms of trainees being familiar with the methodology and modern canal operation and producing practical solutions and plans for the system which they study during the training are significant. The duration of the training is usually two weeks. This experience does suggest that training is actually required in view of the present capacity of the trainees (who are the managers and operators of the systems), for them to be able to profitably apply MASSCOTE. Experience also indicates that this training does not allow them to complete a modernization plan in all its details or finalize all the steps of MASSCOTE. However, they are able to develop a detailed work plan to complete the exercise, and finalize the different steps and a detailed plan which is ready to be executed.

The MASSCOTE process

The MASSCOTE methodology seeks to stimulate the critical sense of engineers in diagnosing, evaluating obstacles, constraints and opportunities and developing a consistent modernization strategy.

MASSCOTE stands for "Mapping System and Services for Canal Operation Techniques" and is specifically developed step-wise to

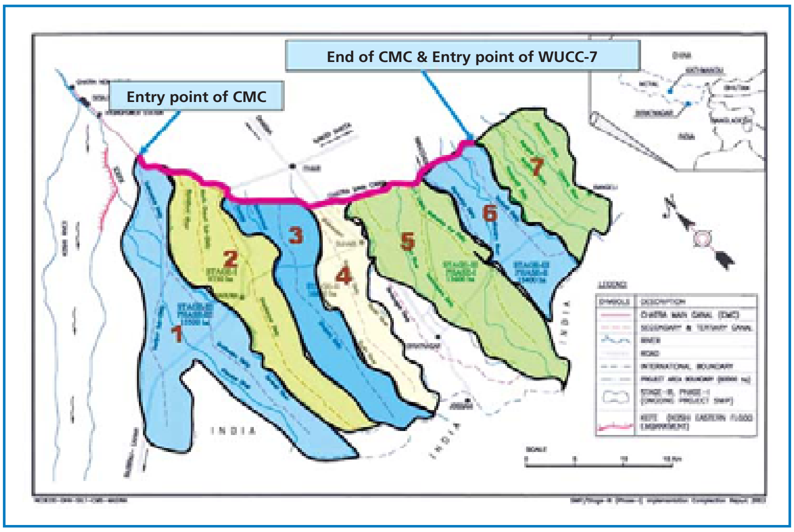

Figure 1. An example of partitioning into professional management units SMIS-Nepal Terai.

convert the complexity into simple and straightforward elements which are then explored in a recursive process leading progressively to a new management set-up and improvements of canal operation, in order to facilitate the shift towards more effective water management and improved water delivery service.

The ultimate Goal of MASSCOTE is to map the entire serviced area into manageable cost-effective units to better serve users (see Figure 1). The design of these sub-units of management is made with the goal of allowing high level professionals recruited by the agency of that level to effectively operate the sub-system and interface with the main system agency.

MASSCOTE is progressively developed in 10 steps (see Figure 2) to reach the ultimate step of the **VISION & PLAN for MODERNIZATION MONITORING & EVALUATION (M&E)**. It is divided into two main parts: (i) baseline information; and (ii) a vision of water services and a modernization plan for canal operation.

- Baseline information

    The Rapid Appraisal Procedure (RAP): A diagnostic tool for assessment of processes and performance in order to increase knowledge about the constraints and opportunities that system management has to consider.

    System capacity and behaviour (sensitivity): This knowledge is critical for operation. The focus is on the hydraulic aspects of canal operation (capacity and reactivity) and on some physical and organizational characteristics.

    The perturbations that are likely to occur along the irrigation canal systems.

    The water networks and water balances, which have a considerable influence on water management in the command area.

    The cost of operating the system.

- A vision of water services and modernization plan for canal operation

    The service to users: This is the main purpose of system management, and canal operation is the primary element in determining the service provided to end users. SOM is the key for modern management; it does not necessarily imply a high level of service but rather one that is best adapted to user demand. A clear vision of the water services should be the starting point from which others steps are carried out (several time horizons might be considered: the mid term 5–10 years and the long term 10–25 years). The vision is what allows defining future demand for services.

    The re-engineering of management: This includes reorganizing the management set-up and defining spatial units (partitioning management units) with the objective of facilitating professionalism and cost-effective management.

    Options for modernization improvements: The methodological development that can be used for developing a consistent strategy for improving canal operation and the project life cycle, in which managers and users need to engage progressively. It examines: analysis of the canal operation demands for the different units, the design of canal operation improvements, and a project to consolidate the improvements. Operation is the entry point but the ultimate scope is much broader, thus options for improvements are not only concerning operation but also cover all aspects of management software, hardware, etc. all changes that allow to operate differently and move towards an improved management set-up.

A consolidated vision of the future of the irrigation system management and a plan for a progressive modernization

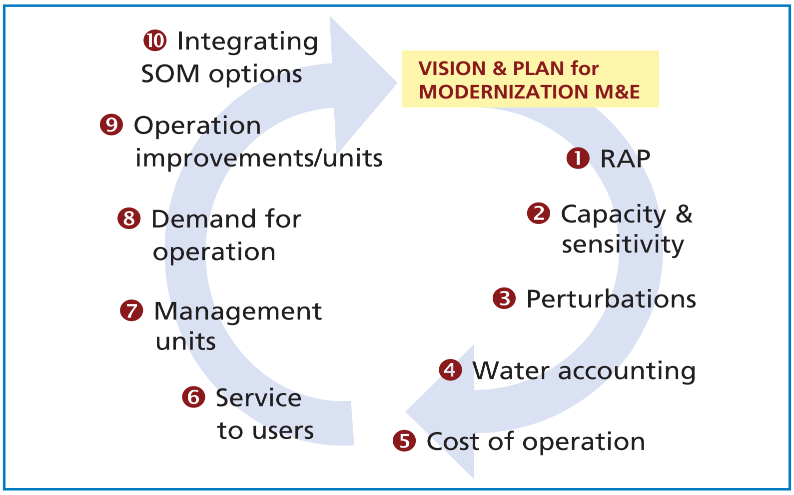

Figure 2. Schematic framework of MASSCOTE.

of irrigation management and canal operation with priority interventions. M&E of performance are genuinely considered at this level as an essential management tool.

MASSCOTE applications

Since 2006 MASSCOTE has been applied with successful outcomes in seven large irrigation systems in China, India and Nepal but the methodology is rooted out of the confluence of several streams of work. The most important among these are:

- seminal works on irrigation modernization from the 1990s by FAO, the International Water Management Institute (IWMI), the Irrigation Training and Research Center (ITRC), the World Bank and IPTRID;
- numerous RAPs carried out by FAO since 2000 in Asia to evaluate irrigation system performance and to identify constraints and opportunities for improvements in these systems;
- a study conducted with the Department of Irrigation of Nepal in Terai, where the MASSCOTE methodology was tested in two irrigation projects; and
- studies conducted with staff of Karnataka Neeravari Nigam Limited (KNNL) in Karnataka (India), where MASSCOTE was refined and finalized. ■

For more information, a MASSCOTE document published as the FAO Irrigation and Drainage Paper no. 63, including 2 CD-ROMs (training material and technical documents) is available online or upon request; or contact: Daniel Renault at Daniel.Renault@fao.org, Thierry Facon at Thierry.Facon@fao.org and Robina Wahaj at Robina.Wahaj@fao.org.

Irrigation systems allow provision of multiple water service

Introduction

The multifunctionality of irrigation systems is a recently developed concept. It is based on the notion that capture, transport and distribution of agricultural water generates negative and positive externalities especially in the context of rapid urbanization, but allows also multiple-use water services that can be essential for communities. This article, based on Bolivian, Sri Lankan and French case studies, describes the development of possible agreements between associations of irrigators and communities, contributing to sustain these irrigation systems and to better manage water locally.

Irrigation has both positive and negative externalities

Firstly the irrigation canals can be thought of as part of the water cycle: the actual volume of water used by crops is generally small compared with the volume extracted from the natural environment. Return flows occur through groundwater recharge or direct discharge into river through escape canals. These positive effects are now largely recognized: river flow support, water supply to wetlands, or groundwater recharge, which in coastal areas helps to prevent saline water intrusion. The irrigated scheme of Kirindi Oya (10 000 hectares) in Sri Lanka is a good example of multiple use of water in a context of growing urbanization. During the dry season, irrigation water is the only source of raw water in an area of some 70 000 inhabitants. Agricultural use only consumes 30 percent of the total flow, the remainder being shared between domestic uses, preservation of wetlands, fishing and maintenance of trees (coconuts palms and other fruit and medicinal trees).

Secondly, irrigation canals contribute directly to the functioning of identifiable municipal services, and help to prevent costly investments for municipalities:

(i) As potable water supplier to communities through recharged groundwater. In France, for example, the groundwater of “La Crau”, that brings drinking water to more than 200 000 inhabitants, is recharged mostly by surface irrigation;

(ii) As urban storm water drainage and sometimes as flood mitigator in the absence of specialized infrastructure, as observed in the peri-urban areas of Cochabamba in Bolivia; and

(iii) To fight against domestic fires in inhabited areas or bush fires in dry isolated areas through privileged access to water.

Finally, irrigation canals contribute to improvement in the quality of life (recreational or tourist activities, walking, fishing, hiking paths), and to shape the identity of the territories (valuable architectural constructions, scenery or landscapes).

However, irrigation systems also generate negative externalities: water extractions from rivers; pollution (accumulation of polluted urban water in canals, use of pesticides for maintaining canals); flooding of agricultural or inhabited areas; and risks of drowning in the canals. Irrigation associations are often reproached for not being concerned by the negative effects they generate. However, reality shows us that they are ready to lower them, provided that they alone are not expected to bear the corresponding costs.

Urbanization of irrigation schemes is an opportunity for multiple service development

All over the world, urban encroachment is progressing over agricultural lands (thus decreasing incomes for irrigation associations) and disturbs canals operation and maintenance (increasing costs). Furthermore, urbanization increases the need for water and the pressure on existing resources. Finally, it also generates a multiplication of canal uses (e.g. urban storm water drainage) which involves increased standards in water management and new missions for irrigation associations (e.g. security of goods and people). In practice irrigation associations, using either surface or pressurized systems, can implement multiple-use water services: raw water supply to communities for further treatment before use as potable water supply, or to industries for various uses, raw water supply for home garden irrigation or for municipal watering of green spaces. For municipalities, it enables operation and investment savings for their potable water service (decreasing of potable water consumption), or to secure their local water resources (either by reduction of groundwater boreholes, or through inter-basin water transfers from dams or rivers outside the local area).

There is a need for supporting and catalyzing change, rather than prescribing it

Multiple-use water services, positive and negative externalities, and the urbanization process are thus four largely interdependent concerns. If they are not managed, they induce new costs that associations are to bear alone. However, if they are integrated into the management of irrigation systems, they turn out to be real opportunities for consolidating the income of these associations. They already develop informal or formal arrangements (conventions, contracts) with local stakeholders (communities, industries, environmental associations, local residents, etc.) in order to share "the cost of change". The transactions are diversified: financial contributions, loan of office space, materials, human resources for technical or administrative management, sharing of investment costs for works, etc. For example, in a peri-urban area of Cochabamba, Bolivia, the municipality has concluded an agreement with a local irrigation association so that storm water is evacuated in exchange for the lining of canals.

These arrangements must be encouraged. A good example is the newly developed "Canal Contract" by the Rhone-Mediterranean Catchment Management Agency in France. The aim is to conjunctively manage irrigation canals, in the local context of available water resources, by following three steps. First, the existing demands are elicited for multiple-use water services and positive/negative externalities are identified, by integrating a prospective vision of urbanization over the next twenty years. Second, the agency identifies the water allocation that could be saved in the medium-term, in order to decrease water extraction from the river or to seek localized river flow supports. Third, a charter of objectives is signed by all stakeholders, and an action plan is decided upon. The conditions of implementation must be: i) to meet the main water demands; ii) to share the cost of adapting the irrigation system and iii) to consequently adapt its governance. There are already around twenty pilot projects of such nature, proving that multifunctionality of irrigation systems can improve their sustainability. ■

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- **IPTRID.** *Leaflet in Spanish and French*

Issue Paper

- **Payen, J. and Gillet, V.** 2007. *L'irrigation informelle en Afrique de l'Ouest – une solution ou un problème?* IPTRID Issue paper 6. FAO, Rome.

Events publications

- **IPTRID.** *International Symposium on irrigation modernization: constraints ans solutions,* Syria. Proceedings. FAO/IPTRID/NOSSTIA/ICARDA. Damascus, Syria. FAO, Rome.

Other

- **FAO. IPTRID.** *Handbook on Pressurized Irrigation Techniques.* FAO, Rome.

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Innovative information system: the Irrigation Equipment Supply (IES)

Nowadays it is inconceivable for organizations to function without the support of internet-based information technology. More so for those programmes or units that encompass worldwide audiences. As such, these programmes are not only developing their main corporate webpage but also find themselves creating or combining efforts with partners in order to produce more specific instruments catering to projects, geographical areas or thematic subjects, as the circumstances may require.

In this particular case, the Irrigation Equipment Supplies (IES) web site is a thematic database developed initially by the Water Development and Management Unit (NRLW) of FAO as part of their mandate to provide specific information on irrigation and drainage. Because of the relevance of the IES subject matter, the International Programme for Technology and Research in Irrigation and Drainage (IPTRID) reacted favourably to NRLW´s proposal to join hands in upgrading this information service.

Potential beneficiaries of IES are those who need to locate information on irrigation equipment at regional or country level. The aim of IES is to establish and maintain an up-to-date worldwide list of suppliers and/or manufacturers providing irrigation equipment. Moreover, the web site offers a trilingual database query facility for identifying both Suppliers and Manufacturers providing specific irrigation equipment as well as a description of irrigation equipment, an account of pertinent standards and links to other related sites.

Innovative characteristics

IES, as it operates now, represents a major change in the workflow paradigm for the way an organization such as FAO maintains its database services. While up to a few years ago the staffing situation permitted FAO to actively collect information, insert it into its databases and keep it up-to-date, today after a series of budget cuts, the Organization is no longer in a financial position to offer this kind of centralized data collection and data maintenance services. While the financial and staffing situation had dramatically changed, its mandate as an independent global agricultural knowledge provider had not and thus the alternative to discontinue offering certain services was not really acceptable. Therefore, in the case of IES, the concept of transferring the responsibility of data entry and maintenance to the interested parties (for example, irrigation equipment suppliers/manufacturers) emerged.

As a consequence and as part of the NRLW-IPTRID alliance, the IES database recently underwent an upgrading process with the main objective of allowing suppliers/manufacturers to autonomously subscribe and to independently insert/update their information and, as a by-product, to improve the database query and reporting system. After its re-launch, the application presented itself as primarily supplier/manufacturer-driven in the sense that information contained in the database is inserted and maintained exclusively by the suppliers/manufacturers of irrigation equipment, with minimal supervision of a web master. An automated access code system (similar to an on-line banking PIN) prevents third parties from having write/edit access to information owned by the contributors, thus guaranteeing that the information is exclusively in the hands of the owners and as correct and up-to-date as the supplier/manufacturer wishes it to be.

The process of recording a new supplier/manufacturer and the irrigation equipment provided is rather simple and consists of two steps: The company wishing to record its business in IES for the first-time is requested to provide it's profile, i.e. name, address, contact information, etc. Once the profile has been completed and submitted through an on-line form, the supplier/

Table: IES entries by service and region

Suppliers	Manufacturers	Region
29	15	Africa
34	37	Asia
12	3	Europe (Non-EU Countries)
92	147	European Union
3	0	Former Soviet Union Countries
60	20	Latin America and Caribbean
19	53	Middle East
38	104	North America
27	26	Oceania and Pacific

manufacturer automatically receives a unique and confidential access code via e-mail. This access code number then becomes the key to the second step, i.e. entering information about the irrigation equipment the company sells as well as for any subsequent data entry/update activity.

The only point of intervention of FAO/IPTRID is right after the first-time registration of a company where the owner of the application reserves the right to reject any non-pertinent contribution by not clearing (i.e. rendering visible) a supplier/manufacturer profile.

User feedback

To assess the opinion of the users and suppliers/manufacturers on the improved version, a survey was carried out in July 2006. It is interesting to note that the highest number of responses was received from African participants, showing their interest for this database and highlighting the relevance of upgrading the database to meet their needs. Those that had already used the database judged it positively, considering it relevant or very relevant for their job. A limited awareness of the existence of the database was however recorded among respondents, highlighting the need for more publicity and promotion of the web site among groups of potential users. Overall, about 75 percent of the suppliers/manufacturers perceived the web site as a useful support to business expansion beyond the local/national level.

Current status

Currently, the database holds more than 700 entries (315 suppliers and 406 manufacturers) from more than 90 countries (Table). Efforts to increase the number of contributors from specific countries and regions will be the main goal for the coming years, in respect of this particular information tool. ■

For more information contact Carlos Garcés-Restrepo, Programme Manager, IPTRID (carlos.garces@fao.org) or Wolfgang Prante, Information Management Officer, NRL (wolfgang.prante@fao.org). The web site is available at: www.fao.org/landandwater/ies. It can be equally operated in English, French and in Spanish.

Visit the ***Irrigation Equipment Supply Database*** *web site at:* www.fao.org/landandwater/ies/

Learning to irrigate better with a Wetting Front Detector

We already know how to irrigate efficiently. You need to predict or measure the soil water deficit in the root zone, and then apply sufficient water to refill the profile back to the full point. You also need an irrigation system that can deliver water uniformly to the crop.

There are some excellent tools available for monitoring or predicting the soil water status, but their uptake by farmers is disappointingly low. Part of the problem is the cost or complexity of these tools. Another issue is that most irrigation farmers think differently to irrigation scientists. The farmer will take into account several different cues before making a decision including observations about the crop and soil, combined with their experience, operating constraints and perception of risk.

Scientists from CSIRO in Australia and the University of Pretoria, South Africa, set out to develop an instrument that made intuitive sense to farmers, which farmers could use to evaluate their own practice. The result was a Wetting Front Detector – a mechanical device that gives a signal to the farmer when infiltrating water passes a specified depth in the soil.

The Wetting Front Detector is comprised of a funnel, a filter and a float mechanism. The funnel is buried within the root zone of the crop. When rain falls, or the soil is irrigated, water moves downwards through the soil into the funnel. The films of water around the soil particles become focused or concentrated as they move towards the narrow end of the funnel until the soil at the base becomes so wet that water seeps from the soil through a filter and into a reservoir. This water activates a float mechanism, which in turn operates an indicator flag above the soil surface. There are no wires, no electronics and no batteries.

If the soil is dry before irrigation, the wetting front will not penetrate deeply, because the dry soil absorbs most of the water. A lengthy irrigation would be needed to activate a detector. However, if the soil is relatively wet

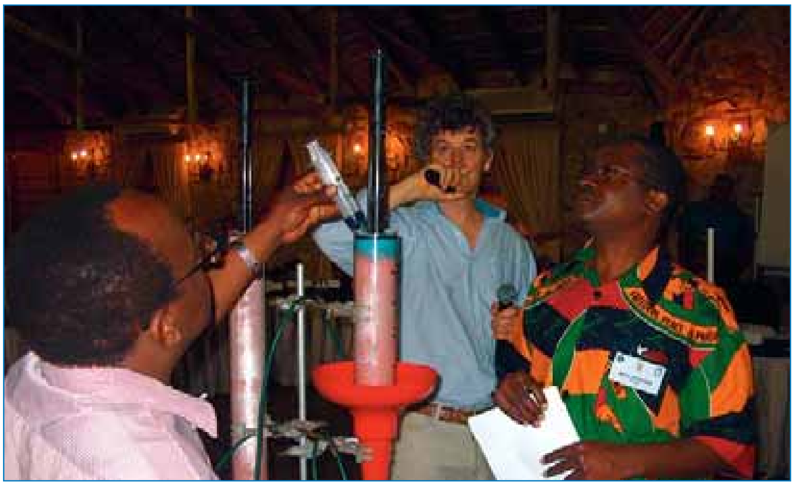


Figure 2. The wetting front detector is an ideal tool to help farmers and advisors gain a better understanding of water and solute movement. Sponges representing the topsoil, subsoil and soil below the root zone are 'irrigated' to show the movement of the wetting front (above left). A sand filled Perspex tube, irrigated with different coloured water, is used to show how irrigation affects the movement of salt and fertilizer in the soil profile (above right).

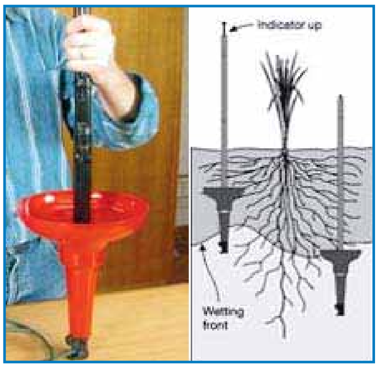


Figure 1. The Wetting Front Detector (left). The red funnel part is buried in the soil with the black tube protruding above the soil surface (right). When a wetting front reaches the detector a red indicator pops up. Detectors are usually placed in pairs, with the depths depending on the method of irrigation.

before irrigation, it cannot store much more water, so the wetting front penetrates more deeply into the soil.

One of the key insights the researchers have gained in working with farmers is that the detector is a learning tool. It is much easier to visualize the depth that water is moving to than it is to think in terms of volumetric water content or matrix suction. One of our aims is to help farmers become semi-quantitative about the way they irrigate. We encourage them to record how much water they apply – and how deeply it penetrates into the soil, based on the response of the detector. Armed with this knowledge, we get a picture of whether watering is too shallow – and thus a greater proportion would be lost to evaporation – or too deep, in which case more water would be lost to drainage.

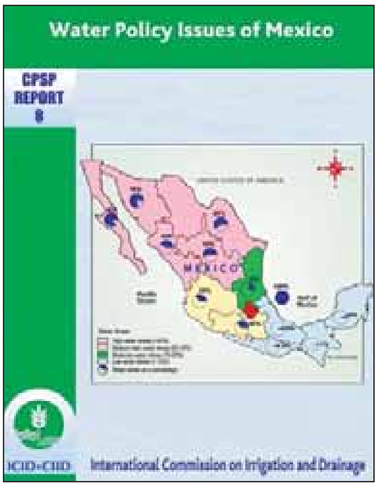
In addition to informing the irrigator that the wetting front has reached a certain depth, the detector retains a sample of water which can be extracted via a tube using a syringe and analyzed for its salt or nitrate concentration. This is done in the field using an inexpensive pocket salinity meter and color nitrate test strip (see pictures).

Monitoring salt and nitrate also gives some fascinating insights into how well irrigation is practised. In one case study, farmers complained that the wetting front detectors rarely responded to irrigation, especially the deeper ones. However, when they did respond, high levels of salt were measured in the water extracted from the detector. We found out that many farmers were under-irrigating and salt was accumulating in the root zone. Over-irrigation is more common. Showing how quickly nitrate is being washed out of the root zone provides a strong motivation to change.

All tools have their limitations and it is necessary to work within them. The Wetting Front Detector does not tell an irrigator when to start irrigating – it simply informs them how well the last irrigation filled the profile and helps them to make a decision about the timing and duration of the next irrigation. The detector also has a sensitivity limitation. After irrigation has ceased and redistribution of water occurs down the profile, the wetting fronts become weaker and can fall below the detection limits of the detector. Thus, some fine-tuning needs to be done to find the appropriate placement depths for different situations. Work is also continuing on more sensitive detectors for specific applications.

The Wetting Front Detector was developed largely through funding by the South African Water Research Commission, together with the CSIRO in Australia. In 2003 the research team was awarded the WATSAVE award by the International Commission on Irrigation and Drainage (ICID) for contributions to water saving in agriculture. Following its commercial release by a South African company in 2004, over 10 000 units have been sold. ■

For more information see www.fullstop.com.au



CPSP: Water policy issues of Mexico

The present document is the result of a study conducted as part of the Country Policy Support Program (CPSP) initiated by the International Commission on Irrigation and Drainage (ICID) with the financial assistance from the Sustainable Economic Development Department, National Policy Environment Division, Ministry of Foreign Affairs (DGIS), the Government of The Netherlands. The ICID assigned this study to the Mexican National Committee (MXCID).

The report is a basin-level consultation to discuss issues concerning water resources development and management and reflects social concerns, including water policy issues in the area, and of the country in general. The study took place in the Baluarte River Basin in the State of Sinaloa. The catchment area is 5 180 km^3 of which 89 percent remains as forest. The current population is 60 000. Presently, water resources are harnessed mainly through run-of-the-river flow diversions and it is projected that by 2025 the net cultivated area will be 53 000 hectares, of which 45 000 hectares will be irrigated. Currently some one million cubic meters is diverted for municipal water uses and this is expected to double in the coming twenty years.

The majority of the participants in the Consultation agreed that there is a need to divert some of the basin's water resources – through a proposed reservoir – to increase agricultural production in irrigated lands, to generate hydro-electric power, to foster aquaculture activities, and assure future municipal water uses but paying particular attention to the protection and needs of the environment in the upper woods and in-stream ecosystems.

The Consultation allowed other elements of the new water management approach in Mexico to be discussed, such as: conflicts between neighbouring states and within hydrological regions; charging rights to water use, discharge and extraction of materials; the application of the integrated water resources management concept; participation of users in planning regional water use; the creation of a new water culture; and the establishment of river basin councils.

Finally, discussions recognized that the increase in food production for domestic consumption and export must be attained without neglecting the water needs of the ecosystems. To achieve such a goal will require searching for innovative ways to finance local initiatives, develop capacity-building and social learning, and to pursue the full application of science, technology and knowledge in water management.

The Report can be obtained from ICID Headquarters at icid@icid.org or from the Mexican National Water Commission available at www.cna.gob.mx.

IPTRID attends events in South Africa

As part of the regular contacts with partners and donors, the IPTRID Programme Manager met in Kuala Lumpur with officials of the Water Research Commission (WRC) of South Africa who showed interest in the Programme's activities and suggested finding a good opportunity to visit their country in order to discuss potential collaboration between the two entities. Such an opportunity presented itself when the South Asian Regional Irrigation Association (SARIA) and the Water Research Commission (WRC) jointly organized in Pretoria a workshop on "Training to Promote Experiential Learning and Participatory Irrigation Management by Farmers on Smallholder Irrigation Schemes". Thus, the IPTRID Secretariat organized a mission to South Africa with the following objectives: i) attend the SARIA Workshop; ii) attend the SARIA Steering Committee meeting upon special invitation; iii) explore opportunities for IPTRID collaboration with the WRC of South Africa, and iv) explore avenues for IPTRID interaction in the SARIA countries.

The two-day workshop had two main components: the first day it dealt with the process that took place for the development of a "Guide for Farmers, Trainers and Facilitators" which was executed in the context of the project on "Revitalization of Smallholder Rainfed and Irrigated Agriculture" sponsored and funded by the Water Research Commission. This project actually deals with the identification of research results that can be transferred to farmers via training and which were reflected in the "Promotion of Experiential Learning" component of the workshop. On the second day, activities concentrated on a different project of the WRC dealing with "Building Capacity in Irrigation Management with Wetting Front Detectors (WFD)". In this case, the exercise can be seen more as the uptake of a proven technology, namely the WFD. It is clear, therefore, that the workshop was of great interest to IPTRID as it dealt with the issues of research uptake and exchanges of technology in farmers' fields that are essential to the Programme's mission.

With respect to SARIA itself, it should be noted that this body has its roots in the International Commission on Irrigation and Drainage (ICID). Its mission is to enhance research, training and development of appropriate science and technology in irrigation and drainage. It is a non- profit regional organization dedicated to improve the livelihoods of the South African Development Community. Currently, SARIA has 14 members.

During discussions several delegates of the SARIA countries pointed out that it has been a long time since IPTRID has conducted activities in that part of the world, and invited the Programme to explore ways to develop joint collaboration. Of particular interest was the idea of formulating a project for the introduction of the Wetting Front Detector in pilot areas. A "basic" project would be developed between WRC and IPTRID and "addendums" made to cater for specific needs of interested countries. Another important point discussed was the idea of seeking regional financial support by presenting a SARIA-IPTRID proposal to the international donor community catering to the region. A third consideration was for IPTRID to interact with individual organizations in these countries to identify specific activities that could be supported as part of the Programme's regular activities. A closing point was related to potential networking activities under the IPTRID banner. Follow-up on all these issues will be part of IPTRID's 2007 and 2008 activities. ■

Survey on adoption and technical performance evaluation of the Swiss Concrete Pepal pump (PEP)

The Federal Office of Agriculture (FOA) of the Swiss Government was instrumental in the development of a concrete pedal pump, now known as "PEP" and has continued providing support towards the upgrading, promotion and dissemination of the device. At present, the PEP has been tested and introduced in India, United Republic of Tanzania, Burkina Faso, Peru, Uganda, Mozambique and Madagascar; and efforts are currently underway for introduction in Mexico.

IPTRID was contacted by the Swiss FOA to explore the possibility of conducting an independent evaluation on the PEP including aspects related to the technical performance of the pump, socio and agro-economic impacts, and institutional issues that may constrain or facilitate promotion, adoption, perceptions and acceptance by users. A project in such terms was formulated by IPTRID and funding was approved by FOA in late 2006 with activities getting underway in early 2007. Two countries are targeted, India representing Asia and Tanzania representing Africa. Both the international consultant and IPTRID Secretariat staff are involved and supported by national staff in each country.

The one-year effort, which will end by the first trimester of 2008, is field-oriented including the physical evaluation of the PEP and users' surveys on acceptance and adoption. With respect to the former, the project looks into technical operating performance parameters, among others, efficiencies, durability, resilience, vulnerability, stability, wear and tear of components, working and maintenance conditions, ergonomic considerations, etc. However, beyond the purely technical evaluations the project documents the impact of the technology on agronomic aspects of the user, including irrigation methods, emerging cropping patterns or farming systems due to the adoption; and in general socio-cultural changes due to the introduction of the technology. The work is complemented with a literature review on related subject matter, mainly other similar pump low-cost technology, used in support of project implementation.

In each targeted country, visits are being carried out to government agencies, manufacturers, dealers, NGOs and other private entities involved in the promotion and dissemination of pumps, with particular attention to the PEP. This component is considered an integral component of project implementation. Results are being analyzed and a Final Report with conclusions and recommendations for various actors involved, including the FOA, is forthcoming. ■

IPTRID Staff changes

Suzanne Vancliffe Torresi joined the Secretariat for one month, as a Temporary Assistance Person (TAP), replacing Ms Edith Mahabir, Senior Secretary, during her annual leave for family visit in Trinidad & Tobago. During her stay, Ms Vancliffe Torresi provided assistance to the Staff as required and especially supported the Programme Manager. She helped in the finalization of the 2006 Annual Report. After her departure from IPTRID she continues working within FAO in ODG.

Water wars: myth or reality?

Many commentators, again in the publicity around this year's Water Day in March, seem to think that scarcity of water will cause water wars. The purpose of this note is to examine the link between water scarcity and the likelihood of water wars. We will first examine what scarcity of water means and then come back to the likelihood of conflicts and wars about water.

Water scarcity

For centuries the amount of water on the earth available to mankind has been small because most (97.5 percent) of it is saline while two-thirds of the freshwater is locked away in ice caps and glaciers. Less than one percent of the fresh water is annually renewed by precipitation, and not all of the water in rivers is readily available for human use either. A case in point is the Amazon River, which contains some 15 percent of the world's runoff but is accessible to only 25 million people. Nearly 95 percent of the Amazon's water flows unused back to the sea. However, even in more densely populated India only part of the Ganges water can be captured for human use. The monsoon rains fall between May and October and much of that monsoon water is not captured but flows to the sea unused by humans. What makes us aware that water is scarce is the diminishing amount available per person: worldwide the amount of water per person has dropped by 58 percent since 1950 and is expected to decrease again by one-third within 50 years as the world population reaches 9 billion people. It is worse in the developing world where the per capita availability of water is now about one-fifth of what it was in 1950.

Water scarcity results from physical limitations of the resource or lack of money to develop available resources. Physical scarcity occurs in arid and semi-arid regions, including West Asia/North Africa, North China and South East Australia. IWMI estimates that nearly one-third of the world's population already live in countries with economic water scarcity (Molden, 2007). For example, in many countries of sub-Saharan Africa only a fraction of the available freshwater resources (including groundwater) has been developed. Water quality degradation often contributes to water scarcity. However, lack of access to adequate drinking water or sanitation is not necessarily caused by scarcity of the resource. It is more likely the result of non-existent or insufficiently performing service installations.

Predictably, when water becomes scarce, competition between various water users intensifies. Water withdrawal for agriculture from all sources of fresh water is about 70 percent of global water withdrawal. There are wide variations in this figure among different continents and regions with the highest percentage going to agriculture at 85 percent in sub-Saharan Africa. Water is depleted (or used up) when it is no longer available for other uses because it evaporates, is transpired by plants, or becomes so polluted that further use is impossible. Agriculture not only withdraws most of the water globally, it also depletes a larger part of it than other users: 93 percent of global water depletion occurs in agriculture versus 4 percent in industry. The net effect of global warming and of widespread ethanol production for biofuel is likely to be an even greater future demand for water than was forecast on the basis of population growth alone.

Water conflicts and water wars

The list of water conflicts is long, starting several thousands of years ago with Noah's flood and similar mythical stories recorded in Persia. Most have nothing to do with competition for water, but are military interventions in water storage or distribution systems. In fact, the last (and only) war fought specifically over water took place 4 500 years ago, between the city-states of Lagash and Umma along the Tigris River. Over the last 50 years, there have been only 37 acute disputes (those involving violence). Various causes of such conflicts have been identified, e.g. unequal social and economic water-related development, unequal access and control over water resources, shared water resources seized for political gains, water used as a military tool and water infrastructure used as military targets.

If there is a causal relationship between environmental scarcity and conflict, it is hardly ever simple and direct. Martin et al (2006) list a set of conditions under which resource scarcity amplifies existing social fault lines. These include: 1) relative deprivation/inequity; 2) a history of recent violent conflict which makes society more vulnerable to another conflict as it deepens poverty; and 3) lack of opportunities for livelihood diversification, low level of mutual interest, and poor mechanisms for conflict resolution.

The 2006 Human Development Report, published in November 2006 by UNDP, titled "Beyond scarcity: power, poverty and the global water crisis" agrees that the roots of water crises can be traced to poverty, inequality and unequal power relations. Flawed water management policies exacerbate the scarcity.

Allan and his colleagues (School of Oriental and African Studies, University of London) have studied water conflicts in the Middle East in detail. Based on empirical evidence they concluded that an individual rather than a country is more likely to use physical violence in seeking recourse to a perceived water injustice. Turton and colleagues (2002) working in South Africa think this is particularly relevant in Southern Africa where protracted civil war has been the norm, and where large numbers of weapons are readily available. They interpreted their evidence to mean that conflict potential increases dramatically in a non-linear fashion as the range of potential coping strategies, expressed as the number of viable policy options tends towards zero. This is graphically depicted in Figure 1. The potential for violent conflict is high when an armed farmer threatens a gate operator in an irrigation system in order to steal water from his neighbours. The reason for the lower level of conflicts between countries is thus related to the wider range of remedies that are available in the international policy economy. This perception is confirmed by data in the Human Development Report (2006) which reported that during the last 50 years more than 150 treaties were negotiated, far more than the 37 violent conflicts during these years.

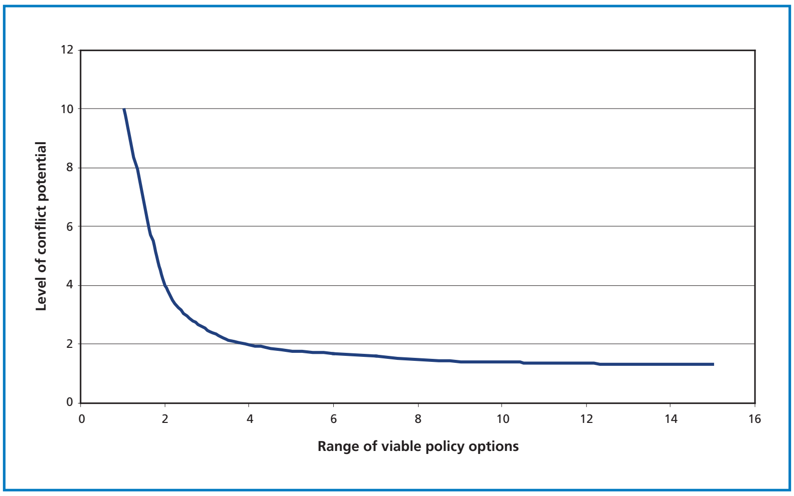


Figure 1. Level of conflict potential (range of 1 to 10); as function of viable policy options (range of 1 to 15).

River basin organizations

In international river basins, especially in arid and semi-arid regions, any attempt to improve the security of supply by one riparian country merely heightens perceptions of insecurity elsewhere into the river basin. This gives rise to the importance of what social scientists call the "desecuritization" of water. They mean the breaking of the link between security of supply and national security. Security of supply for all riparian countries can only be achieved through acceptance of a basinwide development plan that secures the supply for all in a coordinated and non-competitive manner. Water resource management in transboundary river basins is therefore more about international relations than about water resources management per se.

Central to the success of river basin organizations in international river basins is the need to develop an uncontested set of hydrological data. This implies the ability to collect such data, and - as least as important - the socio-political skills to bring about consensus on their acceptability by all riparian countries. Third parties can and do play a mediating and financially supporting role in the collection and acceptance process as there usually are no universally true data of river flows past or present.

Efficient allocation of water

Scarcity, according to many economists, makes water an economic good, and economic logic should compel societies to use the scarce resource in a way that will maximize the economic output of the resource use. However, as water is not only an economic good but also a public good, water for drinking and sanitation should be available even for poor people who cannot pay the economic value of the water.

Allocating water efficiently at transboundary scales raises the question of where staple crops can best be produced. Many countries in Africa produce vegetables and tomatoes for European markets and buy their food grains on the world market. In real terms world market prices of grains have consistently come down over the last fifty or more years. This makes it attractive to buy rather than produce grains, especially if local production takes expensive irrigation water. Fewer countries appear to aim for self-sufficiency in food production provided they have food security, namely that they will be able to buy what they need. Lester Brown of the Earth Policy Institute (2006) therefore thinks that future international competition for grain may be of greater significance than international competition for water.

The recent change in the world commodity price index for food and for non-food agricultural products (Table 1) is therefore of interest. The data indicate that a rise in the commodity prices indices occurred around 2000-2001. It is too early to tell whether this upswing is one of the usual periodic

Table 1: World market price index for food and non-food agricultural products (NFA).

	Dec 2002 (1995=100)	Dec 2004 (1995=100)	Dec 2005 (2000=100)	Dec 2006 (2000=100)
Food	79	80	127	154
NFA	74	80	135	139

Source: The Economist issue of December 2002, 2004, 2005 and 2006.

fluctuations or a harbinger of more significant changes to come.

Conclusions

Some 145 nations comprise land that falls within international river basins, while 33 countries are located almost entirely within these basins. This physical interdependence has not led to widespread wars in the past fifty years. Wolf et al (2005) have pointed out that water is a greater pathway to peace than to conflict in the world's international river basins. International cooperation around water has a long and successful history and the river basin institutions that were created have been resilient, even when relations were strained.

The incentives to launch resource wars are likely to be lower for renewable resources, such as land and water, than for non-renewable resources such as iron or oil. However, Homer-Dixon (1993) rightly raises the possibility of environmental degradation passing a threshold of irreversibility. Land and water degradation are widespread and regionally or locally already restricting the availability of these resources.

Precisely because future international cooperation around water could be strained, we should not act as if future water wars are inevitable but instead without delay support water peacemaking strategies. Such strategies can create shared regional identities and institutionalize cooperation on issues larger than water. Contributions in the peacemaking efforts will come from facilitators experienced in conflict resolution, and from donor agents prepared for long periods of support that might not produce quick or easily measurable results. However, the riparians themselves should lead the process.

For more information contact Jacob W. Kijne, Water Management Consultant at **jacobwillem628@msn.com**

Fighting poverty and managing water resources go hand in hand

The past decade has seen Africa hit by nearly one-third of all the world's droughts and floods. Over 135 million people have been caught up in this catastrophe with over 10 000 killed as a result of flooding alone.

The solutions will be complex and costly as the Intergovernmental Panel on Climate Change (IPCC) warned in *Climate Change 2007: Impacts, Adaptation and Vulnerability* – one of the biggest studies yet on the effects of global warming. The report suggested that rising sea levels, reduced agricultural capacity and growing water shortages would affect livelihoods and could displace up to 200 million people by the middle of the century, fuelling instability.

Even if we stopped emitting greenhouse gases into the atmosphere today the global temperature would still continue to rise by one centigrade, but we need to plan for temperature rises of at least two degrees based on the current global rate of greenhouse gas emission.

Disappearing glaciers will create freshwater shortages for about a sixth of the world's population. Extreme rainfall is likely to become more frequent and intense, raising the risk of flooding. The twin spectres of flooding and drought will have implications on sustainable development; and 'by 2020 between 75 and 250 million Africans will be exposed to an increase of water stress due to climate change' while 'in some countries, yields from rainfed agriculture could be reduced by up to 50 percent.'

Poverty, growth and rainfall

Rainfed agriculture is far more susceptible to the large climactic variability experienced in sub-Saharan Africa. Poverty can be 20-30 percent lower in areas where a higher proportion of land is irrigated and, with irrigation, the cropping intensity can grow by 30 percent, so the need to manage water resources effectively and collaboratively has never been more pressing.

The evidence shows us that there is a remarkable correlation between rainfall patterns and economic growth. In Ethiopia, so sensitive is economic growth to hydrological variability that even a single drought within a twelve-year period (the historical average is every three to five years) will diminish average growth rates across that period by 10 percent.

Part of DFID's own response to the global water crisis is to double aid to water, sanitation and integrated water resources management in Africa to £95 million a year by 2007/2008, and then to more than double it again to £200 million a year by 2010/2011.

Water remains a priority focus for the Department and earlier this year we marked UN World Water Day (22 March) with a focus on water scarcity and a synthetic wallchart *Water: the works*. In November 2006 DFID also published its *Global Call to Action* which called on the international community to invest more money in clean water and sanitation, ensure funds are spent effectively and make sure the right structures are in place to deliver.

Managing the competing demands for water

A growing population, an urbanizing world and economic growth will increase competition for water. People with more money in their pockets will want more choice over what they eat and drink. It is likely that they will choose meat and vegetables instead of cereals – and this will consume more water. Trade-offs between the different demands for water, especially from agriculture – at a time when unpredictable patterns of food production caused by global warming become the norm – are at the heart of the challenge of achieving basic water security.

Investment in agricultural water development in sub-Saharan Africa has declined in the past two decades, despite the increasing volatility of rainfed agricultural production across the region. Following the *Global call to action on water and sanitation* and our recent White Paper *Making governance work for poor people*, we're now making a major push and important commitments on water resources management, with a major African focus. Our strategy targets poverty reduction, coping with the effects of climate change and providing the right level of support at the country and regional levels. We must ensure they translate into action and we think there are three main overarching objectives on water resources management:

- **Better government planning in developing countries** - linking water management to the bigger picture of fighting poverty and getting the balance right between the competing demands of economic growth, livelihoods and sustainability.
- **Improved regional governance** and building regional capacity for management of waters, shared between countries.
- **Improving international systems and processes**, which supports national and regional water resources management, including sound financing to ensure the sustainability of programmes.

Improved agricultural performance is at the heart of Africa's economic growth, encouraging Africans to use their own strengths, abilities, resources and political leadership to generate development and growth – but farming is a major consumer of Africa's water resources, so DFID will re-prioritize water resources management in agriculture.

To help DFID and its Comprehensive African Development Plan (CAADP) partners (including NEPAD, other African institutions and the wider donor community) address the key issues and enable a more informed dialogue, we have developed a new diagnostic framework for agricultural water management in Africa. It prioritizes water resources management and institutional linkages in relation to the CAADP and more widely across the continent. Also, it aims to agree to a more coherent approach to managing water resources in Africa.

Developing and building agreement around conceptual frameworks will always present problems, but we feel this will help enable us to engage in and form dialogue around the social, economic, environmental and political issues and within a comprehensive approach to African water management. The new framework is a deliberately simple and 'light-touch' instrument. It presents the essential components of policy and evidence, but avoids being prescriptive – instead, seeking to set out policy principles that will guide future interventions.

Promoting regional cooperation

Promoting regional cooperation on integrated water resources management is a key element. Cooperation offers huge potential for development, for example, for some of the world's poorest people living around the Nile basin. DFID supports the eight-year old Nile Basin Initiative, and Africa-led programme that helps countries move towards regional water resources management with joint analysis, data sharing and better planning. This is a real step forward in a region that is fiercely protective of national water security.

Increased trust between countries is helping to extend collaboration beyond water and trade is on the increase. We also support the parallel Nile Basin Discourse Programme, which helps promote a broad and constructive engagement with civil society throughout the region. Supporting work throughout the Nile Basin is just one of the ways DFID will develop its work on integrated water resources management, which strikes the right balance between the demands of the economic growth, livelihoods and sustainability.

The challenge just got bigger

It is clear that climate change is making a huge set of existing challenges even more difficult. Africa's inherent climatic variability has long been one obstacle to development and a major challenge to effective integrated water resources management. Global warming means even bigger challenges ahead and the solutions are unlikely to be quick, easy or cheap.

With only modest rises in global temperatures we can still expect major impacts. In the words of Mark Lynas, author of *Six Degrees: Our Future on a Hotter Planet*: 'Places that are wet to get wetter, dry places will get dryer and rain will be concentrated into intense storms.' It is clear that we have to make faster progress on water resource management if we are to enable people - especially the poor who are the worst affected - to cope with the daily realities of climate change.

For more information, contact **Antony Robbins**, DFID's policy and communication adviser or visit **www.dfid.gov.uk/mdg/water.asp**

The ICID Challenge – Top 10 Technologies

Only 8 years away from the Millennium Development Goals deadline and the global food security challenge rages on. We believe the commercial farming sector is to play a key role if we hope to achieve success.

Which technology has the capability to revolutionize food production so that we can meet the challenge of producing 67 percent more food with only a modest increase in water use over the next 25-30 years? At right, our top choices:

1. **Farmer controlled water supply**
2. **Emitter delivery systems for precision irrigation**
3. **Wetting front detector**
4. **Drain controllers**
5. **Wetting-drying rice**
6. **No-till (NT) or minimum tillage technologies**
7. **Fresh-saline irrigation**
8. **Salt and drought tolerant food crops**
9. **Remote sensing coupled with the Internet and mobile communications**
10. **Drainage**

Join our ICID led e-conference under our recently created **icid_top10tech** group at icid_centraloffice@yahoo.com and participate in the discussion concerning each choice above and propose those technologies you feel merit to be on the top-ten list.

Peter Lee,
President ICID

IPTRID

The uptake of Research and Exchange of Technology and Innovations in irrigation and drainage for a sustainable agriculture

The International Programme for Technology and Research in Irrigation and Drainage (IPTRID) is a multidonor trust fund managed by the IPTRID Secretariat as a Special Programme of FAO. The Secretariat is located in the Land and Water Development Division of FAO. The IPTRID acts as a facilitator mobilizing the expertise of a worldwide network of leading institutions in the field of irrigation, drainage and water resources management.

IPTRID aims at improving the uptake of research, exchange of technology and mamagement innovations by means of capacity development in the irrigation and drainage systems and sectors of developing countries to reduce poverty, enhance food security and improve livelihoods, while conserving the environment. The Programme therefore is closely aligned with the Millennium Development Goals.

Together with its partners, the IPTRID Secretariat provides advisory services and technical assistance to countries and development agencies, for the formulation and implementation of strategies, programmes and projects. During the last ten years, it has been supported by more than twenty international organizations and government agencies. The present programme is co-financed by the Food and Agriculture Organization of the United Nations (FAO), the United Kingdom, the Netherlands, France and Spain, the World Bank and the International Fund for Agricultural Development (IFAD).

DIARY

3–6 September 2007
Brisbane, Australia
10th International River Symposium and Environmental Flows Conference
Contact: Lynette Maxwell
Tel.: +61 (0)7 3846 8215
Email: lynette@riverfestival.com.au
Web site: http://www.riversymposium.com

3–6 September 2007
Helsinki, Finland
3rd International Conference on Climate and Water
E-mail: esko.kuusisto@ymparisto.fi
Web site: www.environment.fi/syke/cw3

30 September–06 October 2007
Sacramento, USA
58th ICID International Executive Committee Meeting and the USCID 4th International Conference on Irrigation and Drainage
Contact: U.S. Committee on Irrigation and Drainage
1616 17th Street, #483,
Denver, CO 80202 USA
Tel.: + 1 303-628-5430
Fax: + 1 303-628-5431
E-mail: stephens@uscid.org
Web site: http://www.icid2007.org/

16–19 October 2007
Dongying City, China
3rd International Yellow River Forum on Sustainable Water Resources Management and Delta Ecosystem Maintenance
Contact: Yellow River Conservancy Commission (YRCC), China
E-mail: iyrf@yellowriver.gov.cn
Web site: http://218.28.41.9/vh/hhgjlt3/Eindex.htm

30 October–1 November 2007
Tel Aviv, Israel
4th Water & Environmental Technologies Week – Water technologies and environmental technology week
Contact: Kenes International, P.O. Box 56, Ben Gurion Airport
70100 Israel
Tel: +972-3-9727562 (Liat Skorak)
Fax: +972-3-9727588
E-mail: lskorak@kenes.com
Web site: http://www.watec-israel.com/

4–9 November 2007
Pretoria, South Africa
HELP - Local Solutions to Global Water Problems: Lessons from the South
Contact: Taryn Van Rooyen
Tel.: +27 (0) 11 463 5085
Fax: +27 (0) 11 463 3265
E-mail: conference@soafrica.com
Web site: http://www.unescohelp2007.com/

12–15 November 2007
Basel, Switzerland
CAIWA 2007, International Conference on Adaptive and Integrated Water Management – Copying with complexity and uncertainty
Contact: CAIWA Conference office
Institute of Environmental Systems Research
University of Osnabrueck, Barbarastr. 12
49069 Osnabrueck, Germany
Tel.: +49(0)541-969-23 71
Email: caiwa@usf.uos.d
Web site: www.usf.uos.de/projects/caiwa/index.htm

15–18 April 2008
Adelaide, Australia
Water Down Under 2008
Contact: Graeme Dandy
E-mail: gdandy@civeng.adelaide.edu.au
Web site: http://www.waterdownunder2008.com/

15–18 May 2008
Juventud Island, Cuba
7th International Congress on Hydraulic Engineering: 'Enough Water for Sustainable Development!'
Contact: Rafael Feito Olivera
E-mail: rfeitoo@hidraulicos.cu
Web site: http://www.viiicongresohidraulica.unaicc.cu/

14 June–14 September 2008
Zaragoza, Spain
Expo Zaragoza 2008 'Water and Sustainable Development"
Contact: Expo Secretariat
E-mail: contacta@expo2008.es
Web site: http://www.expozaragoza2008.es/

16–21 June 2008
Venice, Italy
4th International Conference on River Restoration from the European Centre for River Restoration
Contact: Francesco Pra Levis, ECRR
Viale Garibaldi 44/A
30173 Mestre (Venice), Italy
Tel.: +39 041615410
Fax: +39 041615410
E-mail: ecrr@cirf.org
Web site: www.ecrr.org

25–28 June 2008
Kampala, Uganda
International Conference on Groundwater and Climate in Africa
Contact: Richard Taylor, University College London
London WC1E 6BT, United Kingdom
Email: info@gwclim.org
Web site: www.gwclim.org

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Ministry of Agriculture, France
Ministry of Agriculture, Spain
The Federal Office for Agriculture, Government of Switzerland

IPTRID has cooperated with more than 60 organizations in 40 countries

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