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International Programme for Technology and Research in Irrigation and Drainage (IPTRID)

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Issue 28, February 2008

Submission of material
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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Modern irrigation equipment:
Center pivot system. *(FAO)*

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,

In relation to our activities

The six month period since our last GRID issue concentrated on the reorganization of our Governance, in line with what we had reported earlier. We had a Management Committee meeting in Stockholm in August 2007 where we set the basis for the establishment of our new apex body, the Steering Committee (SC). Then we met in Sacramento, USA in October 2007 under the Consultative Group to formalize the proposed changes. Finally, we had our first SC meeting in London in November where three main donors: DFID from UK, the Ministry of Foreign Affairs from France, and FAO [maybe we will be able to add Spain], once more, committed to support IPTRID for 2008 and beyond. Subsequently, a new strategy and work-plan was formulated setting the stage for a renewed Programme which focuses its activities on facilitating the research uptake and the exchanges of technology in the context of irrigated agriculture in the poorest countries in the world.

With respect to other activities, the Programme continued its involvement and support in a varied number of ways: We celebrated signed Letters of Agreement with our partners ANAFIDE from Morocco and ARID in West Africa (based in Burkina-Faso) to pursue dedicated e-mail conferences on water scarcity and maintenance of small scale irrigation, respectively, under the framework of the CISEAU project. We edited and published for ARID, a French version of the APPIA Manual "Participatory Rapid Diagnosis and Action Planning for Irrigated Agricultural Systems". We stepped up our interventions in India and Tanzania in relation to the Swiss PEP pump. In Egypt we concluded the study on their experience in Irrigation and Drainage Research Uptake, and among others, in collaboration with our host partner at FAO, the NRLW Division, we initiated a review of the status of spate irrigation, on a global scale.

Concerning this issue

Our periodical, GRID 28, the first issue of 2008 had again our Senior Technical Officer, Hervé Levite, as Guest Editor. Our flagship magazine continues to draw international attention as evidenced by the numerous messages of support, including a request from Central Asia to have it translated into the Russian language, something we are exploring, as we went to press with this issue. We do not expect to disappoint you with the issue in your hands.

For our interview we tapped Mr Daniel Zimmer, the Chief Executive Officer of the World Water Council. He tells us about his organization's activities and how it relates to our work and how IPTRID can grow and thrive. Our main article, from India, fell under our Country Policy Support Project (CPSP) agreement with ICID when we decided to include one more article under this arrangement. After that, we traveled the world: From Mexico, the work on COTAS, their groundwater organizations; in Gaza Strip we learn about waste water reuse and its importance for day to day livelihood; Kenya presents us with its efforts on modernized, low-cost technology, the drip kits; and the Mediterranean region offers an article on Gender and Irrigation, which is the first time we address this issue in our magazine.

The Research and Technology section deals with modern irrigation in France and a *fertigation* device from Egypt. One may also read about the role of GIS in rural development. In the Forum, a discussion on water and livestock should interest you, as well. Finally, our Book Review touches on water lifting devices.

Enjoy your reading and send us your contributions. GRID belongs to you!

Carlos Garcés-Restrepo
IPTRID Programme Manager

Interview with Daniel Zimmer

In this new issue of GRID we have the pleasure of bringing you an interview with the Chief Executive Officer of the World Water Council, Mr Daniel Zimmer. The Council, serving as a platform to promote awareness and encourage debates on critical water issues at all levels, is thus a fitting interlocutor for IPTRID as our Programme parallels their mission in the narrower subject of technology and research for irrigated agriculture. Mr Zimmer provides a candid view about his organization and how it can interact with our Programme [The Editor]

On WWC and its activities

The "true" impact of the World Water Forum is often brought into question, what is your reaction to this?

All global events are under scrutiny. Criticism is important since it puts pressure on the organisers and forces them to ensure that a Forum is not "just another meeting". Since the first Forum, a lot of progress has been made to ensure continuity and concretely follow-up on the proposals and commitments that are announced.

We see more and more the World Water Forum as a triennial process. The Forum week is just a pause when the work carried out during the preparatory process is discussed. Conclusions must be drawn and then followed-up on. Besides, it cannot be denied that the Forum has truly accelerated debate and dialogues, creating a better understanding of issues and interests. We still have far to go, but bridges are being built to cross the divides in interests, ideologies and solidarity for the benefit of the planet and all people on it.

What importance does the WWC give, within its efforts, to "water for agriculture" as opposed to "water supply and sanitation"? Do you see a balance or think there is a bias towards the latter?

The theme "water for agriculture" lacks good international representation which would enable the communication of simple and clear messages to the world. The WWC strives to put this issue on the global agenda, but it cannot compensate for the lack of good international representation.

More generally, I have noticed that the issues that are easily at the centre of the global debate are those that are directly related to water and not those looking at water as an instrument for something else. Issues such as "water for health" or "water for industry" are not better represented than "water for agriculture".

This highlights an important feature of the water community which, for the past ten years, has done a lot of valuable work for itself in order to increase its coherence. By doing so, it has forgotten that water is not, in general, an end in itself, but simply a means to achieve important objectives, food production being one of them. I often say that today the water community needs a Copernican Revolution: it has to see itself more like one planet in an interconnected system rather than as the centre of the universe!

Can you brief us about the Istanbul Water Forum preparation? Do you see irrigation and drainage being again on the international agenda, especially in a country like Turkey where new investments are huge in the last couple of years?

The Istanbul Water Forum will be built around the 100 most important questions we have to respond to in order to significantly progress in addressing the daunting water related challenges. Collaborative work is in progress to define these questions, and I expect that agricultural water will feature high in this list of questions.

The WWC is leading activities on "financing water for agriculture". Can you tell us about this and what the results are, so far?

Work on this issue started in preparation for the Mexico Water Forum. It has highlighted the difficulties in prioritizing where financing is mostly needed. For irrigation specialists, the priority simply lies in the "development of irrigation". But when confronted with the financial world, agricultural specialists have difficulties explaining, more precisely, if their needs entail e.g. building new schemes, and if so, which kind, modernizing existing schemes to increase their efficiency, building more storage capacity or protecting water resources. One issue is perhaps that, from a water-centred perspective, it is difficult to convince people that building systems to use more water is a priority, while the message conveyed in many places is that we face increasing water scarcity. Work is required to develop a message that is coherent with this general perception.

Monitoring is a key aspect for achieving the Millenium Development Goals (MDGs). You are leading a water monitoring alliance for that. Can you tell us about the specific tools developed for the water for food sector?

One of the greatest difficulties in monitoring results comes from a lack of coordination between the institutions engaged in such activities. A great deal of data is collected, but it is not made available to those who truly need it! The Water Monitoring Alliance was created as a response to this problem. We have already collected information for more than 120 significant monitoring programmes who deal with water, and we are discovering new ones every day! The Water Monitoring Alliance web-site is designed to facilitate access to water related data by providing information on these programmes and facilitating the interrelations between them.

We are also developing country and regional pages where the most relevant data is made accessible.

On WWC and IPTRID

How familiar are you with IPTRID and its activities?

I had the pleasure of working with IPTRID for several years in my previous position with Cemagref, the French Research Institute on Agricultural and Environmental Engineering. This was in the early years of IPTRID, and I believe a lot of relevant work was accomplished at that time by research institutions from several countries.

Since WWC is in contact with a very broad number of institutions working on water, what role do you foresee for the Programme in the near to mid-term future?

I believe a lot should be done to improve and disseminate knowledge on all water management techniques, ranging from large scale irrigation to conservation practices. Agricultural water management should develop a comprehensive approach, and technologies are key in achieving that.

An important issue in this respect is the conditions of the adoption of new technologies by farmers. These conditions need to be better understood. For this purpose, a better understanding of the "development dynamics" of farmers is required. One important and misunderstood factor of this is probably the demographic dynamics of farming families: when the agricultural population's density increases, more resources must be allocated to the production of food supplies and less to market crops. In such conditions, many farming families enter into "survival mode" and are no longer in a situation where they can afford or adopt innovations. In my view, IPTRID could play a role in developing a better understanding of this.

On research and technology issues

You know very well the research community, being yourself from this domain at Cemagref. Researchers are often criticised for not having enough impact on the ground. Do you share this opinion and do you have some specific recommendations to enhance the situation?

Researchers should not be criticised for not having enough impact on the ground. After all, this is not their duty. What is very important though is the definition of the research priorities. These priorities should be defined through processes in which users and researchers interact.

But change is not a matter of research only. If researchers want to have a greater impact, they also need to understand the dynamics of change, which has to do with politics, economy and sociology.

In relation to irrigation and drainage in the developing world, what particular technical aspect would you think would be of importance for IPTRID to address?

Irrigation and drainage should deal with the large spectrum of water management activities ranging from water conservation techniques to large irrigation schemes. A major challenge for the future is to improve the low yields of small-scale farmers, typically below 2T/ha. Under this threshold the water productivity is very low, and paradoxically, improving these low yields would have a positive impact on the total water consumption. ■

Water policy issues of India: study outcomes and suggested policy interventions

Country Policy Support Programme (CPSP)

In order to analyse the supply and demand issues of all three sectors, namely food, people and nature in an integrated manner, ICID initiated a 'Strategy for Implementation of Sector Vision on Water for Food and Rural Development' initiative in the year 2000. ICID also felt the need to mobilise strong international support for strategies and policies in the water sector to achieve food security and reduce poverty in developing countries through independent water assessments. In line with this, ICID launched a project entitled "Country Policy Support Programme (CPSP)", with funding support from the Government of The Netherlands.

Since China, Egypt, India, Mexico and Pakistan hold 43 percent of the world's population and 51 percent of the world's irrigated areas, they were chosen to participate in the CPSP. Multi-stakeholder consultations at the respective basins and at the national level were held to discuss the outcome of detailed assessments, including extrapolation at the country level. Findings from such consultations were used to identify elements in the national policies that required changes in the context of integrated and sustainable use of this vital natural resource.

For carrying out detailed water assessment in India, a water deficit basin on the west coast, (the Sabarmati river basin) and a water rich basin on the east coast, (the Brahmani river basin) were chosen (See map). A Basin-wide Holistic Integrated Water Assessment (BHIWA) model supported by ICID was applied to these two basins. The results of the assessment for these two basins, extrapolation of the assessment and policy related issues highlighted by the studies were presented in a National Consultation held in November 2003, in New Delhi. This article summarizes the water and related policies issues that have emerged from the two basin studies.

India – Water resources

The geographical area of India is 329 Mha, of which is 180.6 Mha is arable. A total area of 142 Mha is net sown area, of which 57 Mha is an irrigated area. India has the largest irrigated area in the world. The total drainage area of India is divided into 24 basins of which, 13 major basins have a drainage area larger than 20 000 km^2. The average annual renewable water resource of the country was assessed at 1 953 billion cubic meters by the National Commission for Integrated Water Resources Development Plan (NCIWRDP). The potentially usable water resource is estimated at 1 086 billion cubic meters, (690 billion cubic meters from surface water and 396 billion cubic meters from groundwater). The per capita availability of water, which in 2001 was 1 901 cubic meter per year, considering the population of 1 027 million and renewable water resources as just mentioned, will be reduced to 1 518 cubic meters per capita under the projected population of 1 333 million in 2025. The present water withdrawals are assumed by NCIWRDP as 629 billion cubic meters and in 2025 are projected to grow further and are expected to be 843 billion cubic meters, considering the growth of population, urbanisation and industry. See table 1.

The BHIWA model developed for assessment of water resources at the basin level was applied to two sample river basins, namely the Sabarmati and Brahmani basins. The sample basin results were extrapolated to other basins in India. Policy interventions emerging from the studies in the context of integrated and sustainable water use were evaluated. A summary of the key policy issues emerging from the detailed assessments and consultations held at the basin/ national level is as follows:

- Precipitation is the primary source of all waters on land, rather than terrestrial surface and ground water runoff being recognised as the primary and real source for water assessments (See Table 2);
- Consumptive use, which results in the depletion of resources, needs to be managed through increases in efficiencies across all sector uses, and by curtailing especially its "non-beneficial" component of evapo-transpiration, both from lands under natural use and agricultural use;
- While local harvesting of rain can, to some extent, be promoted, its usefulness in water short basins, where the existing reservoirs hardly fill up, is very limited;
- Integration of land and water use is necessary. In irrigation projects, where all lands cannot be irrigated in all seasons due to water availability and other

Table 1: Water demand for various sectors in 1998 and 2005, in India (BCM)

SECTOR	1998	2025	2050
Irrigation	524	618	807
Domestic use	30	62	111
Industrial use	30	67	81
Inland navigation	0	10	15
Power	9	33	70
Environment	0	10	20
Evaporation losses	36	50	76
TOTAL	**629**	**850**	**1180**

constraints, rain-fed agriculture needs to be integrated in the cropping patterns;

- Inter-basin transfer of surface waters from an adjacent river basin or basins is an obvious option to meet the additional needs of water deficit basins such as Sabarmati and to restore the groundwater regime and provide for environmental flows in the downstream;
- The high groundwater use, which has developed in many water-short basins, needs to be curtailed as artificial recharge from imported water may be technically and economically unviable, besides threatening water quality and reducing dry season river flows;
- For water short basins, a better soil and water management through introduction of sprinkler and micro irrigations etc. would no doubt be of some help in demand management. The increasing hazards of pollution of surface and ground waters, through higher proportion of return flows, needs to be countered both by adequate treatment of the wastewater being discharged into natural waters, and by encouraging reuse of wastewaters without discharging these into water bodies;
- The use of good quality stored water, for dilution of wastewaters, appears a costly solution, which ties up the precious water resource. Adequate treatment of wastewaters, recycling and reuse appear to be the more efficient options;
- In some water-rich basins, the groundwater use is not developing beyond that which is required for meeting domestic demands of the rural areas. The growing use of surface water for irrigation is likely to increase the returns to the groundwater, and the consequent regime changes in groundwater can lead to water logging. A balanced, conjunctive use of both sources is essential for avoiding such hazards. Policies, which encourage the farmers to use the groundwater, in preference to the cheaper public canal water, need to be put in place in such situations;
- Adjusting the cropping patterns to the availability of water, through a shift from post monsoon irrigation to monsoon irrigation, can reduce the consumptive use of water;
- The high priority given to drinking water must be developed by defining the core and non-core demands, and by allocating the better quality and more reliable sources to meet the core demand;
- Development of urban water supply is necessary as is development of a sewage system and sewage treatment. A mandatory provision, which does not allow the public funding of only the supply part, would be of help;
- A periodic review of supply norms, in regard to domestic water, is necessary. In the long run, the disparity between urban and rural users needs to be diminished, by providing piped household connections and flush toilets, in the rural areas;
- Environmental water requirements need to include both the requirements (mostly consumptive) of the terrestrial ecosystems, and the flow requirement (EFR) of the aquatic ecosystems. While environmental flow requirements (EFR) need

Table 2: Water balance of a typical 1 Km^2 low rainfall rural area in India

LAND USE	PORTION (ha)	RAINFALL (mm/year)	ET (mm/year)	RUNOFF (mm/year)	RUNOFF (m^3/year)
Forests	10	750	650	100	10 000
Barren	30	750	500	250	75 000
Agriculture (Rainfed)	60	750	600	150	90 000
TOTAL	**100**	**--**	**--**	**--**	**175 000**

to be recognised as valuable, acceptable methods need to be developed, as well;

- Navigational use is many times compatible with the environmental flow requirements. However, where the navigational flow requirements in some months are more than EFR, the trade-offs between navigation and other uses would have to be considered, and the basin water management may have to be adjusted to meet the accepted navigational requirements.

The detailed hydrologic modelling and analysis of past, present and various scenarios for the future for the two sample basins have provided a better understanding of the water resources and human impacts in these basins. The holistic view of the assessments taken through the modelling gives a sound and much broader basis to describe the state of water availability and likely water use under different sectors and various future scenarios at the basin/sub-basin level, source-wise (surface and ground water, separately) and interaction between the two. Modelling has also been used to develop a set of indicators, which help in understanding the current water scene for other basins of India. More importantly, the comprehensive modelling framework developed under CPSP has allowed the testing of various policy options and possible scenarios of the future land and water use, including their hydrologic implications, as provided above. ■

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

The COTAS in Guanajuato, Mexico: a new approach towards groundwater management

Introduction

The Technical Aquifer Councils (*Consejos Técnicos de Aguas Subterráneas*, COTAS) of Guanajuato employ a promising and innovative approach towards groundwater management. Their experience shows that participatory groundwater management at aquifer level is a good alternative for locally engaging the global groundwater management challenge. Because of severe over-exploitation and pollution of aquifers in many parts of the world, it is now widely recognized that the centralized administration of groundwater has failed and that new forms of groundwater management are needed. In view of this recognition, the State of Guanajuato, through the State Water Commission of Guanajuato (*Comisión Estatal del Agua de Guanajuato*, CEAG) has created 14 COTAS to work on the implementation of participatory groundwater management plans at aquifer level. This article describes the COTAS, their formation process, achievements, challenges and future perspectives in the Mexican context.

The water problem in the state of Guanajuato

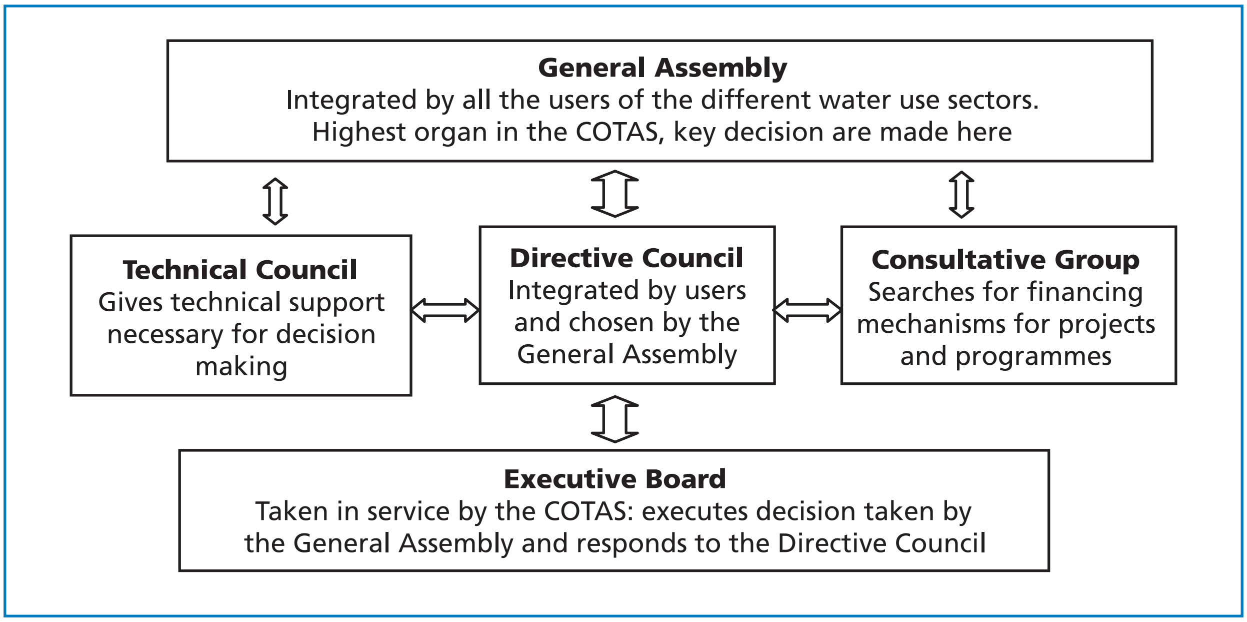
The state of Guanjuato in Mexico has an overall negative water balance. Mean annual surface water runoff is 1 364 MCM while its demand for surface water is 1 557 MCM and many problems of water quality in most of the state rivers are identified. At the same time, the mining of groundwater has triggered the threat of depletion, quality deterioration and a reduction in the social benefits extracted from this resource. All its aquifers are overexploited, with studies by CEAG indicating that total groundwater extractions fluctuate around 4 100 MCM, while recharge is around 2 900 MCM for the whole state. Although irrigation accounts for the majority (83 percent) of extractions in Guanajuato, groundwater is also critically important for industrial and urban water use.

The new approach toward groundwater management

Between late 1996 and 2000 the CEAG set up 14 COTAS in the state of Guanajuato. These developments were in line with the institutional changes that took place in Mexico from the mid-1980s onward, as a response to the national concern about water quantity and quality issues in the different basins.

COTAS are conceived as full-fledged user organizations, which are to serve as mechanisms for reaching agreements on aquifer management by the various sectors using groundwater. Their composition and representation is based on the active participation of the water users of the different water use sectors within the state. In most COTAS there is an active participation of the industrial, potable water, and service sectors as well as of the commercial farmers or agro-industrialists and the small farmers and peasant groups (*ejidos*).

The internal functioning of the COTAS is basically decided upon by



Graph 1. The structure of the COTAS (based on CEAG, 2002)

the general assembly which consists of all the users participating in the COTAS. To manage the day to day functioning of the organization a directive council is elected by the general assembly from amongst the users. There is a president, a treasurer, a secretary and a couple of general board members that usually come from the different water use sectors. The directive council is supported by a hired full-time executive board, which is consists of a general manager, a technician and an administrative support staff member. The role of the governmental institutions is to technically and financially support the COTAS and their work through the Technical Council and the Consultative Group (See Graph 1).

For most of their activities COTAS are financially dependent on the state and federal governments, mainly the Guanajuato State's Trust for Social Participation in Water Management (FIPASMA), and channeled through the CEAG. Some COTAS have been able to obtain extra sources of funding through the private sector, the municipal governments, the drinking water companies, contributions from the users themselves, NGO's and the National Water Commission (Comisión Nacional del Agua, CONAGUA).

What have COTAS done?

In the almost ten years that have elapsed since the creation of most of the COTAS in Guanajuato, these institutions have established themselves as important stakeholders in groundwater management. They have become permanent spaces where the groundwater users have the chance of setting up agreements and get funding to work in the specific context of each aquifer. See Figure 1.

Agriculture is the largest water use sector in all aquifers. As it is assumed that a lot can be gained out of more efficient irrigation, most COTAS work intensively with the agricultural sector. The work concentrates on the improvement of irrigation efficiencies and crop productivity. Several COTAS have focused on pilot zones with the agricultural users to identify and reach agreement on measures to reduce groundwater extractions. In these pilot projects the various government support programmes for irrigation modernization are introduced. These consist mainly of subsidizing the installation of piped conduction systems, sprinkler and drip irrigation, as well as plot leveling. The final goal is to produce the same amount or more crops with less water. Once the new irrigation systems are installed, the users are trained to use them and are organized in aquifer monitoring committees to monitor aquifer levels, report extracted volumes of all users and evaluate the results of the interventions. Users taking part in these programmes have to install meters on their pumps.

In the Terms of Reference established since 2005 between COTAS and CEAG, several activities that the Executive Board of COTAS have to do and report include: capacity building on rights and responsibilities water users have within the legal water rights system; the promotion of water awareness campaigns in schools and farmer groups; bi-annual reading of the monitoring wells that CEAG has in the different aquifers; the organization of farmer monitoring groups; and make a yearly update of the database on groundwater wells in the aquifers.

The number of users that are members of the COTAS has risen through the years from 225 in 2000 to 8 610 in 2006 (of an estimated 18 000 groundwater users), and 20 aquifer monitoring committees were formed. Additionally, the COTAS have also been actively involved in training around 5 300 users.

Another important achievement of the COTAS is that each has updated and verified the database on groundwater wells. Lastly, for many farmers, the COTAS have become an important *help desk* or *service window* that supports them in their interactions with government agencies. Especially concerning groundwater concession titles, the COTAS play an important role as intermediary between farmers and CONAGUA, both for obtaining and renewing the groundwater use titles.

Because of the user-based character of these institutions, different COTAS have focused on different problems and therefore different activities in their aquifers. Some examples are:

- COTAS Irapuato-Valle has done several flood risk assessment studies and has worked on several water quality programs in its aquifers together with universities and the municipality of Salamanca;
- COTAS Jaral de Berrios has worked a lot on user participation, training of users and monitoring committees and is now finalizing a feasibility study for the construction of aquifer recharge infrastructure; and
- COTAS Ocampo and Sierra Gorda have focused more on small-scale infrastructure for rainwater harvesting as they have no groundwater problems in their aquifers.

Future perspectives of the COTAS

Initially the CONAGUA was skeptical about the participatory character of the COTAS. It wanted COTAS to be yet another state institution. It was the CEAG that advocated the participatory and user-based approach of the COTAS. Based on the success and experience of the COTAS in Guanajuato, the CONAGUA has stimulated the creation of COTAS in over-exploited aquifers in the rest of the country. In these COTAS the CONAGUA forms part of the Consultative Group, and if the COTAS wish, the CONAGUA can also serve as the Technical Office of the COTAS. However, this office can also be filled by a state government representative, or by somebody appointed by the users. At present there are more than seventy COTAS in Mexico. ■

For more information contact: Jaime.Hoogesteger@wur.nl. This article is based on research done by the Irrigation and Water Engineering Group or Wageningen University, the Netherlands.

Figure 1. Farmer gathering.

Analysis of socio-economic impacts of wastewater reuse schemes in Gaza Strip

Introduction

The Gaza Strip is a plain coastal strip of 365 km^2 located in a semi-arid area. The annual average rainfall varies from 400 mm at the north to about 200 mm at south The entire population depends totally upon groundwater. The total abstraction of groundwater exceeds 155 Mm^3/year. The agriculture consumes around two thirds of groundwater pumped through more than 4000 wells with the remainder being used for industrial and domestic water supplies. The aquifer is being over-exploited. The gap between water demand and water supply increases with time as a result of rapid population growth in this small area. The water balance record reveals a deficit of about 55-60 Mm^3/year.

The reuse of treated wastewater effluents represents a national interest and it is considered an important component for the overall maximization of water resources. Wastewater reuse provides an alternative to groundwater for irrigation when 110 Mm^3/year of well treated wastewater can be used for irrigation per year as it is planned in the National Water Plan by year 2020. The use of effluents in irrigation would give significant benefits, including reduction in groundwater abstraction for irrigation, potential to irrigate areas currently rainfed, fertilizer savings and an increase in crop production.

Social consideration

Agriculture in the Palestinian lands is an important productive activity. In the Gaza Strip the main water consuming crop is citrus. The public acceptance of wastewater reuse is a key factor in a reuse policy success. The main reasons behind the high level of agreement of interviewed farmers to use wastewater for irrigation includes increasing salinity level in the local agricultural wells, increasing fuel price and maintenance costs. The health and religious aspects are also major concerns of people. A great effort should be made to introduce safe wastewater as a water resource and to increase public awareness. In the southern area, where the cubic meter of fresh water purchased is more than 2.0 NIS (US$ 0.45) the quality of groundwater, has increasingly deteriorated both qualitatively and quantitatively. More than 91 percent of farmers accepted direct wastewater reuse schemes, while the remaining expressed their hesitation and conservative attitude towards the idea. The educational level, living background and the environment played a remarkable role in convincing farmers about the feasibility of using treated wastewater, as observed in the two pilot projects financed by the Agricultural Mission in the French Embassy in Amman (MREA). At the beginning, almost all the Bedouin people were hardly convinced of the safety of feeding their animals with plants irrigated with treated water. In the second pilot project site in Gaza (City), no difficulties to get the farmer acceptance about irrigating their farms with treated waste water was observed. In June 2006, a new survey was conducted in the eastern parts of Khan Yonis area which showed that more than 96 percent of farmers interviewed accepted unconditionally the use of wastewater due to the severe shortage of fresh water, poor water quality, the high costs of purchased water, and the impact of educational programs.

Economical aspects of wastewater reuse

It is stated in the National Water Plan (NWP) that wastewater investment costs represents about 37 percent of the overall Palestinian investment plan for the Gaza Strip. The time period to achieve the strategies and targets are outlined in the National Water Plan. Wastewater reuse schemes are an indispensable option for Palestine in general and Gaza in particular. It is relatively of a lower cost than other options like importing water or desalination of brackish water which was estimated roughly by PWA and the World Bank at US$ 0.55/m^3 for production purposes only. For example, farmers in the South of Gaza buy water from Israeli Water Utility at US$ 0.5/m^3. By comparison, the cost of purified effluent used for irrigation or groundwater recharge has been recently estimated at US$ 0.1/m^3 (for capital costs) which has led to significant financial savings.

Cost/Benefits of wastewater reuse schemes

The valuation approach suggests that cost benefit analysis must incorporate socioeconomic, health-related and environmental impacts of wastewater reuse in agriculture, for proper assessment. When evaluating wastewater reuse projects, the initial approach is to categorize all benefits into two groups, direct and indirect benefits. For the former, increased crop production, savings on fertilizer costs and on water supply as well as generating job opportunities, are just a few. For the latter they are

Table 1: Input/output costs of citrus and olive (NIS/dunum, farm gate prices) (KFW, PWA, 2006) 1 US$=4.44 NIS; 1 Dunum=0.10 Ha

	Full yield (EC=<1.7)		Yield at EC=2 Effluent(1)	Yield at EC=3.2 Groundwater(2)
	Olive(3)	Citrus		
Yield (kg/dunum)	350	3000	2,400	1,500
Selling price (NIS/kg)	5	0.5	0.5	0.5
GROSS PROFIT (NIS)	1,750	1,500	1,200	750
Expenses:				
Fertilizer	52	172	172	172
Chemicals	65	35	35	35
Water (0.5 NIS/m^3)	188	450	450	450
Hired machinery	40	30	30	30
Labour costs(4)	300	480	480	480
TOTAL VAR. COSTS	645	1,167	1,167	1,167
GROSS MARGIN	1,105	333	33	-417
Depreciation	200	147	147	147
Interest on capital	63	135	135	135
TOTAL COSTS(5)	908	1,449	1,449	1,449
NET PROFIT	842	51	-249	-699
Results of the agricultural development program				
Lowered cost of water(6)	131.75	281.25	281.25	
Lowered cost of fertilizer(7)	26	86	86	
GROSS MARGIN	**1,262.75**	**700.25**	**400.25**	**-417**
NET PROFIT	**999.75**	**418.25**	**118.25**	**-699**

(1) For EC = 2 dS/m, yield reduction of 20 percent. (2) For EC = 3.2 dS/m, yield reduction of 50 percent. Groundwater expected to be more saline than effluent. (3) No yield reduction expected due to salinity. (4) Including hired and family labour. (5) Land rent not included. (6) Cost of effluent assumed at 0.15 NIS/m^3. (7) Fertilizer value of the effluent, sludge replacing imported manure

minimized environmental damages, controlled soil erosion and protection of groundwater which reduces waste and enhances water conservation.

An estimate of the economic benefits and the potential of using treated effluent in irrigation have been made by different models. The purpose of this is to show the impact of the use of treated effluent for irrigation at the farm level. The economic parameters of the market, such as product selling price and other factors have been observed as being constant. The reference standards for this computation have been taken from FAO studies. The computation method employed is an input/output analysis applied to crops. A simple input/output calculation is shown in Table 1.

Areas with groundwater EC of 3.2 dS/m would in theory experience yield reductions in citrus of about 50 percent, at which level citrus production would make a loss on gross margin of 417 NIS (US$ 93.7) per dunam. By replacing well-water of this quality for effluent at a future projected salinity of 2 dS/m and by using sludge, the gross margin would become positive, estimated at 400 NIS/dunam (US$ 90.1). Olive trees are more tolerant of salinity and significant yield reductions are not expected within the range of concentrations in the area. By irrigating with effluent and using sludge, the gross margin may be expected to increase by 14 percent. This indicates an economic improvement for farmers switching from groundwater to effluent irrigation, even though full yield potential of citrus will not necessarily be achieved. For this example, a low tariff for effluent was assumed in comparison with well pumping costs which exceed 2 NIS (US$ 0.45). The average rate of yield per tree in Gaza Strip is about 100 kg/tree, while the records of Shetwai farms reached 170-200 kg/tree, with an observed income and savings in the fertilizer applications.

Groundwater expected to be more saline than effluent. (3) No yield reduction expected due to salinity (4) Including hired and family labour (5) Land rent not included (6) Cost of effluent assumed at 0.15 NIS/m^3 (7) Fertilizer value of the effluent, sludge replacing imported manure

Concerning the nutrient load in the treated effluent, wastewater contains nutrients and trace elements necessary for plant growth. The value of nutrients for an assumed added water volume of 800 m^3/dunam is about US$ 70. The average cost of fertilizers needed for one dunam is approximately US$ 100 or 13 percent of the total production running costs. This indicates that nearly 70 percent of the cost of fertilizers can be excluded from the total production cost, which would result in a clear increase in the profits. In addition, treated sludge could represent a significant source of income. Treated sludge for soil conditioning and fertilization has a nutrient value equivalent of between US$ 0.125 to US$ 0.50/year while manure or chemical fertilizers can cost more.

The benefits of wastewater reuse schemes for job creation programmes, in the special case of the Palestinian people (in particular, because of the severe and tense circumstances in the region) is estimated and evaluated as being worthwhile. Most of the Gazan farmers depend on agriculture as their main income, and many of their children, women and younger also participate in the working activities in the various farms. Furthermore, such wastewater reuse projects will create many other supported jobs, e.g. transport, packing of citrus, crushing of olives and marketing jobs.

Despite those benefits, some potential negative environmental effects may arise in association with the use of wastewater. One negative impact is groundwater contamination by a high level of saline nitrate and other detergents in the effluent reuse. The quantity and kind of salts present in wastewater are probably the most important two parameters for evaluating the suitability of treated effluent for irrigation. Data on the increase of salt content in wastewater resulting from wastewater use and the variations increases within a sewage system are especially important in evaluating the reuse potential of wastewater in irrigation projects.

Conclusions

The obvious conclusion and all the socio-economic indicators of the relevant studies and the initial results of the current pilot projects carried out in GS emphasized that a high degree of effluent reuse must be achieved in Gaza in order to reduce the current levels of groundwater withdrawal by the agricultural sector and to mitigate the negative environmental impacts. All future collection and treatment strategies should integrate reuse possibilities whenever and wherever practical. Reuse of wastewater effluent offers the release of complementary resources, sustaining the existing and expanding irrigated areas and in addition, the treated wastewater provides a renewable and valuable source for agriculture and free limited water supplies for domestic and industrial purposes. ■

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Orange production field from treated waste water in Gaza.

Low-head drip irrigation kits in Kenya

Kenya – a water scarce country with untapped irrigation potential

Kenya has 582,000 Km² of landmass out of which only 17 percent has medium to high agricultural potential. The remaining 83 percent is either arid or semi-arid and is usually collectively known as arid and semi arid land (ASALs). Agriculture is the mainstay of Kenya's economy contributing to over 50 percent of the country's export earnings and accounting for about 80 percent of rural employment, with women providing 75 percent of the labour force. Growth and development of the agricultural sector is heavily dependent upon developing the ASALs. The conservation of water resources is important in arid and semi-arid areas where water supplies are scarce and people have to walk long distances to retrieve water. This makes the technology attractive in dry land agricultural production.

Drip irrigation technology delivers water into the plant root zone. Small amounts of water can be applied in drip irrigation, which would not be possible under traditional irrigation methods (flood, furrow and sprinklers). It is with this in mind that the introduction of drip irrigation technology to the smallholder farmers has attracted interest in the government and development partners.

Genesis of low-head drip irrigation in Kenya

Affordable, low-cost drip irrigation was introduced in Kenya in 1988, when missionaries from the USA brought the Chapin bucket drip irrigation kits to Kenya. They set up a base in Nairobi where they demonstrated small-scale vegetable gardening using these kits. They initially gave the kits for free to the local people but started selling them at a subsidised price in 1989. In April 1994, the missionaries left for their home country and the technology started to die off. Basically, the drip kits that were left behind were sold at a giveaway price and the project could no longer sustain itself. There were also issues of poor management of the already installed kits. Problems of clogging in the drip lines were frequent and the community lacked simple innovative measures to maintain the drip systems.

The gap left by the missionaries was later filled by the Kenya Agricultural Research Institute (KARI) who got officially involved in the small-scale drip irrigation technology in August 1996. The Institute imported material and assembled hundreds of Chapin bucket-kits and promoted a training program that had shown promising impact in Malawi. KARI scientists followed-up to assist the farmers to address new challenges in the technology. KARI also set up demonstrations in Nairobi and four other centres. From the early stages of development, KARI collaborated with various stakeholders to assist in the low-cost drip irrigation technology transfer.

Current drip irrigation systems in Kenya

The range of low cost drip irrigation systems in Kenya now includes bucket, drum, farm kits (eighth acre) and family kits (¼ acre) for vegetable gardens and orchard drip irrigation kits for fruit trees. These systems are briefly reviewed below.

Figure 1. A five year old drum kit drip irrigation system.

Bucket drip irrigation systems

The bucket drip irrigation system is comprised of a 20-litre bucket, two or more drip lines for a total of 30m, a filter screen, connecting tubes and end closures. The material for assembling the bucket kits is bought from Chapin Third World Projects in the USA or other local suppliers for the local brands of bucket kits e.g. the dream bucket drip irrigation kit supplied by Kenya Rainwater Harvesting Association. These bucket units are ready to assemble the system. KARI used to be the main supplier of bucket kits assembled from materials from Chapin but KARI no longer stocks them since local suppliers have kits assembled from materials sourced locally. A typical bucket kit to irrigate 100 plants costs US$ 17 when supplied complete with the bucket.

Drum drip irrigation systems

The drum drip irrigation system (Figure 1) is comprised of a 200 litre drum, placed one metre above the ground, a manifold made of PVC or polyethylene pipes, tees, gate valve and fitted bends, filter system, and ten drip lines, each 15 metres long.

A typical drum kit to irrigate 500 plants costs US$ 135 when supplied complete with the drum.

Farm kits drip irrigation systems

The farm kit drip irrigation system can service up to one-eighth of an acre and consists of a screen or disc filter, sub-mainline, connectors and drip lines. The system usually get its water supplied from a 1000 litre tank raised one meter high, to create the pressure. A typical one-eighth acre kit to irrigate 2 500 plants costs US$ 424 when supplied as a complete kit, with the tank (see Figure 2).

Family kit

The family or quarter (¼) acre drip irrigation system is similar to the one-eighth acre drip kit but is double the size. The system also gets its water supplied from a 1000 litre tank raised one meter high, to create the pressure. A quarter acre kit to irrigate 5 000 plants costs US$ 681 when supplied complete with the tank.

Orchard kit systems

The orchard system comprises of a screen or disc filter, sub-main lines, polyethylene pipes and button drippers. The system usually gets its water supplied through a 1000 litre plastic tank raised anywhere from three to five metres, above the ground, depending on the area covered. The cost of orchard systems has ranged from US$ 200 to 1 000, tank included.

Emergence of tailor-made drip irrigation systems

In Narumoru where farmers are faced with water scarcity in the midst of a semi-arid environment, since the area lies in the rain shadow of Mount Kenya, farmers have modernised their old hand watering practices to drip irrigation systems. The irrigation systems are modelled along the Chapin/KARI one-eighth acre system but uses drip lines manufactured by a local factory located in Thika near Nairobi. With more skilled farmers often providing the technical advice, units ranging from one quarter to half an acre are in place. The farmers have also discovered that apart from saving water, the technology leads to better crop quality. This is important to the farmers who grow snow peas for the export market.

In the Isinya – Kitengela areas of Kajiado District, where migrant farmers have settled in areas previously under pastoral use, in order to survive the arid nature of the area, the settlers have intensified water harvesting and storage. Apart from run-off water harvesting, some settlers have made water connections to supplies such as the municipal set-up or to commercial bore holes. Faced with water scarcity, these settlers are using drum farm kits and orchard drip irrigation systems to grow crops for the home and market. The settlers usually employ a farm hand (gardener) to handle the systems. There is a growing population of farm hands, skilled in low head drip irrigation technology, who have become important in the area.

Economics of the systems

Experience with the drip irrigation kits has shown that small-scale farmers in dry lands are able to adopt and use them successfully. Field reports for the various low-cost drip irrigation systems in the dry lands of Moiben, Uasin Gishu District showed gross returns from the sale of tomatoes, cabbages and traditional vegetables amounting to Ksh 4 320 (US$ 72), 19 600 (US$ 297) and 76 200 (US$ 1 155) for bucket, drum and eighth-acre systems, respectively. The net returns were Ksh 3 670 (US$ 55), 17 900 (US$ 271) and 71 100 (US$ 1 077) for bucket, drum and eighth-acre systems respectively. Thus, these drip kits make economic sense considering that their expected life span is six years.

Social benefits

Drip irrigation can adapt to family capacity to meet household needs for both food and income. Women tend to use the small kits which are used in the homestead/kitchen garden while men use the larger kits i.e. farm kits and other higher-capacity kits because of their high economic value. Women and children were found to undertake the light gardening duties while men and the youth were involved in more demanding duties such as double digging of plots, installation of kits, servicing and maintenance of the systems. ■

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Figure 2. A farm kit system.

Promoting gender mainstreaming in water resources management in the Mediterranean region: the GEWAMED project

The GEWAMED project is financed within the Six Framework Research Programme of the European Commission (EU). It emphasizes networking, coordination and dissemination of past and present research activities, related to gender and water issues. [The Editor]

Gender and water resources: Myth or reality?

The development and management of water resources have been on-going activities since the origin of civilization. In the last decades, activities related to water resources have been the subject of great attention and a body of knowledge has been developed. As part of that body of knowledge, the Integrated Water Resources Management (IWRM) approach was developed and promoted by national and international organizations. More recently, the notion that gender should be mainstreamed into the IWRM has emerged, but for many persons how this should be done is not clear.

What does gender mainstreaming in water resources mean in practice? The most common notion of this problem is reflected by the image of a woman carrying a jar of water on her head. Although this image is a reality in some countries, there is much more to it than that in gender mainstreaming and water resources. Let us review some of the problems that are closely connected:

- Access to land and water resources: Irrigated land is the main source of livelihood for many rural populations. In some of the Mediterranean countries the inheritance laws discriminate against women (they receive only half of the land or no land at all). This has been widely documented, for example, by a survey on Law and Practice related to Women's Inheritance Rights in the Middle East and North Africa (MENA) Region" carried out by the Geneva-based Centre on Housing Rights and Evictions (COHRE);
- Access to work in agriculture: It is also widely documented that women undertake as much as 50 percent of the work in farms (irrigated and not) and are rarely adequately compensated for the work done. When women are paid, their wages are considerably lower than those of men. In some countries, or regions of a country, women are not allowed to do work in the field. Irrigation by women at the farm is often forbidden because of traditions;
- Access to domestic water supply: In most of the Mediterranean countries access to domestic water supply is not a problem, as coverage of domestic networks are close to 100 percent, but there are still three countries [Syria, Morocco and Turkey] where the rural coverage is less than 80 percent and therefore important pockets remain in the rural areas where the image of the woman carrying water is still a reality. Moreover, even when the access to domestic water is provided by watering points at the village level there are problems related to how these watering points are managed and maintained;
- Access to information and technologies: Many rural women in the Mediterranean region are illiterate. This in itself is a strong limitation for accessing information. But even when women are literate the modalities for providing information are not suitable or the information is not addressed to the needs of women;
- Very limited representation of women in the participatory management of water resources*:* One of the pillars of IWRM is the more participative management of the water resource. The progress made in achieving this objective is modest in most of the MENA countries but even where water users' associations are established women are hardly represented. In part, the problem arises from the inheritance laws but also due to traditions and lack of recognition of a female work force;
- Scarce representation of women in the water institutions: Where the public sector is responsible for the development and management of water resources the presence of women at the decision making level is very modest or absent, although at the administrative and support services level this presence at times, is more substantial.

Figure 1. Woman working in the field.

What is the GEWAMED project doing to contribute to the solution of some of the outlined issues?

The dimensions of some of the problems outlined before are very large and no single project is in the position of tackling them simultaneously, in an efficient manner. As a result, there is a need for concentrating on some lines of action that, with the limited resources available, may provide higher returns. Essentially the GEWAMED project is engaged in three strategic lines of action, namely:

1. Creating a greater awareness about some of these problems and identifying others that have not so clearly emerged;
2. Establishing cooperation networks at regional and national levels that allow a more fluid exchange of information in identifying positive experiences and possible follow-up to repeat them;
3. Contributing to the adoption of policies and other decision making instruments that will correct some of the above-mentioned situations.

All three lines of action are an attempt at promoting a greater dialogue among the concerned stakeholders to change the existing unsatisfactory situation.

How is GEWAMED achieving these objectives?

The GEWAMED project is a consortium of 18 organizations from 14 Mediterranean countries: five EU countries and 11 from South East Mediterranean Region (SEMR); See table on Partners. The consortium itself represents a network of governments, universities, research and NGO institutions with different backgrounds and experience. To strengthen the links between partners and to develop common knowledge, annual regional workshops are organized. The exchange of experiences and increased collaboration already represents an important step towards the construction of a body of common knowledge.

In addition, each country in SEMR is establishing national networks where the main stakeholders are represented. These national committees are not only an important vehicle for exchanging information but also for promoting activities in connection with the project objectives.

To create greater awareness and disseminate project results the project uses several means of communication that include:

- Participation in international and national conferences;
- Organization of regional, national seminars and workshops;
- Establishment of national communication networks;
- Field days;
- Development of Regional and National websites; and
- Publications, brochures, posters and other bulletins.

To contribute to the adoption of more gender-oriented policies the

GEWAMED Partners

Partic. No.	Participant name	Participant short name	Country
1	Mediterranean Agronomic Institute- Bari (Project Coordinator)	CIHEAM- MAIB	Italy
2	Centre de Recherche en Economie Appliquée pour le Développent	CREAD	Algeria
3	National Water Research Center- Strategic Research Unit	NWRC-MWRI/SRU	Egypt
4	Faculty of Agriculture University of Jordan-	UJ-FA	Jordan
5	Association Marocaine de Solidarité et de Dèveloppement	AMSED	Morocco
6	Palestinian Agricultural Relief Committee	PARC	Palestine
7	Egyptian Environmental Affairs Agency	EEAA	Egypt
8	The Center of Arab Women for Training and Research	CAWTAR	Tunisia
9	Cukurova University- Faculty of Agriculture	CUKUR	Turkey
10	Agriculture Research Institute	ARI	Cyprus
11	Mediterranean Office for Environment, Cultural and Sustainable Development	MIO-ECSDE	Greece
12	Osservatorio Nazionale per l'Imprenditoria ed il Lavoro Femminile in Agricoltura	ONILFA	Italy
13	General Commission for Scientific Agricultural Research Ministry of Agriculture and Agrarian Reform	GCSAR	Syria
14	International Commission on Irrigation and Drainage. Italian Committee	ITAL-ICID	Italy
15	Instituto Andaluz de la Mujer- Junta de Andalucía	IAM -JA	Spain
16	African Training and Research Centre in Administration for Development	CAFRAD	Morocco
17	René Moawad Foundation	RMF	Lebanon
18	Programme Solidarité Eau	pS- Eau	France

project will stage several national policy seminars presenting the project activities and results to stimulate decision makers into taking specific actions identified. Other institutional changes are promoted through the established cooperation. For instance, the establishment of a National Observatory for Rural Women Entrepreneurs in Lebanon is under promotion with the support of the Italian Government. ■

For greater information about the GEWAMED project consult the Regional website: **www.gewamed.net** or contact Juan A Sagardoy at **sagardoy@iamb.it**

LATEST AND FORTHCOMING IPTRID PUBLICATIONS

Issue Paper

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

Project Report

- **IPTRID.** 2007. Manual. *Diagnostic participatif rapide et planification des actions d'amélioration des performances des périmetres irrigués.* Application à l'Afrique de l'Ouest. DPRP. FAO/IPTRID. Rome, Italy.
- **IPTRID.** (forthcoming). *Syria Symposium Proceedings on Irrigation Modernization: Constraints and Solutions.* FAO/IPTRID. Rome, Italy. [CD-ROM only]
- **IPTRID and National Water Research Center, Egypt.** (forthcoming). *Egypt's Experience in Irrigation and Drainage Research Experience.* FAO/IPTRID. Rome, Italy.

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The role of GIS in rural development

Geographic information systems (GIS) are powerful tools that can be used to link diverse sets of spatial data, including those needed to generate development strategies and policies. Spatial data sets up underlying rural livelihood strategies in developing countries including, for example, population pressure, crop production, livestock husbandry, degradation of natural resources such as soil and water, and access to markets. Recently GIS has become readily available for use on PCs and many spatial data (e.g. remotely sensed imagery) are in the public domain and can be downloaded for free. This makes it easy for poor country professionals to analyze spatial data to extract information necessary for policy-relevant analyses.

The current issue of *Information Development* (vol. 23, combined issue 2 and 3, **http://idv.sagepub.com**), presents examples of how geographic data combined with GIS are being used in rural development, planning and research in some African and Asian countries. The articles describe how participatory processes can facilitate the generation of innovative information from spatial data. In some cases the output of the process includes one or more maps, e.g. a crop distribution map for Sub-Saharan Africa, a poverty map of Uganda, an atlas consisting of several thematic maps of the Ethiopian rural economy and a similar set of maps for Vietnam. Another paper describes how participatory mapping processes provided a way to obtain detailed spatial information from communities in Northern Thailand which illustrated local resource utilization and changes that had occurred over time. This was important information for a local watershed management network. Another paper describes the importance of small-holder irrigation market development for moving farm families out of poverty in West African Sahel.

However, the papers make it clear that restricting the perceived use of GIS to the production of maps would underestimate the value of spatial information in development practice and research. An unusual and interesting example is presented in the first paper of this issue of *Information Development.* The authors, G. Rambaldi and colleagues, describe how hunter-gatherers of the Ogiek indigenous peoples in Kenya participated in the development of a 3D model of their ancestral hunting grounds, now threatened by ecosystem destruction due to deforestation and encroaching agricultural production. Although the affected people could have used the information to strengthen their court cases against the loggers, it became more important to the hunter-gatherers to preserve a particular set of values, information and wisdom about the ecology of their home territory for the next generations.

The papers describe in some detail the processes of data collecting and analyses, but the emphasis is on how the spatial information obtained through GIS processes from data sets can contribute to the formation of development strategies. As expected, the socio-economic, biophysical, infrastructural and other geospatial datasets all showed characteristic heterogeneities, whose nature is poorly understood and documented. Moreover, resource information was found to be scattered, unavailable or uncertain, while some institutions required lengthy processes before their data could be obtained. All of this leads to high costs of data gathering. Moreover, many of the study areas are undergoing rapid change. As was noted in several of the papers, the observed variability required highly disaggregated mapping, i.e., detailed.. In some cases, the derived development strategy would probably also be applicable only at a small scale where NGOs are operating. Governments are less likely to be able to make context-specific strategies and policies at this level. The need for up-scaling from the disaggregated, local level to the macro-scale of a region or province therefore remains to be addressed. In spite of the difficulties they encountered, the authors of the papers in *Information Development* collectively present a strong case for the value of GIS and spatial data sets in formulating development strategies. It is worth reading. ■

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The Gignac canal: an experimental laboratory for irrigation canal control

Context: improving canals efficiency

Besides demand management, modernisation of irrigated schemes through an improvement of transport and delivery channels, management appears to be the main way to achieve water savings. Indeed, manually operated open channels are characterised by a low efficiency (30 percent in some cases), which can reach 70 percent or more on fully automated systems.

Scientific issues

From a scientific point of view, the control of open channel irrigation is complex. This complexity is due to multiple factors like: delayed and non-linear dynamics, complex topology of networks, interactions between control devices and unforeseen perturbations.

Improved hydraulic management can look into two groups of control methods of growing complexity:

- local mono-variable automatic control, sometimes associated with manual operational rules at some devices,
- multi-variable control, generally centralised and associated with analysis of method robustness.

Those methods can be tested on hydraulic models but they need a real-sized validation before being industrialized. According to this, the Gignac canal laboratory has been equipped with a double objective:

- evaluation of the first group of methods, which could be of particular importance in developing countries,
- development and the in-situ tests of the second group of methods.

The Gignac canal

The Gignac canal is the main work of an irrigated area managed by the "ASA[1] du canal de Gignac", and was built in 1890. The main canal is 50 km long, with a common trunk (8 km) and two branches on the left and right banks of the river (respectively, 27 and 15 km). The nominal flow of the common trunk is 3.5 m^3/s. The dominant area is about 3 800 ha.

It is located about 35 km west from Montpellier, where the Agropolis Research Complex hosts several research institutes dealing with water issues, attracting several national and international events and many delegations from all over the world interested in thematic visits.

Description of the project

The experimental project consisted mainly of installing sensors and controllers, and building an open SCADA[2] system for the canal, enabling supervision and local or remote automatic control. It has been designed to make possible the test of a wide range of control architectures and algorithms. Level, gate position and flow velocity sensors have been installed along the main canal at strategic locations.

On the common trunk and on the right bank, gates have been modernised and motorised, allowing the control of a four reach system.

Partnership

The project associates the canal manager, scientific teams, engineering companies, and colleges

[1] ASA : Association Syndicale Autorisée = association of landowners, under public administration control
[2] SCADA : Supervisory Control and Data Acquisition System

Figure 1. Control structure with motorized gates.

to a "scientifically focused group" (*Groupement d'Intérêt Scientifique*), which has a contract valid for five years.

The association of scientific teams, engineering companies and a canal manager promotes the transfer of academic knowledge and focuses the experiments on problem solving and end-users' requirements.

Colleges benefit from the facilities for hands-on practice in teaching programmes on hydraulics and automation.

Funding

Funds were donated by the French government (through Cemagref), the Regional authority (*Conseil Régional*), the Departmental authority (*Conseil Général*), and the Basin Water Agency (*Agence de l'Eau Rhône-Méditérranée et Corse*).

Experiments

The experiments are conducted mainly before and after the irrigation period, which starts generally at the beginning of March and ends in mid-October. During those two periods, the canal is completely dedicated to measurements and experiments.

Some tests may also be achieved during the irrigation period, when and if they do not disturb the water delivery.

Research topics

Canal model

A hydraulic model of the primary canals has been built with the SIC software, which allows simulation of one-dimensional steady and transient flows. The large amount of precise data enabled an appreciation of the precision of the model. It is used for testing scenarios and control modules before their implementation on the real system.

Perturbations

Demand Study: Due to the inherent time delays of the system it is interesting to make a prediction of the water demands and to use it in a feed-forward controller combined with a feed-back controller.

Evolutions in the System: Some former lands are converted into urban areas where the new inhabitants keep the ancient water rights associated with the land. A low pressure piped network is then constructed, providing raw water for gardening, swimming pools and some domestic uses. This change, although still limited, has an impact on the water demand and therefore on the canal operations that are currently being studied.

Observation:

Canal Supervision: As soon as real time measurements are used for real time control, the issue of data validation, data reconciliation and fault detection is raised. Several studies have been conducted on this factor, leading to scientific publications, a Ph. D thesis and software tools.

Flow measurement: several options are available for measuring flows in a canal, such as calibrated rating curves, ADCP techniques and device-based equations. The quantity of data that are measured and saved in the database allowed us to evaluate and compare several alternatives for these measurements.

Commands

Several control action variables are possible as outputs of a controller. The main classical ones are the gate position W or the discharge Q. These alternatives could be further tested and compared on the real system. This work was presented in scientific publications and is still under investigation.

Controllers

Several SISO and MIMO controllers have been studied in the frame of several research projects leading to scientific publications and Ph. Ds. ■

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A *fertigation* device for surface irrigation from Egypt

One of the main recommendations adopted at the FAO expert consultation meeting on the use of irrigation systems for fertilizers and pesticides applications held in Egypt in 1991 highlighted the importance of *fertigation* as a new technology in crop production in both pressured systems (sprinkler and drip irrigation) and surface irrigation. Likewise it was reported that the *fertigation* process through drip and sprinkler irrigation systems has been in use for many crops and on many soil types in the Near East.

Fertigation, as a technique, is considered the most convenient means of applying fertilizers as it increases the efficiency of added nutrients and saves labor costs next to decreasing environmental pollution.

In Egypt, *fertigation* is practiced in only 13 percent of agriculture lands, while in the other 87 percent, fertilizers are placed in soils. The Egyptian farmer is used to applying nitrogen fertilizers as needed, to different crops, usually once or twice during the growth period either by broadcasting or placement methods. There is usually less efficiency and great losses occur from N fertilizers by leaching due to the application of excess amounts of irrigation water in the common surface irrigation technique used.

Figure 1. The simple fertilizer application device.

To pursue the benefits of *fertigation*, "a fertilizer applicator device" for surface irrigation system was designed and built for small fields of up to half a hectare. The fertilizer application device is a cylindrical container made from light weight metal with a 40 cm diameter and about 50 cm in length, (which can hold about 60 liters from fertilizer solution). The size can be increased according to the field area. The container is firmly sealed except at the top where a removable cover allows for refilling. In addition, it features a narrow tube (5 mm) in the center, to overcome the differences in hydraulic head during the solution discharge and also to maintain a constant flow-rate. In the bottom, there is a valve to adjust the flow-rate of fertilizer solution according to the rate of irrigation water reaching the field (time used in dripping the solution is equivalent to the time required for irrigating the field).

Plastic tubing about 20m in length and 1.1 cm in diameter is connected to the valve. The irrigating farmer distributes the fertilizer solution by placing the end of the plastic tubing at the end of the field plot that receives the irrigation water. (See Figures 1 and 2 for two applicator models).

The simple "fertilizer applicator" was used for applying urea solution to cotton in the field. Results indicated that *fertigation* under surface irrigation maintained an even distribution of N in the field and a high N content in plant parts, as well. Cotton yields increased by 30 percent, as compared to the common placement method. In addition, for relatively larger field areas, the land leveling laser technique was applied to ensure rapid and even distribution of irrigation water and more than one of the fertilizer applicator units was adjusted and used to drip the liquid fertilizer into the main field head irrigation canal where plastic siphons were used to distribute the enriched irrigation water to the field furrows.

Figure 2. A large movable fertilizer applicator with a manual mixture.

Furthermore, training programs and field trials for agricultural engineers and farmers were organized, with the cooperation of the Ministry of Agriculture.

It was concluded that the advantages of *fertigation* for surface irrigation systems were:

- Increased efficiency in fertilizer use, with maximum availability of nutrients
- Supplies nutrients, when needed
- Reduced pollution of underground water; particularly of nitrogen
- Increased uniformity of fertilizer distribution

- Reduction of application costs
- Increased crop yield and net income
- *Fertigation* may also be applied together with some pesticides, and this *chemigation* saves on the costs of two separate applications
- *Fertigation* under surface irrigation contributes to food security while conserving the environment

Recently, attempts were made to manufacture a large sized, portable unit with a manual mixer built-in, for direct dissolution of fertilizers. Such a unit could be used for applying soluble or somewhat soluble fertilizers and even suspended fertilizers, such as calcium ammonium nitrate or super-phosphate because clogging would not be a problem in this system.

So the aim now is to conduct research testing the modified unit for use in applying different forms of NPK and micronutrients. The successful and efficient use of such a unit will lead, with the help of IPTRID/FAO, to forming a joint project with colleagues from the middle East, far East and other countries applying fertilizer in similar surface irrigation systems to test the efficiency for possible use under different management conditions.

In 1994 the "fertilizer applicator device" for surface irrigation was granted a patent from the Egyptian Academy of Scientific Research and Technology in the name of Prof. Dr. Abdelmoneim Elgala. ■

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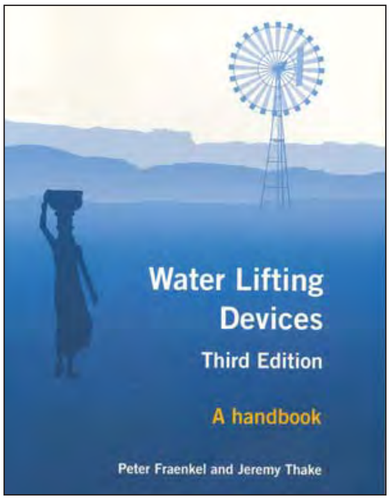

Water lifting devices

by *Peter Fraenkel* and *Jeremy Thake*

The book is viewed by the authors as a "*handbook for users and choosers*". It is a comprehensive guide to pumps and other water lifting devices, the essentials for water supply and irrigation. It is an expanded and updated version of an original book published by FAO in 1956, who is again the publisher. The book aims to inform on the existence of a wide variety of water pumping devices, prime movers and combinations thereof and how they can be best utilized. A second objective is to assist users and planners to understand the technologies, so they can be applied effectively and efficiently. Thus, the main purpose is to provide a comprehensive single source of practical information for decision-makers concerned with the selection, sizing and procurement of water lifting systems and their power sources for both the supply of drinking water and for small-scale irrigation. The overall beneficiaries will be end-users in rural areas of developing countries gaining more accessible, cost-effective and efficient water lifting systems as a result of better planning and procurement decisions.

The handbook not only provides a myriad of technical information but also makes important observations that can impact on the manner in which the equipment can be utilized. The contents are presented around eight main chapters. Besides the Introduction, one chapter is dedicated entirely to drinking water supplies, with consideration for both human and livestock needs. One chapter covers water lifting for small-scale irrigation including water management and crop water requirement issues. A fourth chapter provides fundamentals on water sources, both surface and groundwater, with discussions on water quality, treatment and storage. Two more chapters look into the fundamental physical principles of water lifting and a review of pumps and water lifting techniques. In the former water losses are explained as well as flow through open channels and pipes. In the latter a number of types of pumps are presented. The last two chapters look into power for pumping: human, animal, internal and external combustion engines and electric, wind, solar and water power. On the choice of pumping systems, financial and economic considerations are reviewed and a number of practical considerations offered. ■

IPTRID evaluates the APPIA project in West and East Africa

The Government of France, through its Ministry of Foreign Affairs (MAE), and under the framework of its cooperation for the agriculture sector in West and East Africa, promoted and funded the project "Amélioration des Performances des Périmètres Irrigués en Afrique", better known for its French acronym, APPIA. The project, as conceived, had two geographical components: West and East Africa. In the former, activities took place in Burkina Faso, Mali, Mauritania, Niger and Senegal. The latter saw implementation in Ethiopia and Kenya. In this region the project was known for its English acronym IPIA (Improving the Performance of Irrigation in Africa). The organization primarily responsible for the oversight and implementation of the APPIA-West components was the Association Régionale de Professionnels de l'irrigation en Afrique de l"Ouest, ARID; while the International Water Management Institute, IWMI was allocated the oversight and implementation of the APPIA-East component. MAE asked IPTRID to carry out the final evaluation of this project, which the Programme executed by fielding teams to West and East Africa in June 2007.

The APPIA (and IPIA) projects had a significant impact at the institutional level thanks to the constitution and reinforcement of national committees of the irrigation and drainage commission (CIID) in West Africa (AMAURID, ASPID) and the creation of the Kenyan Association of Irrigation and Drainage (KIDA) in East Africa. These structures made it possible, in many cases, to influence the national policy on irrigation and drainage, in particular in Kenya, or take part regularly in national debates on water strategies in Burkina Faso, Mali, Niger and Senegal.

The performance evaluation of pilot irrigation systems in both Regions showed that farmers' constraints go far beyond those directly related to the administration, operation and maintenance of these schemes. The performance of these systems was evaluated based on the Participatory Rapid Diagnosis and Action Planning (PRDA) methodology developed by the Project. This instrument is seen by stakeholders as a very positive contribution to the sector.

Another broad area of Project achievements dealt with the Capacity Development efforts. More than 70 events took place over the four year period of the Project with more than 2 250 persons benefiting. However, Project efforts to support farmers groups in the context of Irrigation Management Transfer activities were modest as the governments concerned did not have a firm policy on how they would like to approach this issue. Important training material was generated.

A Project like APPIA that had such a broad reach, going across countries and regions within, necessarily faced a number of constraints that impinged on its smooth implementation. The objectives of the Project were seen as too wide and demanding. Such a broad goal led to a loss of focus and to interventions dealing with the whole spectrum of water for agriculture issues rather than the intended and narrower water management aspects of irrigation systems. The Project came at the appropriate time, and it tried to fill an existing void. The Project provided an opportunity for stakeholders to meet and discuss pressing issues and to raise the importance and visibility of irrigated agriculture in the public forum.

The Project leaves behind a wealth of information that needs to be consolidated and made available to interested parties. The evaluators found that many of the field materials produced, including the PRDA Manual and Training Source books, were not available in local languages; a limitation that needs correcting. ■

The comprehensive evaluation of the French Mission in Jordan, Palestinian territories and Lebanon

In 1993, the government of France established a Regional Mission for Water and Agriculture (MREA) based in Amman to promote the implementation of best practices of irrigation. Focusing on improving the efficiency of irrigation water, MREA concentrates on the introduction of new techniques in response to new management rules in pilot areas in Jordan, Lebanon and the Palestinian Territories. The proposed practices and methods of introduction are

IPTRID Staff changes

Virginie Gillet joined the Programme in September 2005 as an Associate Professional Officer supported by the Government of France. She left IPTRID in September of 2007 after completing her two years of service. During her stay with us Ms Gillet provided support across the board in our activities such as M&E of the IWMI-IPTRID joint collaboration; institutional mapping in Thailand under the project on Evaluation Study of Paddy Irrigation under Monsoon Regime or ESPIM; the organization of the IPTRID-ICID Workshop on Monitoring and Evaluation of Capacity Development Strategies in Agricultural Water Management held in Kuala Lumpur in 2006 and activities related to our Virtual Center Project for West Africa. She was guest editor for our GRID magazine; editor of the Land and Water Division Newsletter; helped in the upgrading and monitoring of our various web pages and last, but not least, in handling of our mailing list. Ms Gillet has gone to Australia to pursue her Ph.D at the University of South Australia in Adelaide. IPTRID wishes her the best of luck in her new endeavour.

Sara Kirsch, joined IPTRID on 31 July 2007 as a Temporary Assistance Pool employee (TAP) in support of our General Services activities, such as the up-keeping of our mailing list, web page improvement and monitoring; hiring of consultants and other general office work. She also assisted other staff, as required, and particularly the Programme Manager. She left the programme on 31 December 2007. Her support was very much appreciated; she will remain at FAO, supporting other programmes on a temporary basis.

supported by a comprehensive socio-economic and technical assessment of irrigated agriculture in each location. Later in 2001 and with the intention to bring an institutional support to partners in the three countries concerned in order to contribute to the adaptation of coherent agricultural policies with the strategy of water saving and management, the Government of France financed an FSP (Fonds de Solidarite Prioritaire) Project called “Economie d’eau agricole au Proche Orient”. The project proposed to produce elements of action essential to strategic choices that the three countries have to make regarding the management of water, the protection of environment, and the agricultural and rural development. These elements relate to technical, economic and social interventions that deserve to be validated in various situations. It was anticipated that the project would result in the reinforcement of: (1) the regional role of the MREA Programme through a regional component intended to facilitate the capitalization and the complementarities of the actions and work in networking of the partners, and (2) the complementarities of the actions of the French cooperation with the Partnership (which set up a Technical Advisory Committee for the whole Mediterranean Region) like IPTRID and FFEM.

Upon request from the “Agence Française de Développement” (AFD), IPTRID conducted a comprehensive evaluation of MREA and the FSP Project in June and July 2007. The evaluation was based on the common criteria used by the Ministry for Foreign Affairs in France which consists of five main components: relevance, coherence, effectiveness, efficiency, and impact. The findings and conclusions are based on nearly 100 interviews/meetings carried out during the period of evaluation in France, Jordan and the West Bank of the Palestinian Territories with relevant stakeholders, partners, and other donors. Due to the escalation of the political situation in the region, the scope of the geographical mapping was restricted to cover Jordan and the West Bank of the Palestinian Territories while the evaluation of the components in the Gaza Strip and Lebanon was carried out through interviewing stakeholders/partners via video/telephone conferences.

On **relevance**, it was apparent that both MREA and the FSP Project were seen as useful instruments to support facing/combating challenges in the water sector in the three countries. The evaluation also recognized the significant effort made by MREA and the FSP Project in meeting the demand of its main beneficiaries/stakeholders in terms of technical support and policy set up. It also acknowledged interventions made by the French actors, in particular those of the Societé du Canal de Provence (SCP). However, the evaluation found the scope of the intervention too broad both geographically and thematically, which probably affected the real impact on national policies.

On **coherence**, the rational integration with other international initiatives, especially in the thematic donors’ platforms such as the Donor/Lender Consultation Group in Jordan, was seen as acceptable. The case of the rational integration with other initiatives was clearly demonstrated with the observed/reported collaboration with GTZ in the Jordan Valley. It has however, been noticed that MREA has so far, no articulated, clear mission statement despite the fact that the programme has been running for quite sometime in the region. A concern of certain parties that interventions introduced may lose their effectiveness and the situation may become redundant if no appropriate handover process or institutional liability to follow up the development is established has also been expressed.

The evaluation remarkably recognized the **effectiveness** of the programme, expressed in terms of the production of expected results, with the large number of publications produced and the dissemination of results in three languages: French, English and Arabic. However, the Programme's steering mechanism which was set up to be from Paris was seen as slowing the of work process and not helping its progress.

The **efficiency** of the programme, in terms of the correct mobilization of resources at appropriate time and best cost as well as the mode of mobilization of expertise (duration, technical capacity, research and exchange of knowledge), was concluded to be relatively high despite the small team and budget of the programme. A good "value for money" was, thus, achieved, thanks to the assistance of many interns and volunteers from France as well as the use of local resources at very low cost. The result was demonstrated with the training of more than a thousand professionals and the request made by the Japanese Cooperation and the European Union to benefit from the Programme's expertise in irrigation modernization to train Iraqi professionals. The value added from the Programme compared to the effort in the same field has, with no exception, been recognized and confirmed by all stakeholders, including the end users.

On **impact**, the evaluation concluded that no direct impact of the Programme has been traced. Rather, it was contribution/support to an already planned national policy towards the sustainability of irrigated agriculture that resulted. This could be attributed to the location of the programme which was situated far from authority offices and unlike a programme such as GTZ, which is nestled integrally within authority offices. Nevertheless, and despite the fact that the programme was geographically limited to its pilot areas, its reputation and achievement amongst the farming community was well recognized. Furthermore, it successfully encouraged the development of other initiatives such as the European MEDA project, the AFD projects, and the Spanish initiative. It was indeed evident that the programme did resolve the problem of better water management through the successful development, introduction and adaptation of the techniques/research results in terms of action-influence on the ground (official counterparts and farmers), and action-influenced other projects (GTZ, IRWA, etc.). However, capitalization and valorization of research is still seen as scattered in nature. In spite of the credibility gained at the different fronts, visibility of the Programme was limited to its direct beneficiaries and counterparts and its partners in close relationship and visibility and cooperation at the regional level were rather limited.

Finally, partners of the programme showed much concern about its disappearance and suggested ways of capitalizing effort through the organization of a final workshop or the establishment of comprehensive databases to accommodate achievements. They also saw the proposed follow-up, non-profit structure (Methods for Irrigation and Agriculture – MIRRA), which came as a result of the assessment made by the "Groupe de Recherche et d'Echanges Technologiques" (GRET) to guide the programme's way forward, as a promising element for keeping the programme's momentum and maintaining its achievement. ■

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Figure 1. MREA project billboard.

How much water is needed for the keeping of livestock?

Introduction

As diets change and the population grows, demand for food and animal feed will increase. But how much of a rise in demand should we expect? The recently published Comprehensive Assessment of Water Management in Agriculture (CA, for short) expects that the demand for food and feed crops will nearly double in the coming 50 years (See Water for Food, Water for Life. Earthscan, 2007). Part of the inevitable growth in food production can be achieved by improving crop yields and raising crop water productivity (marketable product produced per unit of water evapotranspired). How much of an improvement is needed is illustrated by the assumptions underlying the best possible CA scenario for 2050 listed in Table 1. Water demand in agriculture includes not only water for the production of crops for animal food and feed but also the water they drink. In this article, I will discuss what we know about present water needs for the production of feedstuff for livestock and explore change processes that will affect the availability of water for the production of fodder.

Water for livestock keeping

The challenge for livestock production is epitomized in the expected doubling of meat consumption in East Asia between now and 2050, resulting from the economic growth in this region. A global increase in consumption of livestock products must lead to higher feed grain demand. Livestock are fed by grass, crop residues and feedstuffs (mainly barley, maize, wheat and soya) in different combinations. The experts are not in agreement on how livestock will be fed in the future. Will cattle on a global scale continue to be raised largely on grass and crop residues or will grain feeding become more important when the opportunities to expand grazing land decline? If it is the latter, feed demand will drive future demand for grains, and farm managers will be pressed to increase water productivity in feedstuff production.

How much water is already being used in the production of feedstuffs for livestock is not clear. The CA assessment maintains that, of this global evapotranspiration, slightly more than ten percent or 7 130 km^3 is used in the production of rainfed and irrigated crops. An additional 840 km^3 is said to be used in the production of biomass actually consumed by grazing livestock. Unfortunately, there are no hard data on how much of the global water used in evapotranspiration of rainfed and irrigated crops is for human consumption and how much is for livestock. One often-quoted estimate is that about 45 percent of the global amount of water used in agriculture can be attributed to feed production. According to one estimate, more than 40 percent of the world's grain is being fed to livestock. Since most of the feedstuff is grown under rainfed conditions, the amount of water consumed in irrigated crops grown for livestock is usually estimated at less than ten percent, but we don't know how much less.

Recent reports give two different approaches to calculating the amount of water consumed in livestock keeping. One, a spatially detailed water balance calculation, indicates that about ten percent of the global water used ("evapotranspired") in irrigated crop production is used in growing barley, maize, wheat and soybean for feed. If these four crops constitute about 75 percent of the total feed requirement, the total share of water evapotranspired for irrigated feed production is about 15 percent of the global amount of water used in producing irrigated crops. Similarly, also about ten to eleven percent of the global amount of water evapotranspired in rainfed cropland was found to be involved in the production of the four crops, barley, maize, wheat and soybean grown for feed. According to this analysis, 15 percent of the water globally evapotranspired in agriculture is consumed by feed crops, including grassland and forage.

The CA uses a different set of assumptions and estimated values to calculate the amount of water used in the production of feed crops. This calculation involves the feed energy supplied per kg of grass or feed crops, the average feed energy requirements per animal, the mix of feeds for different kinds of livestock and the water productivity of feed crop and grass production. For all developing countries taken together this approach leads to an estimated water need of 536 km^3 for maintenance of livestock (including here only cattle, sheep and goats). Maintenance refers

Table 1: Assumptions underlying the best CA scenario for 2050

EXPECTED INCREASES IN PRODUCTION IN 2050	%
Cropped area	9
Crop water consumption	20
Water withdrawn for agriculture	13
Global yield of rainfed cereals	58
Rainfed crop water productivity	31
Global irrigated yields	55
Irrigated crop water productivity	38

Table 2: Change processes affecting livestock keeping

ONGOING DRIVERS FOR CHANGE:
Population growth and economic growth
Higher meat consumption in richer countries
Urban expansion on grazing lands
NEW DRIVERS FOR CHANGE:
Crops for ethanol production competing with food and feed crops
Rapid increase in world market prices of grain
Higher world-wide energy costs
Global climate change affecting rainfall and temperature regimes
Growing global awareness of environmental issues (e.g. China)

to the minimum amount of water needed to keep animals alive without weight loss but excludes extra feed needed for growth, lactation and work. The CA estimates the global water used to produce feed at 1 300 km^3, which includes the demand for all other livestock species (e.g. pigs and chickens) and takes into account requirements beyond the basic maintenance needs. This estimate corresponds to 18 percent of the global evapotranspiration in agriculture mentioned above. **Considering the many assumptions made in both sets of calculations, the best estimate that can now be made is that between 15 and 20 percent of global water use in agriculture is associated with the production of livestock products.**

I have not yet mentioned livestock need for drinking water. Livestock in developing countries are estimated to drink about 11 km^3 per year, and globally about 16 km^3. The first estimate is based on an average daily drinking water requirement of about 25 l/day/tropical livestock unit. Some of the drinking water is recycled to the soil through urine and feces. Compared with the water required to produce feed for animals, the drinking water requirement is relatively small.

What started out as a straightforward question ('how much water is currently being depleted in processes associated with animal keeping') becomes complicated when looked at in more detail. How much more land and water will be required for feed production when the world population reaches eight or nine billion people? The answer depends on the assumptions one is prepared to make.

Drivers for change

Livestock keeping in different parts of the world has already undergone many changes in recent years, resulting among other things from pressure on land and water (quality and quantity), and environmental concerns. Table 2 lists the most important on-going and new drivers for changes that are affecting livestock production.

The current change processes highlight the difficulty of predicting what agriculture in 2050 will look like. Most projections for the future include an increase in agricultural trade. Many countries (e.g., Egypt, Malaysia and Japan,) already depend on food imports because production is limited by water scarcity or for various other reasons. This importation of food has been feasible because of relatively low food prices, but suggesting that instead of striving for food self-sufficiency water-scarce countries should import more food from water-abundant countries, presupposes that world market prices of cereals and other foodstuffs will remain affordable. In fact, the commodity-price index of the Economist (www.economist.com; 5 Oct 2007) shows that the aggregated dollar price of food has increased by 45 percent since one year ago, while non-food agriculturals, by 23 percent. If this trend continues, some poor countries will no longer be able to afford sufficient food imports to feed their populations. Part of the reason for the price increases in cereals and other crops is the increased production of crops for biofuel production. One of the Millennium Ecosystem Assessment scenarios anticipates that by 2050, one quarter of global energy will come from biomass. Producing the necessary eight billion tons of biomass would require more than 5 000 km^3 of water for crop water use, i.e. about 70 percent of the present global evapotranspiration in agriculture. Also, if crop residues are no longer plowed back into the soil, it would have a huge impact on soil fertility and soil structure.

In the second half of 2007 crude oil prices have fluctuated around US$ 85 a barrel (with a recent high of nearly US$ 94). Higher energy prices affect agriculture mainly through an increase in the cost of pumping groundwater, increasing costs of fertilizers and for the use of farm machinery as well as transportation of products to markets. The use of crop residues as feedstuff involves no additional evapotranspiration and thus increases crop water productivity. Producing sufficient food and fodder will also require renewed efforts to increase the productivity of land and water.

The required increases in yield and crop water productivity listed in Table 1 will be hard to achieve. Adoption and adaptation of these technologies needs to be accelerated while the world learns to equitably share the resources that none of us own. ■

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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

5-10 February 2008
Second African Show of Irrigation and Drainage SAFID
Ouagadougou, Burkina Faso
http://www.arid-afrique.org/rubrique.php?id_rubrique=35

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

11–13 June 2008
Sustainable Irrigation 2008 - 2nd International Conference on Sustainable Irrigation Management, Technologies & Policies
Alicante, Spain
Email: krobberts@wessex.ac.uk
Web site: http://www.wessex.ac.uk/conferences/2008/irrigation08/index.html

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

06–11 July 2008
10th International Drainage Workshop of ICID Working Group on Drainage
Helsinki, Finland
Web site: http://www.fincid.fi/idw2008/

17–23 August 2008
World Water Week 2008
Stockholm, Sweden
E-mail: siwi@siwi.org
Web site: www.worldwaterweek.org

01–04 September 2008
13th World Water Congress
Montpellier, France
E-mail: wwc2008@msem.univ-montp2.fr
Web site: http://wwc2008.msem.univ-montp2.fr/

8–10 September 2008
Africa Water Resources Management 2008 (AfricaWRM 2008)
Gaborone, Botswana
Web site: http://www.iasted.org/conferences/home-604.html
13–19 October 2008
ICID's 20th International Congress on Irrigation and Drainage
Lahore, Pakistan
Phone: +92 42 9202538
Fax: +92 42 9202154
E-Mail: icid@icid2008.org
Web site: http://www.icid2008.org/

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