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a new approach to integrated water resources management

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DIRECTING THE FLOW

a new approach to integrated water resources management

Directorate-General for Research
International Scientific Cooperation

2006

EUR 22018

Copies are available free of charge upon request from the Information Desk of the Directorate-General for Research, International Relations, 8 Square de Meeûs, B-1049 Brussels, Belgium; e-mail: inco@cec.eu.int. The brochure can also be downloaded in pdf format from: **http://europa.eu.int/comm/research/water-initiative**

French, Portuguese and Spanish versions of the brochure are also available at the same web address.

Cataloguing data can be found at the end of this publication.
Luxembourg: Office for Official Publications of the European Communities, 2006

ISBN 92-79-01024-7

Printed in Belgium
PRINTED ON WHITE CHLORINE-FREE PAPER

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The review panel examined:

- 20 projects with a total EC contribution of €9.977.000 from the period 1994-1998 (Fourth Research Framework Programme)
- 34 projects with a total EC contribution of €25.730.459 from the period 1998-2002 (Fifth Research Framework Programme)
- 13 projects with a total EC contribution of €15.770.000 from the period 2002-2006 (Sixth Research Framework Programme)

More background information on the projects and the review process and its technical report are available at **http://europa.eu.int/comm/research/water-initiative**

Foreword

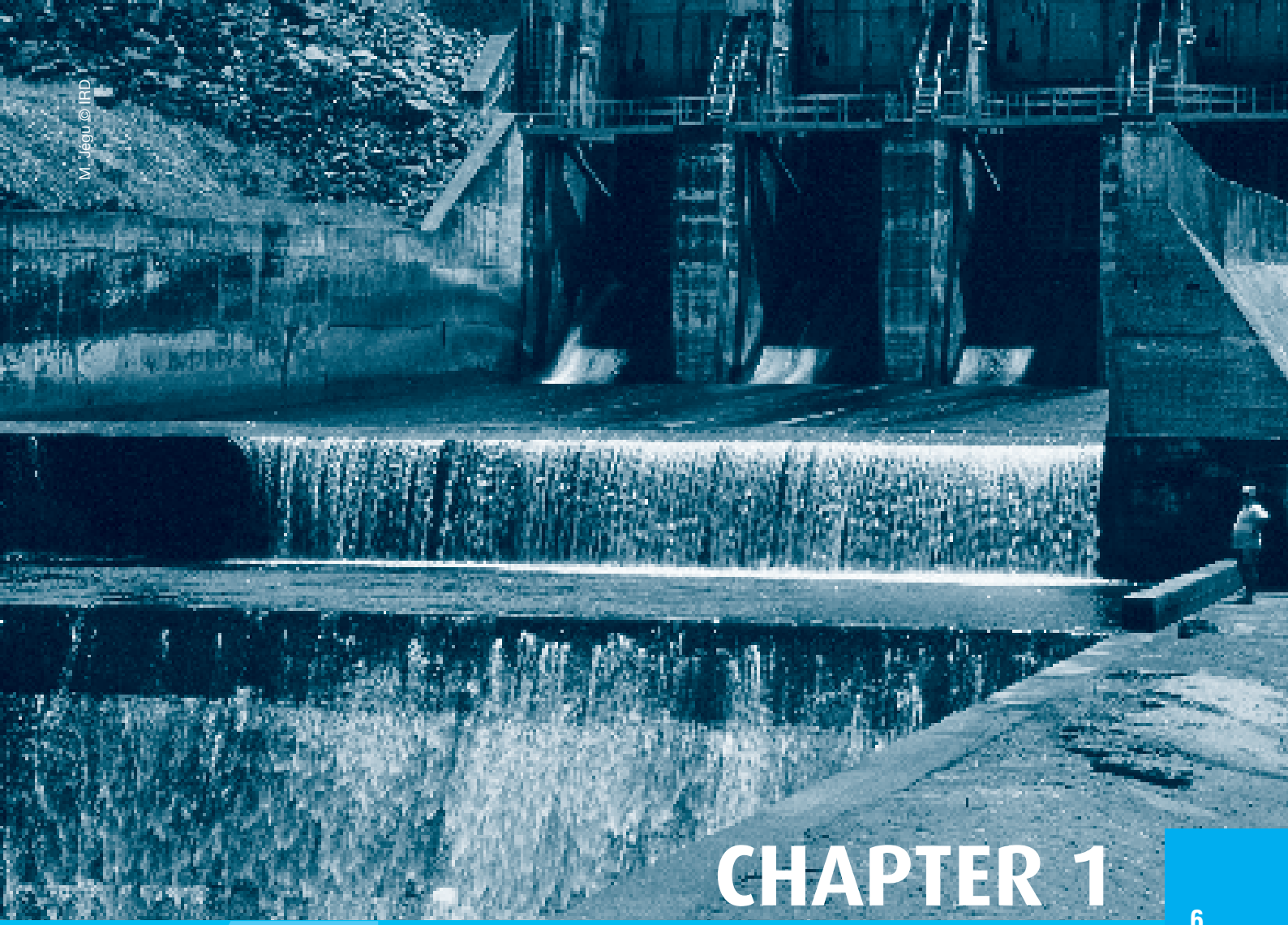
MANAGING AND ALLOCATING increasingly scarce water resources in an integrated way that accommodates different, often competing, uses and users is a challenge of significant proportions. Most accessible water – an estimated 70 to 80% worldwide – is being used for food production for human populations to the tune of about 1 000 tonnes of water for 1 tonne of cereals. Water for domestic and industrial purposes accounts for between 10 and 15% respectively in the overall balance. Through its Water Initiative, the European Union wants to raise the political profile of the water-related Millennium Development goals and improve the implementation process. After all, it is acknowledged that the growing water crisis is also a crisis of governance.

What choices do our societies make to find a balance between various direct human uses of water and the needs of ecosystems? Are ecosystems being considered as essential goods and service-providers for sustainable livelihoods and well-being? These choices are influenced by economic considerations, social and cultural preferences as much as by the growing body of scientific knowledge. All of these have an impact. But engrained social preferences may make new scientific knowledge difficult to incorporate into water policy. On the other hand, their impact is not always easy to measure, particularly as they make themselves known according to very different timescales, and it is difficult to make trade-offs between the short and long term. It is our ambition to make better use of our considerable international co-operation in water research to help address water challenges and promote integrated water resources allocation and management that engages with the people it is designed to help, and meets their needs.

Over the last decade, the European Union has invested significant resources in international scientific cooperation to research the sustainable management of water resources. A selection of 67 such projects has been reviewed by a panel of ten international experts. The aim of the review was to learn about strengths and weaknesses of past research and guide future efforts. The present brochure is one element of this learning process. It also provides some insight into how all those interested in water issues – such major issues for our daily life – can get involved with ongoing research and its results.

I have often said how important it is to work to bring science and society closer together. This brochure is one way in which the European Commission is doing just that. I do hope that the small selection of examples presented here gives you a sense of the ways in which research results can be used more effectively in support of the Millennium Development Goals, and can increase the contribution of international research cooperation to the EU Water Initiative.

Janez Potočnik
European Commissioner for Science and Research



M. Jégu © IRD

CHAPTER 1

Setting the scene: our evolving attitudes to water

Dam on Pitinga river, Brazil.

FROM THE LATE 19TH CENTURY, the rationality and science of the Enlightenment began to change the way people thought about water. The idea spread that Nature existed for people's use, and that men could control it to use it as they wished. The result was the construction, worldwide, of some 45 000 dams more than four storeys high. This building boom peaked in the 1970s when two or three such dams were being commissioned each day.

With the global population expanding from about 1.5 billion in 1850 to 6 billion in 2000, the last three decades of the 20th century witnessed economies in semi-arid regions beginning to experience water shortages. In industrialised countries, the 'green' movement argued that the dams and their irrigation systems were actually starving ecosystems of the water they needed to thrive. People also began to realise that the poor communities which suffered when a dam was built were not those which benefited from its construction.

In the early 1990s, the economic value of water preoccupied many in the water policy field. The idea was that water, like any scarce resource, should be used efficiently and consumers should pay for it. In an alliance between many governments and the private sector, industrialised countries have since adopted this idea. Large water companies and agencies such as the World Bank have tried to export it to developing countries. They are now beginning to rethink this approach, after public opposition harmed such ventures.

Sustainable water management

Enthusiasm for water privatisation has now been supplanted by the idea of sustainable water management. That is, to share water more equitably between all people on Earth, and to do this in ways which will ensure that the ecosystems on which we all depend will continue to thrive.

To achieve this, water policy-makers in the industrialised world now realise that they must take social, environmental and economic concerns into account as well as the physical characteristics of the river basin. This approach has become known as Integrated Water Resource Management (IWRM). It is the current water management mantra, demanding that all stakeholders (water users, civil society, governments and the private sector) be included in consultations and transparent policy-making which will give legitimacy to the decisions made.

An extension of IWRM argues that, although 'management' sounds rational and orderly, it is in fact intrinsically political. All stakeholders have vested interests in the way water is allocated between different groups. At the local level, if one group gets more, others will have less. There is now a suggestion that IWRM should be expanded to Integrated Water Resources Allocation and Management: including Allocation in recognition that it is politics that determines which groups get how much water[1].

EU role

The European Commission has taken an increasingly prominent part in setting the agenda for action and research on water. Through successive cycles of its INternational scientific COoperation programme (EU-INCO) it funds a great deal of research which aims to provide an anchor for water policies in developing countries. The research is carried out by researchers from EU and partner countries working together on problem-solving in partner countries. Research projects approach water in the context of its river basin and, in keeping with IWRM, aim to involve all the relevant stakeholders.

The idea is to open up the European Research Area (ERA) to the world, and to share equitably the knowledge and technology developed by the partners. The results should improve regional co-operation, the development of concepts for sustainable development, and societal and economic innovation. Partner countries learn from European experience while Europeans learn about and from challenges in other parts of the world.

The EU-INCO research model also encourages the projects to seek as much impact as possible in partner countries, by making links with education, training and appropriate institutions and by being explicit about gender and equity.

Compared with most inhabitants of the Okavango river basin, the people living in the Kavango region of Namibia have good access to grazing and fishing. But they cannot depend on these for their livelihoods because the rainfall is irregular. Droughts are their single most important threat.

These people are faced with declining natural resources – fruit trees, grass and firewood. The loss is made worse by the legal situation and the lack of coordination between regional and central government on the one hand, and the local, traditional leaders on the other.

An EU-INCO project[2] has disentangled these and many other threads linking water, natural resources and power in the Okavango river basin.

Traditional leaders used to make sure that their communities used natural resources sustainably. Now, however, neither the law nor the fragmented power structure gives them guidance about making relevant decisions, or the capacity to enforce them – and this as the population is increasing and people are expecting higher standards of living.

Regional government legitimates harvesting that traditional leaders would want to ban. In days gone by, people would either obey local rules or accept the fines imposed by the traditional authority if they broke them. Currently, however, many people (especially outsiders, but also some locals) refuse to accept the authority of the traditional leaders.

The result is that, particularly in times of drought, people cut more fruit trees, and harvest more grass and firewood, than sustainability allows. Namibia's national power utility, Nam Power, is also considering building a hydropower dam at Popa Falls, which could drastically change the amount of water available to downstream countries. Discussions with stakeholders are regularly held in the context of OKACOM, the Permanent Okavango River Basin Commission, created in 1994. It set up a permanent secretariat in 2004 at the completion of the WERRD project.

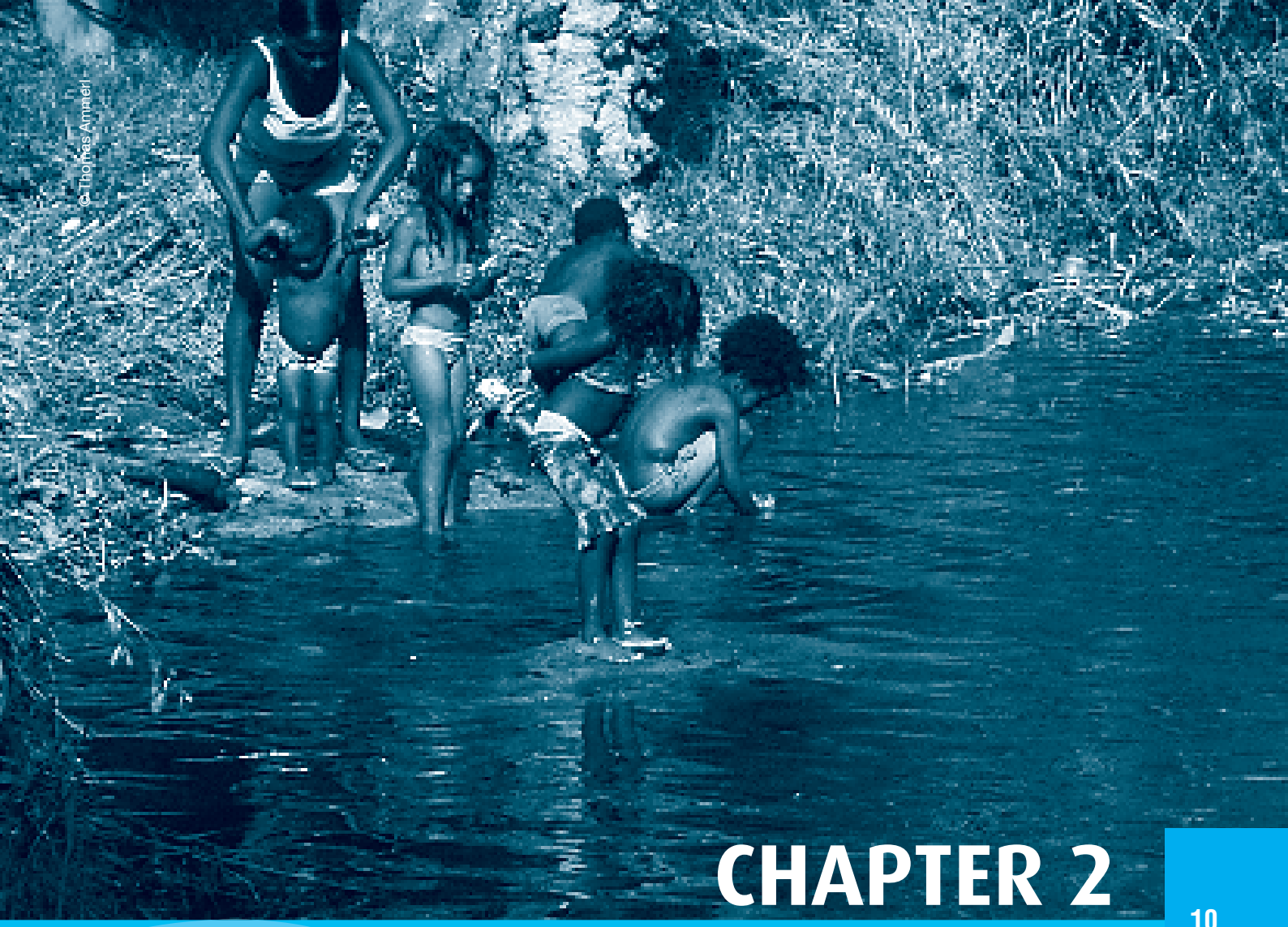
Fishermen in the Okavango river.

Okavango's meanders (Namibia).

Distinguished international experts have recently reviewed a selection of these research projects from the Fourth to the Sixth Research Framework Programmes (FP4: 1994-1998, FP5: 1998-2002, FP6: 2002-2006). They have analysed how well the work has reflected the idea of IWRM, as well as the impact it has had on advancing it, and how well results have been communicated. As well as taking stock of the projects, the experts have identified where future research investment is likely to have most impact and how existing scientifically validated knowledge can be more effectively used in decision-making.

The following pages describe particularly successful projects as examples of the social, agricultural, environmental, technical and cultural aspects of IWRM, as well as debunking some myths about water wars and the privatisation of water supplies and sanitation. They also summarise the review, its findings and recommendations for FP7 priorities for research on water management.

1. Allan, J.A., 2003. IWRM/IWRAM: A sanctioned discourse? *SOAS Occasional Paper*, 50.
2. EU-INCO WERRD project, FP5: ICA4-CT-2001-10040: Water and ecosystem resources in regional development. Balancing societal needs and wants and natural resources systems' sustainability in international river basin systems. The project partners are from Botswana, Namibia, the Netherlands, South Africa, Sweden and UK. http://www.okavangochallenge.com



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CHAPTER 2
Giving everyone a say

Callejón de Andrade (Cuba). In future, children from the surrounding population should be able to use the Quibú river crossing the environmental park.

Water pollution in a peri-urban area of Mexico City.

CALLEJÓN DE ANDRADE is a small urban area surrounded by slums built on the banks of the Quibú river in the City of Havana, Cuba. In the centre of Callejón de Andrade is an abandoned quarry, used as an illegal rubbish dump for years. The last couple of years have seen local leaders and scientists, as well as many members of the public, converting the quarry into an environmental park to clean up the river and educate the district's people about their environment. They have marked out the area of the park, installed a fence, planted 150 seedlings to stabilise the slopes, and built an information centre.

The initiative is the result of an EU-INCO-funded research project investigating sustainable land use and water management in Havana[1]. Working closely with the population, the researchers ran workshops which brought together local people, local leaders, local government institutions and regional and city planning authorities. All had opportunities to learn from each other.

The researchers were experts in geography, hydrology, climatology, soil science, biology, ecology, informatics and computing technology, sociology, psychology and architecture. They made their knowledge available to the workshops, contributing to Geographical Information Systems with data on geology, geomorphology, soils, climate, vegetation and land use. They also used thematic maps showing landscape degradation, natural potentials for land use, and scenarios for possible sustainability. In addition, they carried out surveys among the local people, asking them about their environment and health-related issues.

Not just water

This way of carrying out research is a far cry from traditional methods, in which academics produced papers in their areas of expertise without reference to other fields or wider groups of stakeholders. Practical action on water management also needs to encompass far more than its traditional concentration on basic sanitation and drinking water.

We now understand that we can no longer think in terms of a 'water sector', as no such unified sector exists. We need an integrated approach on a much broader academic front, as well as involvement of local citizens, governmental institutions, civil society organisations and entrepreneurs. This is what integrated water resources management (IWRM) means in practice.

Today, Callejón de Andrade houses 4 000 people. The district is home to small farmers as well as people surviving by dealing on the 'informal' market. Many people in the district live with poor sanitation and ill health; some lack access to drinking water. Any attempt to

Negotiation, not conflict

Water has been at the centre of conflict in the Tiquipaya municipality on the outskirts of Cochabamba city, Bolivia. Having lacked a sewage system for a long time, in 2001, along with the neighbouring Colcapirhua municipality it decided to design a US$ 4-million inter-communal water and sanitation project.

The project was heavily criticised by many on the community-based water committees, which distribute drinking water. The local irrigation users' association also questioned the project fearing, in addition, that it might take control of the water they needed for their agriculture.

The community split, some supporting and others opposing the project. Conflict broke out in 2003, with the army intervening at one stage. In June 2004, the Vice-Minister of Basic Services, looking for a negotiated solution for the conflict, proposed organising a round table to undertake an in-depth review of the project and to negotiate an agreement.

An EU-funded research project[2] developed and tested ways of supporting discussion in Tiquipaya about how to move forward.

Round tables

The researchers organised a series of round-table meetings with 70 stakeholders in all, including representatives of the local communities, the water committees, the Vice-Ministry, the Tiquipaya municipality, local farmers, the National Regional Development Fund (FNDR), the companies in charge of the construction and supervision, and a demographer. They were more or less willing to participate according to how much they felt the round tables might further or hinder their objectives. The researchers acted as facilitators.

Contrary to initial expectations, the stakeholders sat together and aired their disagreements without coming to blows. Five two-day sessions of the round table led them to a deeper understanding of the project. They were able to distinguish its positive and negative aspects, and no longer rejected it as a whole.

research sustainable land use and water management must try to understand how all these factors, as well as the political and planning considerations that underlie them, interact to produce the environment that is their home.

Urbanisation in developing countries has produced thousands of areas similar in various ways to Callejón de Andrade. In the last 50 years, urbanisation has galloped ahead. According to the United Nations, 30% of the world's population lived in cities in 1950. By 2003 that had risen to 50%, and projections suggest it might reach 60% by 2030.

Co-operation campaign among the local population and Cuban and German researchers. More than 100 coconut plants were planted in the environmental park.

Water governance

The United Nations Development Programme defines governance as "the exercise of economic, political and administrative authority to manage country affairs at all levels. It comprises the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their rights, meet their obligations and mediate their differences."

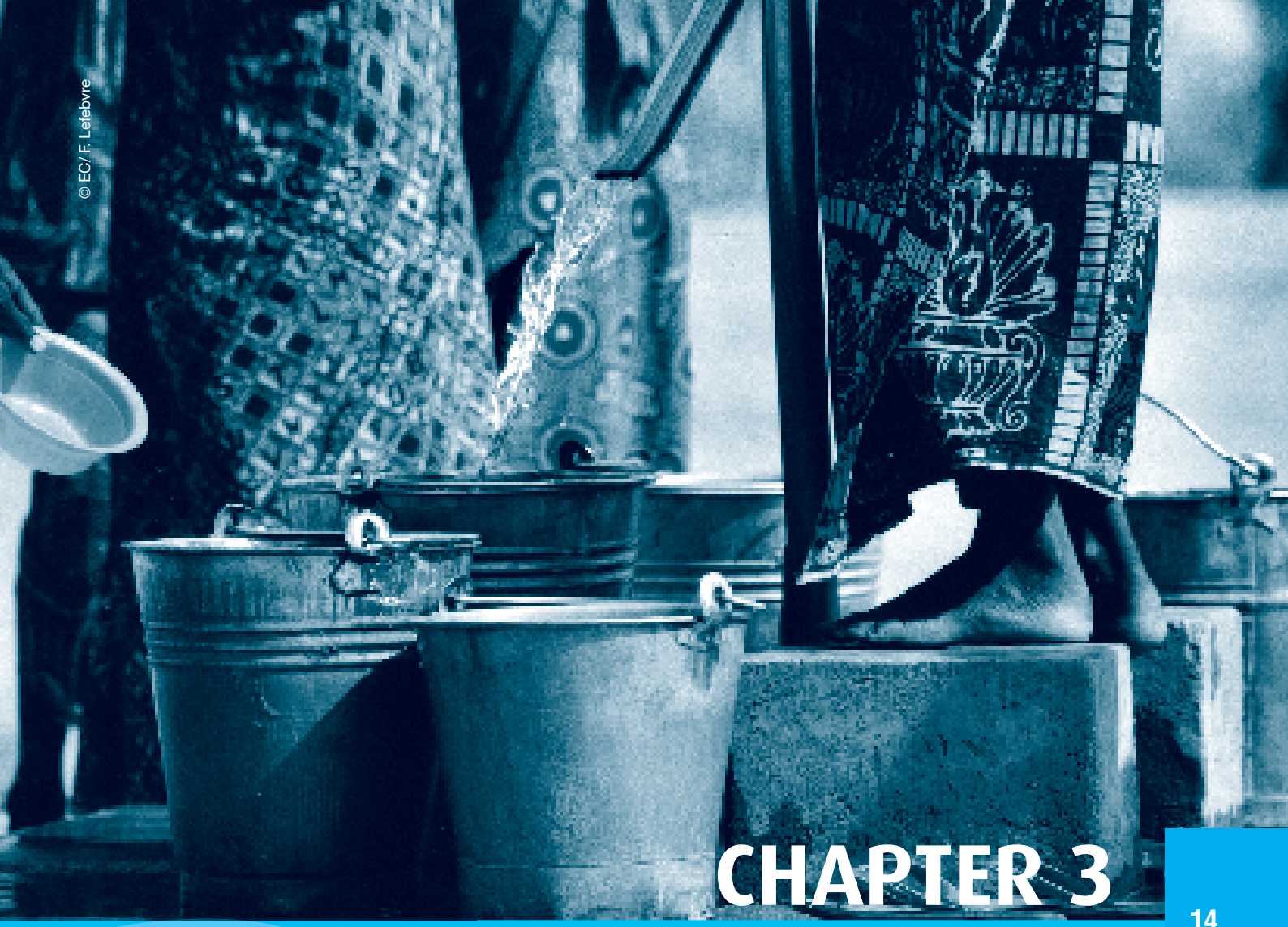
Governance therefore relates to the broader social system of governing, rather than the narrower perspective of government as the main decision-making political entity.

Water governance is a similarly broad concept. It refers to the range of political, social, economic and administrative systems in place to develop and manage water resources and the delivery of water services. It is concerned with how institutions rule and how regulations affect political action. It is crucial for solving social problems, such as efficient and equitable allocation of water resources. As former Commission President Romano Prodi said, when announcing the European Union Water Initiative at the Johannesburg World Summit on Sustainable Development: "The water crisis is a crisis in governance. We will promote better water governance arrangements and transparency, building on stronger partnerships between governments, civil society and the private sector."[3]

Research suggests that effective governance is more likely to result in higher per capita incomes, lower infant mortality and higher literacy. Effective governance is indicated by:

- *Participation* of all citizens
- *Transparency* and free flow of information within society
- *Equity* of all groups in the society
- *Accountability* of different groups to the public or the interests they represent
- *Coherence* of policies and actions
- *Responsiveness* to changes in demands and preferences
- *Integration* and holistic approaches
- *Respect* for traditional rights and ethical principles.[4]

1. EU-INCO CAESAR project, FP5: ICA4-CT-2002-10019: Cooperative applied environmental systems research of urban-rural interface – Sustainability in water management and land use in the Havana region. The project partners are from Cuba, Germany, Mexico and Spain. http://141.84.50.121/Internetseiten/Forschung/Projekte/Caesar/CaesarMuc_E2.htm
2. EU-INCO NEGOWAT project, FP5: ICA4-CT-2002-10061: Facilitating negotiations over land and water conflicts in Latin American peri-urban upstream catchments: combining agent-based modelling with role game playing. The project partners are from Bolivia, Brazil, France and the UK. www.negowat.org
3. European Commission, 2003. *Water for life*. Office for Official Publications of the European Communities, Luxembourg, 48 pages. EUR 20612.
4. Source: Basim Ahmed Dudeen.



CHAPTER 3
Gender

IN INDIA, Bangladesh and Sri Lanka, EU-INCO is supporting a project[1] whose purpose is to produce paid work in environmental sanitation for poor, young women. The aim is to bring the health benefits of sanitation as well as empowering the women through self-sustaining, paid work.

In these three countries there is only a nascent tradition of recycling biologically degradable domestic waste and human excrement for use as agricultural fertiliser. Poor people still relieve themselves in public places, which is especially problematic for women. To maintain their dignity, they may only relieve themselves privately before sunrise and after sunset. This causes health problems such as urinary tract infections.

The project was carried out in peri-urban coastal areas in India (Kerala), Sri Lanka (Kurunegala, on the west coast about 75 km north of Colombo) and Bangladesh (Morelganj). In each area there was one pilot district and three similar districts acting as controls.

Kerala has an established group of women masons who cement local stone to build latrines. The project sent women from Sri Lanka and Bangladesh to visit the Kerala group, and tried to transfer the model back to the other two countries.

The advantages of women workers

The young girls have some cultural advantages that make them suitable for this work. They can communicate with other women more easily than men can, and – unlike men – they are able to work in compounds while the men who live there are out.

Gender roles mean that young women in particular are able to benefit from the work. As they are less mobile than adolescent boys it is not easy for them to find work outside the community, and there are no opportunities for work within it. Having finished school, many girls stay at home without earning a living, until they get married. Building toilets in their own community gives them an opportunity to earn an income, as well as promoting the health benefits of sanitation.

Bangladesh: mapping houses by welfare level, with and without latrines.

The tasks remain new and unconventional for women, and the project is trying different ways to enlist necessary male support for the work. However, a gender balance is emerging in the voluntary groups and in the Project Advisory Committee. More work is needed to achieve the project's objectives as regards the number of women entrepreneurs and the gender balance in the mason teams.

The Bangladesh project has had enthusiastic support from the municipal authorities. The project's volunteers have promoted better sanitation and hygiene and have made Morelganj aware of the issues. This is the first time women in the area have taken part in a public project as actors rather than beneficiaries. Two female and two male masons are at work building toilets – however, the women are still in a subordinate position to the men. One female entrepreneur has started making and selling compost bins.

Twenty-five households have installed a sanitary latrine, and all open latrines that drained into water sources have now been isolated from them. The concept of solid waste management has been introduced, resulting in a municipal plan for the segregation and recycling of organic waste. Meanwhile, numerous households have started waste segregation and composting of organic waste.

Women and protest

"The women's role was to organise, to push and to be the one who used most energy in deciding actions ... they suggested forms of action, they spoke up saying we mustn't back down. They took up the logistical support, the food, to go round collecting food ... So they had a multiple role – while the men's role was to stay at the barricades and resist as well as being in the blockades, the role of the women was to organise and ... to say we should maintain this blockade."[2]

This is how Oscar Olivera, executive secretary of the Cochabamba Federation of Factory Workers and spokesperson for the Coalition in Defence of Water and Life (*La Coordinadora*), described women's contribution to the protests over changes in water management in Cochabamba, Bolivia (see Chapter 2). The women who took part in demonstrations against the new arrangements did so on the basis of their role as providers of water to their households. As they were responsible for domestic water collection, storage and distribution, they knew a great deal about the price structures of different forms of provision. They were also expert on water quality and the associated health risks.

This daily dealing with water supplies led women in Cochabamba to participate in a range of water institutions at community level. They occupied leadership roles in water committees and associations where they monitored attendance at meetings and participated in activities that ranged from fundraising to protests.

These are familiar roles of women when it comes to water. Women are most often the collectors, users and managers of water in households, as well as the farmers of irrigated crops. At least half of the world's food is grown by women, rising to 80% in parts of Africa. Women's considerable knowledge of water resources has only recently begun to be acknowledged by decision-makers. It is one of the major keys to the success of water resource development and irrigation projects.

© EC/R.Canessa

Four steps to gender mainstreaming

EU-INCO has supported a project on the integration of the gender dimension in water management. It has concluded that there are four steps which are necessary for projects to take if gender is really to be integrated into research[3].

1. Researchers should disaggregate all their data by 'men' and 'women'. This will identify the different needs of men and women and allow them to study the differential impact of IWRM interventions on men and women. They should routinely make gender analysis

(examination of women's and men's social roles, resources, needs and priorities in relation to water) part of all situation analysis, planning and evaluation.

2. Researchers need to involve men and women in planning and implementing IWRM interventions on the basis of their various skills and the contribution they can make, rather than on the basis of what is considered "appropriate" by gender. This requires efforts to create space for women in planning and implementation, and to encourage their participation through capacity building.

3. Researchers should promote sensitivity to gender and beneficiary groups on the basis of context-specific disaggregated data, gender analytical information and a clear understanding of women's and men's priorities. Actions need to be explicitly included in policy and project documents and frameworks, backed up with staff and budgets, and monitored and reviewed through appropriate indicators of change.

4. Finally, researchers need to take action to promote gender-sensitive organisations. This step is designed to develop the skills, knowledge and commitment of the staff involved in management and implementation. It is also to address and understand issues of gender differences and inequality within developing organisations themselves. Appropriate capacity-building activities have to be explicitly included in policy, project documents and project frameworks.

1. EU-INCO 4Ws project, FP5: ICA4-CT-2002-10013: Women, well-being, work, waste and sanitation: Action research on alternative strategies of environmental sanitation and waste management for improved health and socio-economic development in peri-urban coastal communities in South Asia. Project partners are from Bangladesh, Finland, India, the Netherlands and Sri Lanka. http://www.irc.nl/page/227
2. Oscar Olivera, quoted in Nina Laurie and Carlos Crespo, *PRINWASS, An interdisciplinary research project, Cochabamba case study,* December, 2004. PRINWASS is EU-INCO project FP5: ICA4-CT-2001-10041. http://www.geog.ox.oc.uk/~prinwass/
3. Hamdy, A., 2005. *Gender and Water Resources Management: Lessons learned and the way forward.* INtegration of GEnder DImension in water management in the Mediterranean region, 2005. EU-INCO INGEDI project, FP6: INCO-CT-2004-510669. This Specific Support Action mobilised researchers and managers from more than ten countries around the Mediterranean. http://ingedi.iamb.it/

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CHAPTER 4
Water for food

Peri-urban vegetable farming in Nanjing, China.

THE THANH TRI DISTRICT lies in the peri-urban region of Hanoi, Vietnam. Part of it is home to 368 households (1 381 inhabitants), about 80% of whom are farmers growing mainly vegetables, cereals and rice and also raising pigs, poultry and fish.

The local farmers water their vegetables with urban wastewater from industry, housing and hospitals. It has not been effectively treated before it is discharged into city's drainage system, and contains nutrients, faecal coliforms and toxic chemicals. In China and other parts of Asia, there is a long tradition of using domestic wastewater and human faeces for fertilising fields and fish ponds; but using hospital wastewater adds risk.

The use of heavily polluted water for growing vegetables brings economic benefits to the village, but also causes environmental problems and risks to the vegetables as well as to the health of the farmers.

These problems arise in many areas of China, Thailand and Vietnam which are all urbanising rapidly. Farmers around the edges of the cities are growing and selling vegetables and other crops on small plots using the resources in hand. Although rural, they are inextricably tied to the cities, using what they have to offer and being affected by them.

There is growing concern about the risk of contamination of water, soils and agricultural products in these areas. Farmers are making heavy or inappropriate use of organic wastes, fertilisers, pesticides, and poor-quality irrigation water.

Improving food production

An EU-INCO project[1], with participants from China, Indonesia, Sweden, Thailand, Vietnam and the UK, is currently studying one village in Thanh Tri, Vietnam as one of the test cases. The researchers aim to see how the farmers could recycle urban wastes and make better use of agro-chemicals to improve their own health, maintain their incomes, and produce safe food with low environmental impact. The goal is to provide consumer and producer organisations and local government with relevant science to help them find and negotiate solutions.

The researchers have organised meetings with local farmers to make themselves aware of local conditions and concerns. They have listened to villagers explaining how they are under pressure from government extension officers and customers in local markets. The farmers must find a trade-off between their use of waste water for irrigation and their customers' demands for clean, safe vegetables. In the longer term, they are threatened by increasing urbanisation, which will mean less land for farming, less income and rising unemployment initially, and a change of occupation and economic base in the longer term.

Growing food in a peri-urban setting

In Southern Africa, settlers are farming on the edge of big cities, just as they are in Vietnam. One EU-INCO project[2] has investigated how farmers on the outskirts of Harare, in Cape Flats near Cape Town and in Mamelodi, just east of Pretoria, can improve their vegetable-growing to provide healthier diets for themselves and their families, and to sell in local markets. The project is described in Chapter 8.

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Vegetableaming in a squatter camp of Klipton, on the outskirts of Soweto (South Africa). Chemical toilets are pictured in the background.

Wastewater for irrigation in the Thanh Tri district of peri-urban Hanoi, Vietnam.

Worldwide water

Worldwide, agriculture and food production account for 70 to 80% of our water consumption. Our demand for water will increase as global population grows.

Fresh water for irrigated crops can come from various sources, most often rivers, lakes and ground water. It also comes from a frequently ignored resource: water stored in the soil.

Soil water is the moisture in the soil that comes from rain. In countries in humid temperate and humid tropical regions, it accounts for most of the water used. Semi-arid regions are, however, poorly endowed with soil water. Worldwide, it accounts for at least 50% of the water used to raise field crops and most of the water needed to grow feed for the world's livestock.

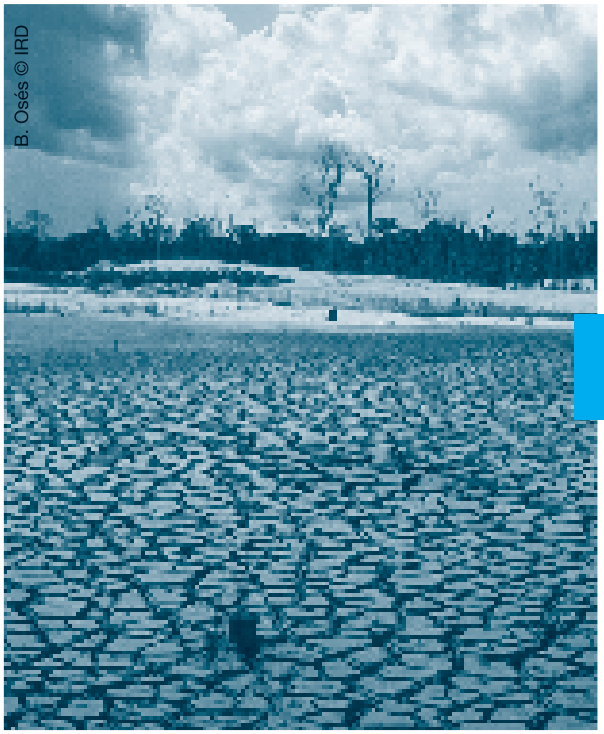
Countries which grow rain-fed crops are able to export their surpluses. As much as 15% of the water used to raise crops goes to produce commodities that are traded internationally. When arid countries import grain, they are in effect importing the water needed to grow it. This 'virtual' water solves their water deficits, and explains why some countries – e.g. in the Middle East – can continue to function with a level of water consumption that they cannot sustain from domestic sources.

The reality is that trade is a visible example of the way economies can substitute one capital (financial) for another (natural water). Theories which focus exclusively on water in an attempt to meet countries' water needs are therefore starting from the wrong place[3]. It is not developing domestic water resources which will lead to enough water in semi-arid or arid countries, but a strengthening of the general economy. This will enable the country to practise more substitution, so that it can enjoy the fruits of another country's water.

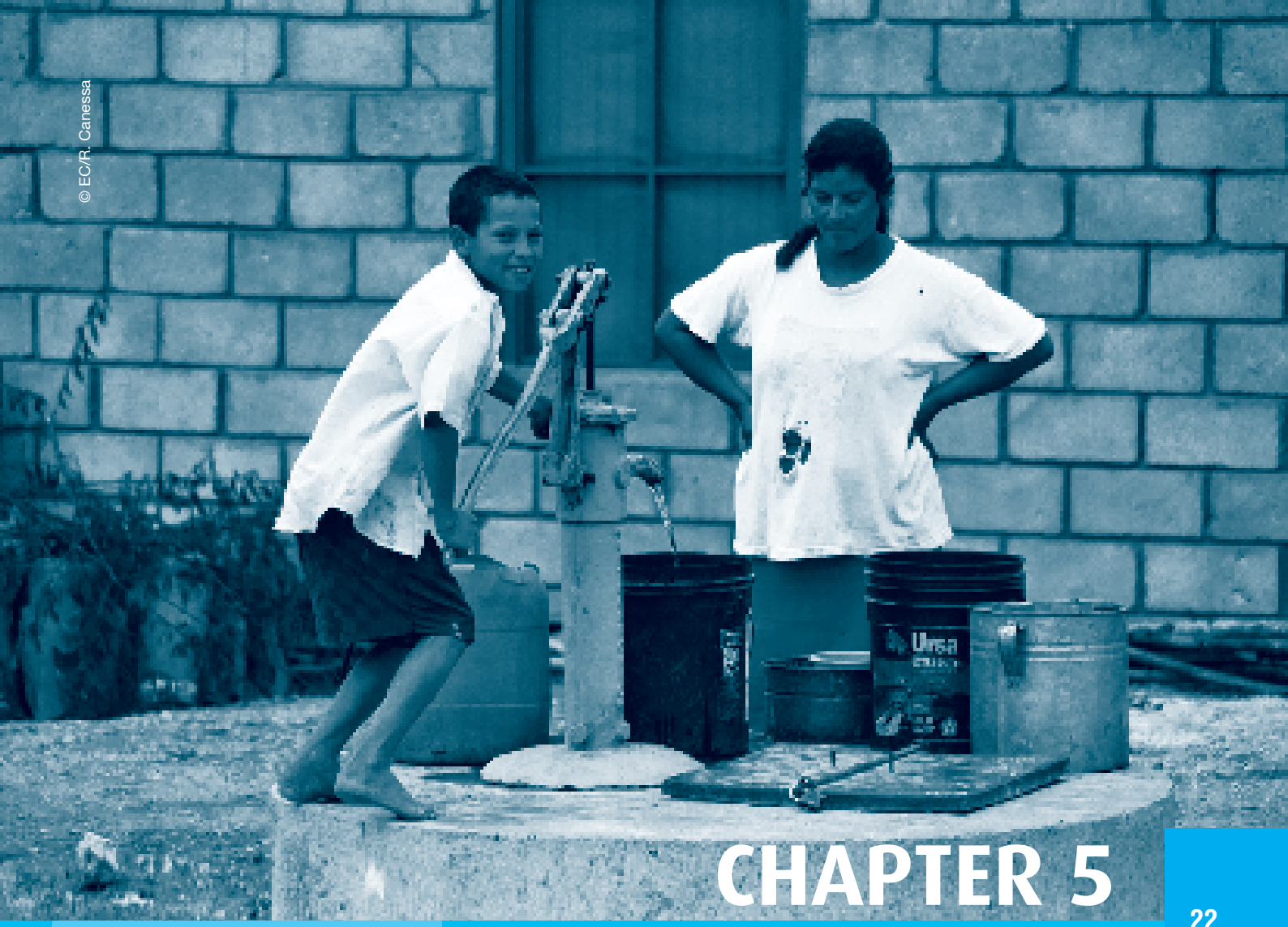
Climate change

Anthropogenic climate change, the reality of which is accepted by all but a handful of scientists, will impact on agriculture and food security across the world. Globally, all societies may experience changes in food production, quality and supply as climates change. Although forecasts of crop production rarely make use of climate change models, scientists' understanding of the relationships between crops and climate has developed to the point at which they are forecasting that the implications of climate change will probably be more serious than they had previously thought, especially in semi-arid and arid regions.

Several studies have tried to provide a global assessment of food supply by using simple measures of the effects of climate on crops. They suggest that food crop production will increase slightly at high latitudes under moderate climate change, but then decrease towards the end of this century. In contrast, crop production is predicted to decline across the tropics, even under moderate climate change[4].


B. Osés © IRD

1. EU-INCO project RURBIFARM, FP5: ICA4-CT-2002-10021: Sustainable farming at the rural-urban interface – An integrated knowledge-based approach for nutrient and water recycling in small-scale farming systems in peri-urban areas of China and Vietnam.
   www.mv.slu.se/Vv/rurbifarm/final_first_annual_RURBIFARM.PDF
   The researchers came from China, Indonesia, Sweden, Thailand, Vietnam and the UK.
2. EU-INCO project, FP4: IC18-CT97-0160: Methodologies and design criteria for soil and water resource management and policy formulation in peri-urban farming systems in Southern Africa. Project partners were from Mozambique, Namibia, Portugal, the UK and Zimbabwe.
3. Allan, J.A., 2005. "Virtual Water – the Water, Food and Trade Nexus" in IWRA. *Water International,* 28(1), March 2003.
4. *Food crops in a changing climate.* Report of a Royal Society Discussion Meeting, April 2005.
   http://www.royalsoc.ac.uk/event.asp?id=2844



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CHAPTER 5
Valuing water

SINCE THE 1980S, the private sector has increasingly participated in providing water and sanitation services in developing countries. The prevailing attitude has been that people were being denied these services because of the inefficiencies of the public sector, and that the more efficient private sector would solve the problem and improve living conditions.

As part of this trend, 1993 saw the Buenos Aires Metropolitan Area assigning the 30-year water and sanitation service contract to the Aguas Argentinas S.A. (AASA) consortium, whose main partner is the French group Suez-ONDEO. AASA took on one of the largest water and sanitation concessions in the world, intended to serve over 9 million people – almost one-third of Argentina's population. Initially, it was seen as a success.

It is now clear that neither this arrangement nor similar ones in Africa and Latin America will fulfil the 2015 Millennium Development Goal of reducing by half the proportion of people without sustainable access to safe drinking water.

As part of a project focusing on the performance of private companies in delivering water and sanitation services in Africa, Latin America and Europe, an EU-INCO project has examined AASA's performance[1]. The researchers cast their net much more widely than the technicalities of water supply. They also considered socio-economic, organisational, institutional, political and cultural factors involved in the failure of the private companies to perform satisfactorily.

AASA

The researchers found that service privatisation meant AASA was running a monopoly in Buenos Aires. The state was meant to regulate its activities, but within a legal and institutional framework which was not up to the task. This meant that regulation was weak, and state was transformed into a facilitator of the company's profits.

Between 1993 and January 2002, AASA raised its domestic bills by an average of 88% while, in the same period, the retail price index increased by just 7%. The tariffs went up in contravention of the company's original contract. The poor suffered most, in spite of efforts to soften the impact on them.

On the strength of this cash flow, AASA invested in water supply and (less) in sanitation. However, it did not fully comply with all its contractual obligations on treating primary waste water or investing to reduce leakage. Low pressure levels affected about 70% of the drinking water network. The company also defaulted on its commitment to expand the drinking water and sanitation networks. This meant that the poorest people's access to

Water management

Any system of water management will have extensive repercussions for the distribution of income, environmental sustainability and gender equity.
The big divide has been between people who advocate privatising water services and those who do not.
Water markets allocate water efficiently, but with less attention to equity than political processes. Consequently, people have tended to line up behind one banner or the other according to whether they consider efficiency to be more important than equity, or vice versa.

A better way of looking at providing water services is to recognise that any particular system will impact on the values of the society and water users alike. The task is then to make those values explicit, so that, as in Hyderabad's waste system (see page 28), all will understand the linkages and which system best suits local conditions.

This is what is meant by the new economy. We need to recognise that different stakeholders value water differently. Some prize clean water above all. Others value the environmental or cultural dimensions of water: its value in the ecosystem or its importance as a symbol of religious belief. Water planners need to understand these and other values, and to do that they need to listen to all the different groups who will use or be affected by the system they are planning.

Buenos Aires seen from the ecological reserve located on the Argentine bank of the River Plate.

water and sanitation did not increase, in spite of the fact that this goal was one of the aims of the contract.

The public's opinion

The public had no way of affecting the company's performance. Citizens and user groups were only taken seriously after they organised massive protests against rising bills and inefficiencies in the service.

AASA borrowed money from abroad to benefit from a favourable interest rate. In January 2002, following Argentina's political and economic crises of December 2001, the peso was devalued. This meant that the company's repayments rocketed, and it defaulted on its loan. Legislation passed after the crisis dramatically changed the conditions in which the private sector operates. As a result, AASA was reported to have lost some US$500 million and requested a renegotiation of its contract. However, in September, 2005, it announced its withdrawal and revocation of the licence.

The researchers conclude that, although the mainstream literature promoting the expansion of private-sector partnership depicts the process as a partnership between the public sector, the private sector, and civil society, in practice the weight of each of these 'partners' has been far from balanced. The poorest people, who are the least protected and suffer most from the lack of water and sanitation services, are also the most excluded from power. They will need to be much better represented politically if all the citizens of Buenos Aires are to enjoy access to these services.

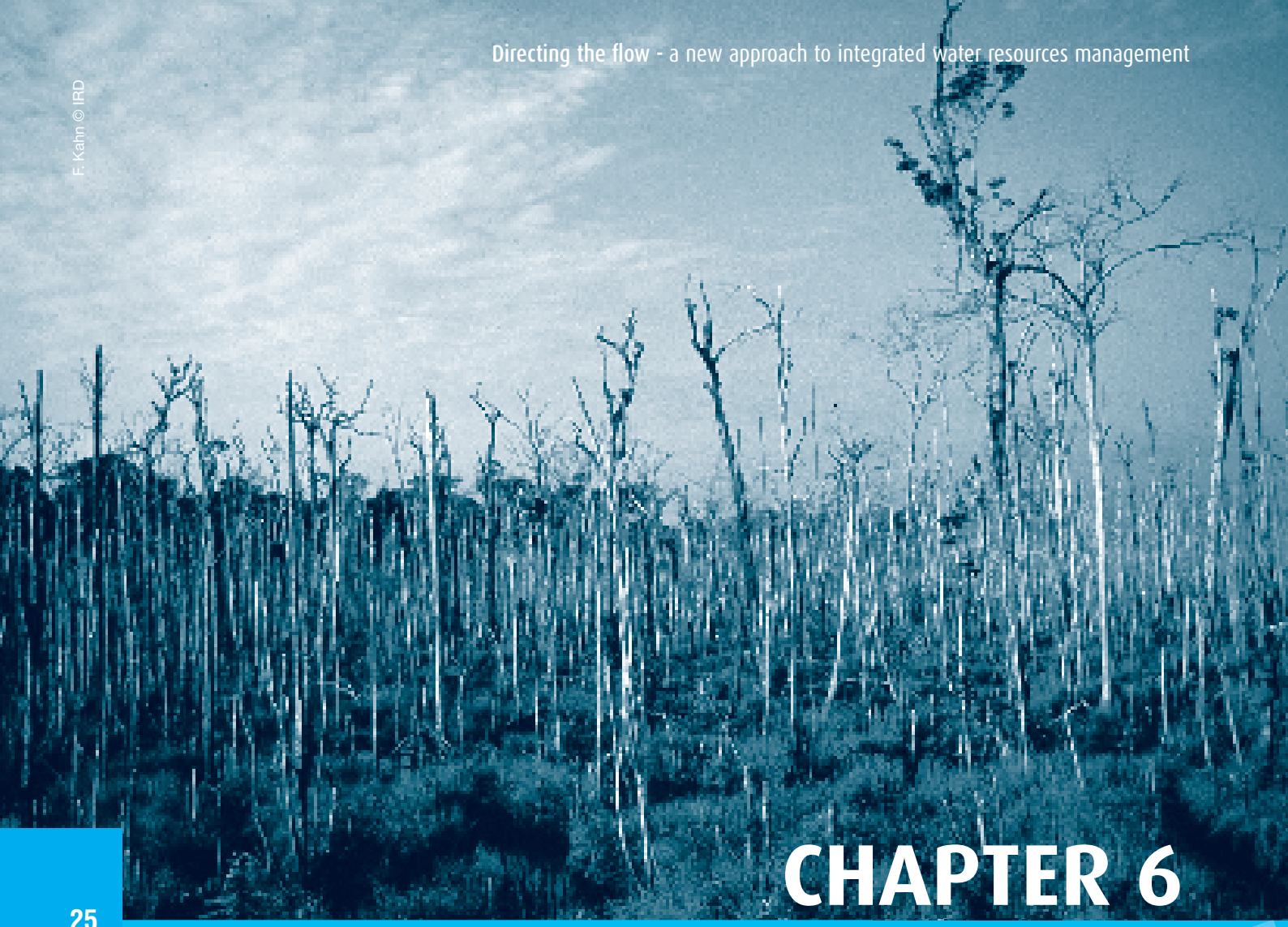
Deficiencies

The other cases in the PRINWASS project involved many of the same factors. It was common to find that the secrecy of commercial contracts meant that the public had no information about the authorised rates of return on investment or the details of investment and financial undertakings. In these circumstances, public scrutiny was impossible and 'participation' often meant willingness to accept decisions that had already been taken with little or no consultation.

Many of the problems of privatised water supplies in developing countries occur not because there is anything intrinsically wrong with privatisation, but because the institutions in the project country cannot implement it effectively. As in Buenos Aires, so in Cochabamba (see Chapter 2), where the conflict spilled over into violence. In this case too, a combination of economic, social and political factors prevented privatisation from succeeding.

Where the need for water is widespread and the government's resources meagre, there may be little alternative to private-sector managerial expertise and services. However, if it is to succeed, the social, institutional and political conditions in the country must be able to support it.

1. EU-INCO PRINWASS project, FP5: ICA4-CT-2001-10041: Barriers to and conditions for the involvement of private capital and enterprise in water supply and sanitation in Latin America and Africa: seeking economic, social and environmental sustainability. The project partners are from Argentina, Bolivia, Brazil, Finland (also bringing in Kenya and Tanzania) France, Greece, Mexico, the Netherlands, Portugal, Spain, and the UK. http://www.geog.ox.oc.uk/~prinwass/



F. Kahn © IRD

CHAPTER 6
Water and the environment

A devastating effect of a dam: a dying forest in Brazil.

THE ARAL SEA in central Asia is testimony to what unsustainable use of water can do to aquatic systems. Over the past 40 years, its tributaries – the Amu-Darya and Syr-Darya rivers – have been diverted for irrigating cotton and rice crops, to the point where the tributaries have dried up almost completely.

The Sea, which previously was as big as the Netherlands and Belgium combined, had shrunk to less than one-third of its original volume by 1990. Its waters have become very saline, wrecking the formerly rich bird and fish life in the area.

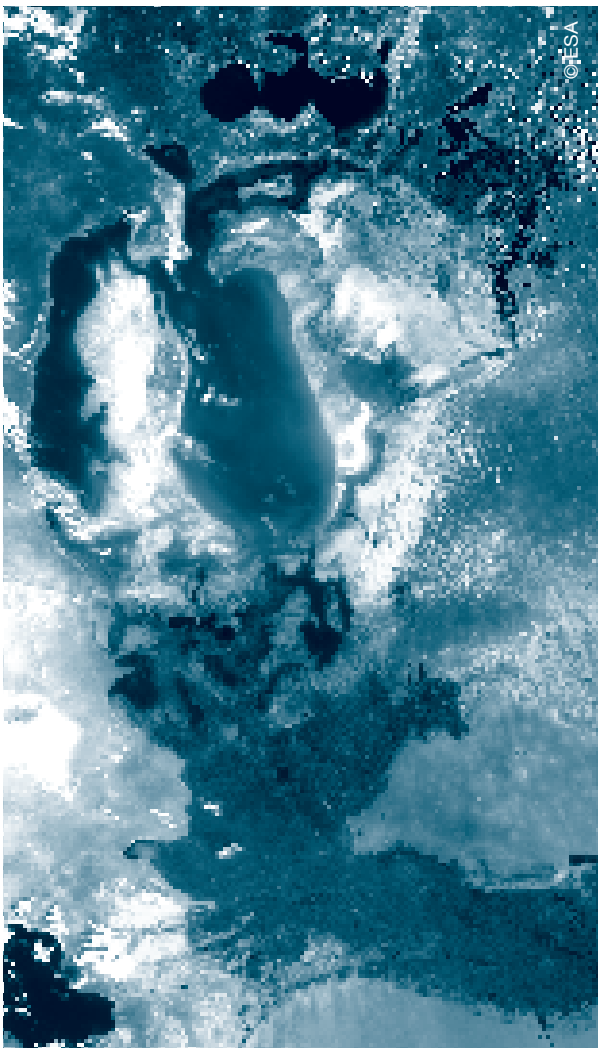
Salt deposited through evaporation has accumulated along the former shoreline. It is picked up by the wind and blown to the irrigated fields to the south. This salt has increased their salinity and, as they are already affected by waterlogging, has lowered their productivity. Desiccation of the soil has given rise to dust storms.

The people of the area have suffered from a higher incidence of serious diseases, such as cholera and typhus, and respiratory diseases, such as asthma and bronchitis. Incidence of these is 30 times higher than previously, as is infant mortality. The number of birth defects has also risen.

The Sea is far shallower than it used to be, and this is believed to have triggered the regional climate to become more desert-like. The reduced area and volume of water has meant a loss in its heat reserves, which has lowered temperatures in winter and autumn and raised them in summer and spring. The relative humidity has fallen, meaning that the area has become dryer, and the strength of the winds has increased.

Researchers are keen to understand how the present situation has arisen and how it might develop, so that they may suggest ways of improving conditions.

A project supported by EU-INCO[1] has undertaken extensive research into conditions in and around the Sea. The researchers, from Belgium, Germany, Uzbekistan, Bulgaria, Turkey, Ukraine and Russia, have developed models of the regional climate, water-salt dynamics, the circulation and ventilation of water in the Sea and the evolution of its ecosystem. To some extent, they have been able to reconstruct some events in the recent evolution of the Sea. This collaboration is one of several on the Aral Sea supported by INCO and INTAS[2] (largely with INCO resources).



Satellite image of the Aral Sea.

The environment needs water

When dam-building was popular, many people thought that river water which reached the sea was wasted. Since then, we have understood that the environment needs water for its own nourishment and, as we depend on the environment, such water is vital for us too.

The 'environment' means far more than just wildlife. Wetlands are an important freshwater ecosystem,

Water wars?

Conventional wisdom has it that water shortages will cause wars in the 21st century, just as oil did in the 20th. Political and geographical boundaries do not match. States share river basins and depend on the same water sources. In the Middle East, Southern Africa, South Asia and on the Nile, water complicates and sours international relations.

It is hardly surprising that water has been cited as the cause of war, when all around the globe the two occur in tandem. But Aaron Wolf, of Oregon State University, has analysed all the wars most commonly cited in the literature as water wars, and comes to the conclusion that "the only problem with these theories is a complete lack of evidence". The various conflicts (generally in the Middle East, but also in South Asia and South America) "turn out to be about political tensions or stability rather than about warfare, or about water as a tool, target, or victim of armed conflict – all important issues, just not the same as water wars"[3].

As far as international relations are concerned, water by itself hardly ever seems enough to cause war. Rather, it is part of broader political relationships between countries and groups and regions within nations. Those relationships are multi-faceted: religious, cultural, economic, territorial, health- and security-related; and statements made about water reflect these various preoccupations. Water lends itself to this precisely because it is vital to every aspect of life.

Inducing co-operation

Wolf also examined the most comprehensive catalogue of international disputes, the International Crisis Behaviour dataset, to see which ones were actually caused by water.

He concluded: "Shared interests along a waterway seem to consistently outweigh water's conflict-inducing characteristics. Furthermore, once co-operative water regimes are established through treaty, they turn out to be impressively resilient over time, even between otherwise hostile riparians [political entities which lie across a flowing river or bank on to one], and even as conflict is waged over other issues. These patterns suggest that the more valuable lesson of international water is as a resource whose characteristics tend to induce co-operation, and incite violence only in the exception."

The intensity of violence about water seems to be inversely related to scale. People are more likely to fight over water than nations are. Most of the conflicts that take place over water happen at sub-national level, between regions or groups of people – as in Cochabamba (see Chapter 2).

influencing not only species distribution and biodiversity in general but also human settlements and activities. They provide natural flood control, carbon storage, natural water purification, and commodities such as fish, shellfish, timber and fibre. These products are especially important for the rural poor who depend directly on natural resources or benefit from ecosystems.

Human activities, including agriculture and settlements, have caused serious damage to freshwater ecosystems and contributed to the loss of about 50% of the world's wetlands during the 20th century.

If this trend is to be stopped or even reversed, wetlands will need to receive enough water of good quality to maintain their biodiversity. This will require environmental or dry sanitation to be adopted on a wide scale. It will need developing economies to increase their investments in waste water collection, treatment, and disposal.

Integrated waste management

D. Wirmann © IRD

Cleaning up a waste dump in New Caledonia.

Like any city of over 4 million people, Hyderabad produces a lot of rubbish. In 1995, the Municipal Corporation of Hyderabad began to privatise rubbish collection.

The way waste is managed has implications for socio-economic conditions. Private contractors pay lower wages than the Corporation does. Employees in the private sector are unable to benefit from pensions, health insurance, housing, sick leave, or working clothes and boots. Female workers in the private sector are supposed not to do night shifts, to protect them from being harassed, yet almost all night workers are women.

These changes are affecting one caste disproportionately: the *Dalits* (untouchables); for one of the few jobs open to *Dalits* is to collect rubbish.

Waste management also affects environmental sustainability. When waste in Hyderabad was collected more efficiently, there was less opportunity for people to pick out what they might be able to sell. This meant that a larger volume of waste ended up being dumped, which was undesirable ecologically.

Traditional research into waste management has regarded it as a matter of public health or of economics. An EU-INCO project set out to uncover the socio-economic and environmental aspects of solid waste management[4]. The researchers recognised that any system would have wide repercussions, involving trade-offs for people trying to judge which system might suit any given situation. By making these trade-offs clear, the project aimed to make solid waste management systems transparent to policy-makers, citizens and the private sector.

This approach, which involved not only close collaboration between the researchers, but also extended interviewing of all the people involved at the different stages of rubbish collection, is called integrated sustainable waste management.

Sustainable water resources management

The Ministerial Declaration at the end of the Hague World Water Forum in 2000 advocated sustainable water resources management as a way of protecting ecosystems. Its underlying purpose was to assure water security in the 21st century.

We are beginning to realise that we must look further than the watershed to bring about sustainable water resources management. We need to look at what is referred to as the “problemshed”: that is, to encompass all the elements of the problem, no matter where they may be located.

This insight leads us to recognise that problemsheds have ingenious ways of solving water shortages. A local watershed with limited water resources may have its water allocation boosted by the importation of commodities which need a lot of water in their production.

For example, it takes 1 000 tonnes of water to produce every tonne of grain, so countries which import grain avoid the costly environmental, economic and political

stress of mobilising 1 000 tonnes (cubic metres) of fresh water for every tonne of grain they import. This water has been termed "virtual water", and it allows many economies to run on more water than they can produce within their geographical borders. In the Jordan Basin, for example, countries have been able to access volumes of water equivalent to between 70 and 90% of their national needs via trade in food[5].

Seeing water resources in this light has given us a new insight into water security. It downplays the fashionable forecast of water scarcity leading to water wars.

1. EU-INCO ARAL KUM project, FP5: ICA2-CT-2000-10023: Desertification in the Aral Sea Region: a study of the natural and anthropogenic impacts. The project partners are from Belgium, Bulgaria, Germany, Russia, Ukraine, Uzbekistan and Turkey. See conference website for selection of recent activities: http://www.intas.be/%5Ccontent%5Cnews%5Cconferences%5CASBC%202005-opening%20page.htm
2. INTAS is the International Association for the Promotion of Co-operation with Scientists from the New Independent States (NIS) of the Former Soviet Union. It is an independent international association formed by the European Community, European Union Member States and like-minded countries to promote East-West scientific co-operation between INTAS members and INTAS-NIS partner countries; http://www.intas.be
3. Wolf, A.T., 1998. Conflict and Cooperation Along International Waterways. Water Policy, 1(2):251-265. See also Yoffe, S.B., 2001. Basins at risks: Conflict and cooperation over international freshwater resources. Dissertation, Oregon State University. http://www.transboundarywaters.orst.edu/projects/bar/
4. EU-INCO project, FP4: IC18-CT97-0152: An integrated economic and environmental assessment of solid waste systems in Kenya and India. Project partners are from India, Kenya, the Netherlands and the UK. For a fuller account, see also Baud, I.S.A., J. Post and C. Furedy, 2004, Solid waste management and recycling; actors, partnerships and policies in Hyderabad, India and Nairobi, Kenya. Dordrecht, London, NY, Kluwer Academic, 303p. (ISBN 1_4020_1975_0).
5. Allen, J.A., 2005. Water in the environment/socio-economic development discourse: sustainability, changing management paradigms and policy responses in a global system. © Government and Opposition Ltd.

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CHAPTER 7
Traditional knowledge

A water master from the Algerian oasis of Adrar showing the 'hallafa' (perforated sheet) that is used for measuring the flows at the outlet of the big foggara.

IN THE SANDY magnificence of the Sahara desert, collecting water would seem to be a problem. Yet traditional water catchment systems have supported oases here and in other arid and semi-arid areas since 1000 BC.

Foggaras – known in other arid areas as qanat, khettara, falaj, madhrat or minas – consist of sloping, horizontal underground tunnels which drain microflows of water and allow gravity to take it where it is needed in an oasis. The tunnels, which extend four to eight kilometres out under the land surrounding an oasis, are linked to the surface by successive vertical air shafts.

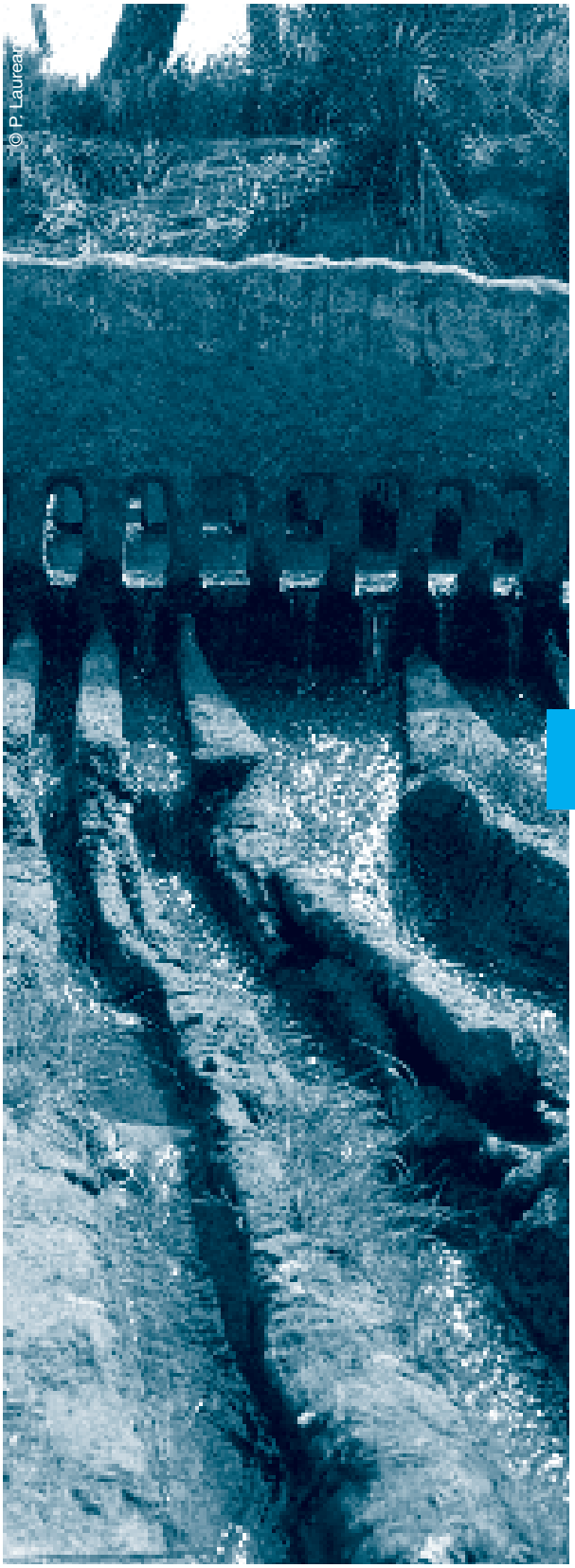
In the desert, the days are very hot and the nights are very cold. During the night, moisture precipitates on colder surfaces: gazelles drink by licking night dew off wet stones. Water is preserved in the pores of the soil, which becomes more and more steeped in water; gravity pulls the water down to the underground canal and to the opening that feeds the oasis.

Natural pump

The foggaras act as a 12-hour cycle pump that attract the vapour-laden air. During the night, cold air sinks to the ground and humidity seeps into the foggaras. After sunrise, the entire process is reversed. As the ground heats up, the air in the foggara rises as it is expelled through the air shafts that are exposed to the burning temperatures of the desert. Air circulates in the underground tunnel, sucking moisture from the shaded area of the oasis. The humidity is thus sucked out and recondensed on the tunnel walls and floor before the air can exit from the shafts.

The tunnels are built above the water table and do not draw water from it. The system replenishes the table with some of the water which sinks down to it from the tunnels.

Some foggara are supplied by rain which falls thousands of kilometres away, and which has taken 5 000 years to reach the oasis where it is harvested. Others are supplied by water precipitated on or near the site. Even though this is not more than 10 mm each year, the areas harvested are large and can yield enough water for an oasis.



Oasis at Timimoun (Algerian Sahara) showing a 'kesria', a water quota sharing system.

Investigating foggaras

A project supported by EU-INCO[1] is seeking better understanding of the way foggaras in European (south-eastern Spain, southern Italy) and Saharan countries (Morocco, Algeria, Tunisia) are built and function. The researchers' aim is to highlight them as an efficient way of producing water, in harmony with water resources and the ecosystem. They also want to investigate why some have been abandoned while others survive, and the feasibility of restoring them so that they can function successfully under today's socio-economic conditions.

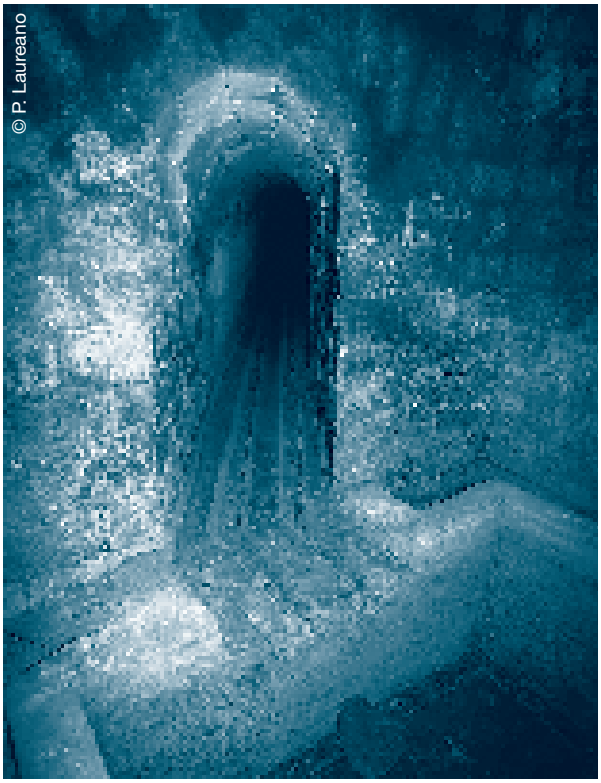
Traditional construction

Rubble walls are made of stones fitted together without mortar. Constructed since Roman times, they mark field and farm boundaries and are part of the Maltese and Gozitan cultural and agricultural heritage.

Sometimes the walls are made with stones of similar shape or size. Sometimes they are irregular, so that walls differ in pattern, and different patterns may occur in bands on the same wall.

Where terraces line the slopes of valleys, rubble walls retain the terraces. A good-quality rubble wall is strong enough to stand for a century or more, and has a level layer of 'coping stones' at the top, which protect it from the wind and rain. Maintenance of rubble walls is crucial because it prevents soil erosion from occurring during heavy storms.

In recent decades, as land has been developed for buildings, roads and quarries, there has been a drastic loss of rubble walls. Traditional knowledge has slowly died with the drop in numbers of local farmers. Many rubble walls have been replaced with modern slab walls as boundaries for new roads and houses. These are made with mortar, but many fail to protect against soil erosion. They are made without the 'wall weeping holes' that controlled the run-off water and prevented the rubble wall collapsing under the force of storm water[2].



Traditional water collection and distribution, Gravina di Matera (Italy).

Foggaras are much more culturally pervasive than mere engineering structures. Water is not simply a commodity, but a symbol of fertility. The patterns made by the irrigation channels appear, for example, in women's clothing and in woven rugs. The smallest quantity of water which can be measured is as big as the tip of the little finger, and called habba – a term for a barley seed and related to the measure of gold. The project seeks to describe these connections to deepen understanding of the links between traditional water management techniques and both environmental and social issues.

Sassi of Matera

The Sassi of Matera are small settlements, typical of the traditional use of resources around the Mediterranean. The settlements, thought to date from prehistoric times, are built along deep, arid or semi-arid valleys. They cluster on the upper part of the cliffs and on a valley's steep sides.

Their water supplies come from rain and dew that is harvested in drains and in cave dwellings. The town's

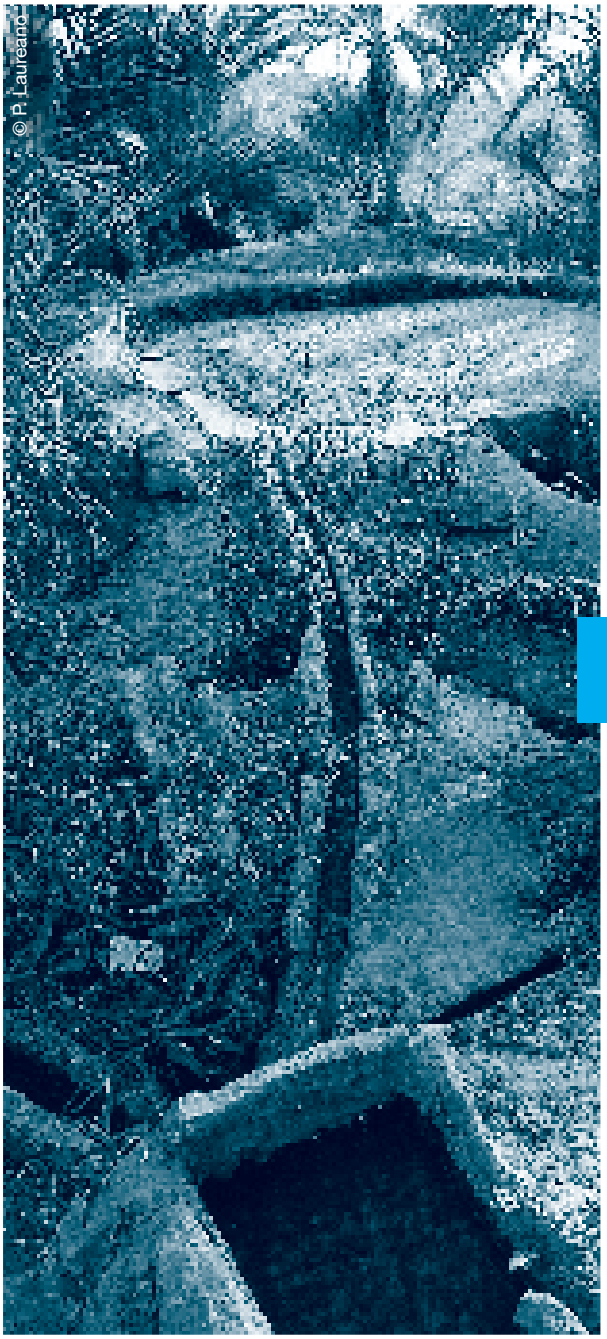
vertical structure uses gravity to distribute the water, and protects it from the wind on the top of the plateau. The arrangement of the narrow streets, stairs and underground passages still follows the ancient water system. Innovations and renovation respectful of the heritage combined with a new economic base through ecotourism to create a success story. An example can be seen at http://www.laureano.it/casalaureano.htm

Integrating traditional knowledge

Traditional ways of water management have much to teach us about sustainable water harvesting. Where they have been successful, they have been integrated into the society, culture and economy of which they have been part. We should look to traditional knowledge to enhance and incorporate appropriate modern technology. Modern systems of water management need to fit into their broader context, just as successful traditional ones did and continue to do.

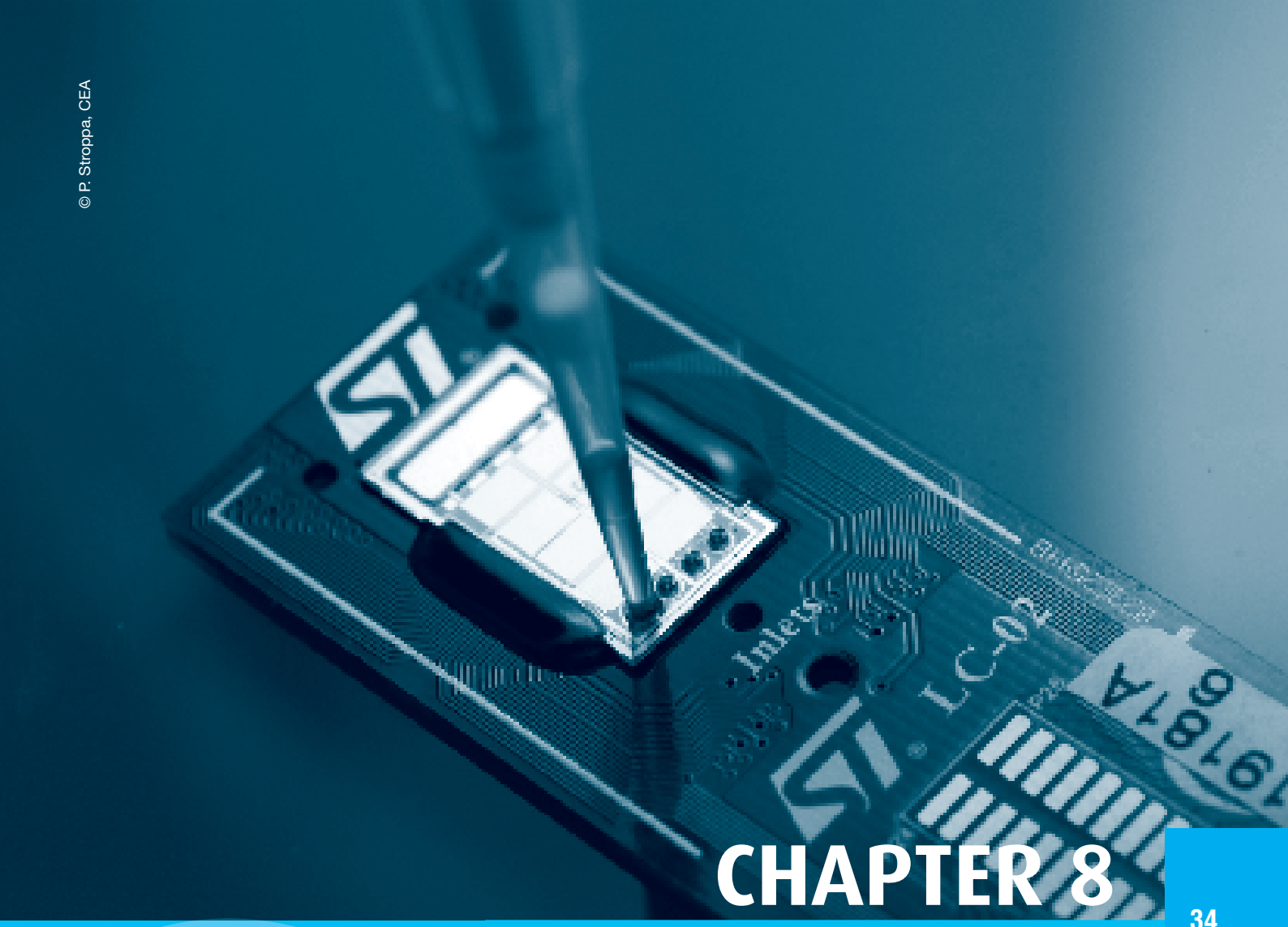
Successful traditional systems were multipurpose and designed to work over the long term. They varied according to the environment and were able to be maintained using local resources of material and manpower. They did not deplete resources, and sometimes even enhanced them.

Where traditional systems were not fully integrated into their environment, they failed. Historians believe that irrigation techniques played an important part in the collapse of the Sumerian civilisation in 4000 BC. Waterlogging of fields meant that water could only evaporate or percolate into the soil, resulting in salt residues building up on and beneath the surface. In time, the fields were unable to support crops, and the civilisation was undermined by food shortages.



Oasis at Timimoun (Algerian Sahara). Water is distributed to each owner by a series of channels on the surface and is temporarily collected in small basins called majen. The shade of the palm trees and the formation of algae on the water surface obstruct evaporation.

1. EU-INCO Foggara project: FP5: ICA3-CT-2002-10029: Inventory, analysis and enhancement of traditional water techniques of European and Saharan drainage tunnels. The researchers come from Algeria, Italy, Morocco, Spain and Tunisia. http://www.ipogea.org/foggara/foggara.htm
2. Source: Anna Spiteri.



CHAPTER 8
Science and technology

8

SOUTHERN AFRICA has seen a significant influx of people into the cities from the countryside, seeking better lives. Many of these people have small plots of land on which they grow vegetables. On the outskirts of Harare, in Cape Flats near Cape Town and in Mamelodi, just east of Pretoria, unemployment is high. Many settlers – mainly women – grow a wide variety of vegetables to provide healthier diets for themselves and their families, and to sell in local markets.

A research project[1] supported by EU-INCO has carried out technical studies to develop ways in which the settlers might increase the productivity of their plots.

The project examined various methods of increasing productivity: developing mixed cropping combinations; finding out the minimum amounts of nutrient-rich materials which are needed to produce good household compost; working out ways of monitoring the richness of compost; and experimenting with anaerobic digestion of wastes. They studied the interactions of the soil, plants and water under different conditions and, through community meetings with local people, ascertained that they did not object to using grey water to irrigate vegetables.

The researchers also tested methods for improving water recycling in households and waste treatment processes, and for setting up low-cost, high-efficiency irrigation technology. They developed guidelines which the women can use for managing crop, soil, water and organic wastes.

Women growing cabbage in South Africa.

Water in context

People may prefer to forego the most modern science in order to realise other priorities. When farmers in Andhra Pradesh, India, were given an informed vote on their government's plans for food and farming, they rejected a future of increased productivity, use of external inputs and reliance on national and global markets, preferring to regenerate sustainable food systems and more localised economies, alongside what they saw as more justice and fairness. They were unimpressed with sophisticated drought-resistant crops, preferring instead to secure drinking water and water for agriculture by traditional means[2].

Policy dimensions

The project also examined the formulation of policy which could support the settlers' agriculture. It discovered a lack of clear land use planning policy which could address their issues, and insufficient community-based structures for representing the people on planning committees. The situation in Harare was complicated by political cliques and power struggles which influenced local land allocation. The researchers concluded that planners and policy-makers need to consult and involve stakeholders more in planning.

The project was carried out by experts in soil science, microbiology, environmental science and agronomy from institutions in Mozambique, Namibia, Portugal, South Africa, the UK and Zimbabwe.

Water in agriculture

Water management also needs to be integrated into agricultural and environmental conditions. Where the needs of the system as a whole are not recognised, water can ruin food production instead of enriching it.

Too little or too much water can poison soil with salt. Too little water fails to wash away the salts naturally occurring in irrigation water from worn rocks and soil. Too much water causes waterlogging, which raises the

The traditional way of carrying water in 'pipes' made from tree trunks is far from efficient (Segura de la Sierra, Spain).

water-table. Roots then draw the water up to a level at which it evaporates, leaving its salts behind.

About a tenth of the world's irrigated land has been damaged by a build-up of salts in the soil. Salinised land produces lower yields and can be so damaged that it has to be taken out of production altogether. Up to 25% of irrigated land in arid and semi-arid regions suffers from salinity.

Salinisation is reducing the world's irrigated area by up to 2% each year. This is a threat to food security. Although only about 17% of all cropland is irrigated, it produces 40% of the world's food.

Good drainage and using irrigation water efficiently can minimise the dangers of salinisation, as it ensures that plants are given what they need without using more water than necessary. Another response to the problem is research into the way plants tolerate stress caused by salt.

Efficiency in agriculture

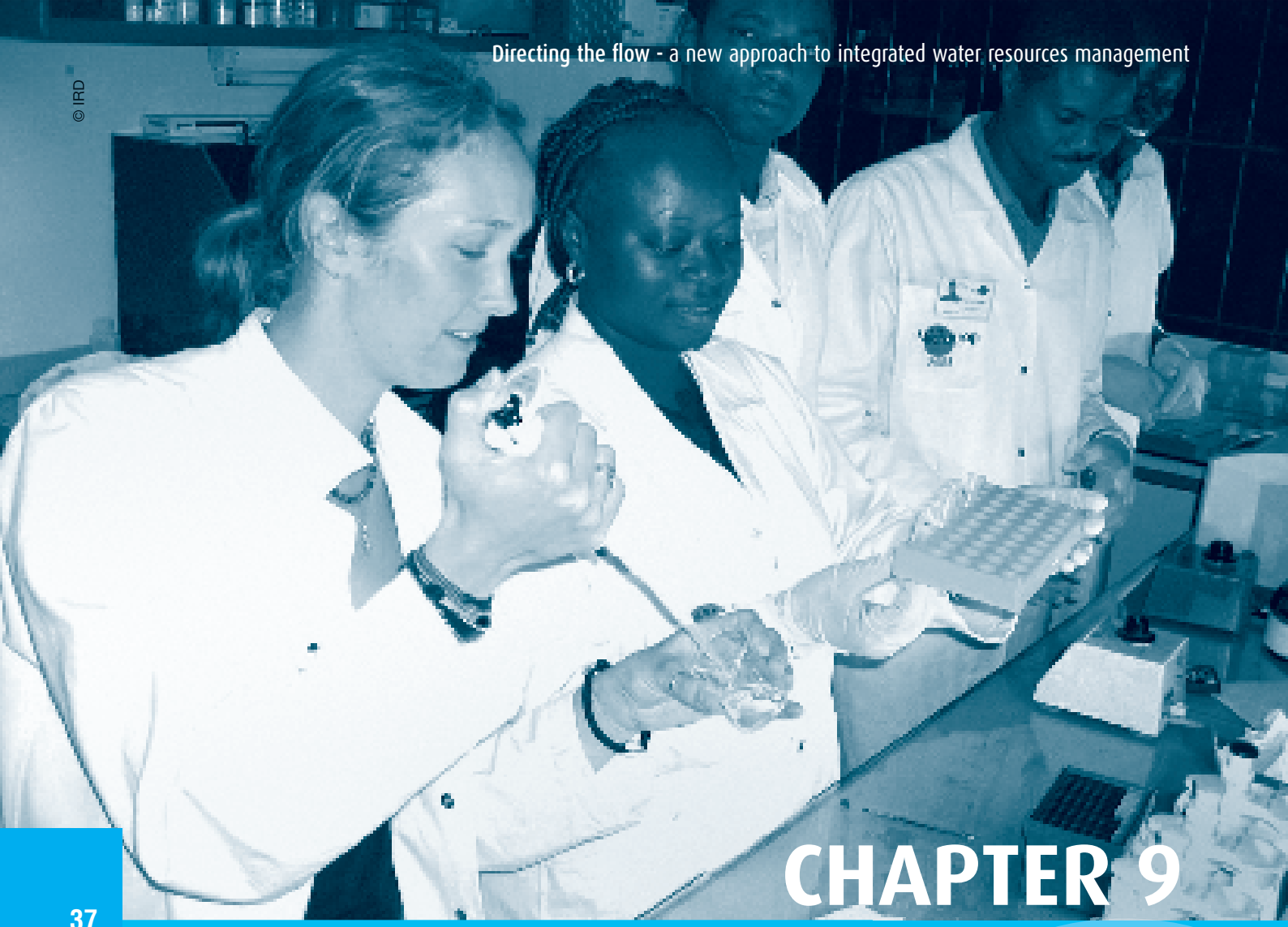
Technology can help reduce waste. We can waste less water by stopping leaks, and ending both day-time irrigation and irrigation using potable water. Existing technology (drip irrigation, low-flow toilets, modern industrial processes) all encourage efficiency. Furthermore, we could change to more water-efficient crops and charge proper prices for water (subsidised for people who cannot afford to pay).

We can recycle water in agriculture. In parts of Saudi Arabia, Tunisia, California, Israel and Egypt, waste-water reuse for agriculture is an essential source of water.

We can reuse water in municipal water supplies. California does this principally to irrigate crops, recharge groundwater and irrigate golf courses, municipal lawns and parks.

One largely unrecognised source of water is soil water: the water that crops depend on. Sometimes, as in temperate Europe and North America, it occurs naturally in the soil; elsewhere it is added through irrigation. Naturally-occurring soil water accounts for 5% of the Earth's freshwater. Increasing agricultural yields – they have, for example, doubled on the rain-fed tracts of Europe and North America since 1950 – mean, in effect, increasing the efficiency with which soil water is used.

1. EU-INCO project, FP4: IC18-CT97-0160: Methodologies and design criteria for soil and water resource management and policy formulation in peri-urban farming systems in Southern Africa. The project partners were from Mozambique, Namibia, Portugal, South Africa, the UK and Zimbabwe.
2. Pimbert, M. and T. Wakeford, 2002. Prajateerpu: A citizens' jury/scenario workshop on food and farming futures in Andhra Pradesh, India. London, IIED.



CHAPTER 9

A review of EU-INCO's water-related research and its findings

OVER THE LAST TEN YEARS, the EU's INternational science and technology COoperation (EU-INCO) programme has spent well over €50 million on water resources management and water services in general.

During 2005, a panel of ten eminent scientists[1] reviewed 67 EU-INCO research projects dating back to 1994 in Africa, Asia, the Caribbean, Latin America, the Mediterranean, Russia, Eastern Europe and Central Asia. The aim of the review was to identify strengths and weaknesses of EU-INCO's past research and to guide future investment[2].

A political process

The panel approached its task in the light of the principles of sustainable development and cultural theory[3] which guided the evaluation. Its underlying assumption was that water allocation is an intensely political process.

All stakeholders have vested interests in the way water is allocated between different groups. If one group gets more, others will have less. Farmers near a river, for example, may be ordered to draw less water from the river to irrigate their crops, to allow more for the river's ecosystem. Many will resist the policy, not wanting their immediate income to suffer for the sake of the longer-term health of the river. What actually happens will depend on the political tussle between the competing interests.

Water in context

The panel's second assumption was that water problems are always part of larger issues. Whenever water management is at stake, the people involved will be from government, private industry and non-governmental organisations as well as water users. All must have their say – not for reasons of political correctness, but to make the research robust in finding sustainable ways forward. Solutions which are not based on the reality of people's lives and competing interests will not turn out to be viable over the long term.

The panel gave the name "constructive engagement" to the process of giving everyone a say, listening to everyone and negotiating sustainable ways forward. Projects which enable this to happen will build up human capital: skilful researchers who are crucial to a longer-term research capability. Because these projects are also those most closely aware of political realities, they will have most hope of making a political impact.

Another important assumption the panel made was that, where poverty and water poverty go hand in hand, poverty comes first. People lack water because they are poor. Water scarcity does not make people poor.

Findings

The panel's main finding was that EU-INCO projects reflect a deepening understanding of the way politics determine how water is managed. This growing realisation has resulted from EU-INCO's demand, in its

IWRM: shocked into being

South Africa's national political transformation resulted in radical constitutional reform, including a new water law, in 1994. "Scientists of all stripes – modellers, ecologists, interpretive social scientists and scientists from the water sector and beyond – have had to respond to and cope with the priorities defined by the urgent needs of society. The priorities are palpable; the politics unavoidable. The option to remain uninvolved in a comfortable core of familiar disciplinary science has simply not been possible. This version of *constructively engaged* integrated water resources management incorporated all components of the hydrological cycle and all levels of stakeholders, thereby defining the way that South African water problems have been addressed during the precise period of this review. EU-INCO has funded a number of research projects in South and southern Africa.[4]"

last call for research applications, that projects are relevant to policy and also address the politics of water management.

The panel found that EU-INCO's greatest strength was to structure the research to emphasise integration across disciplines and the participation of a wide range of stakeholders. It found that EU-INCO research is more relevant to difficult water allocation problems than ordinary discipline-based research.

The most visible achievement of the research was to strengthen human and institutional capabilities in partner countries and regions, as well as in Europe. Economists recognise that human capital is a central precondition to bringing about any form of development.

Feedback from the projects showed, however, that these capabilities take longer to develop than the span of individual projects. The research had most impact when successive projects, driven by a core of excellent researchers, integrated more disciplines to address more dimensions of sustainable water use under conditions of scarcity.

In most societies, women and men have different social roles in relation to water. Some recent projects have addressed these, although most have not.

EU-INCO's greatest weakness was its poor communication of the research to civil society movements and the private sector.

Recommendations for FP7:

"The main challenge is shifting perceptions rather than honing the science."

The period reviewed covered 1994 to 2005, broadly corresponding to FP4 through to FP6.

The main lesson the panel drew from its review of the EU-INCO projects was that water users, water professionals and even many water scientists and engineers need to understand the basic factors that enable societies to have enough water.

Water chemical test in Mali.

Water users do not expect to find solutions to their water problems outside their local watersheds, but this is often where the ecological and socio-economic fundamentals of such solutions lie.

Nationally, it is urban areas which generate solutions to problems of water and food supplies by creating economic wealth. Peri-urban areas often give rise to significant portions of national GDP. "An economy generating such high levels of income and associated livelihoods is exactly what is needed to solve the water and food needs of millions of families," the panel found.

J. P. Montoroi © IRD

Internationally, virtual water enables political leaders to deny that their water and food economies are operating beyond self-sufficiency.

This understanding of water security is confounded by many political and psychological factors. People everywhere resist depending on water and food resources from other countries. Millennia of experience of using local water sources to sustain livelihoods are more powerful than the unfamiliar ideas of scientists. Water users generally do not notice declining quality and safety of freshwater, and shrinking supplies of groundwater.

The panel recommended that one focus of the research in FP7 should be on understanding these mindsets and the processes of economic change.

The aim of such research would be to improve understanding and to identify ways in which stakeholders could interact to change mindsets, public opinion and behaviour. This should create opportunities for bringing about more efficient and sustainable use of water for human well-being and prosperity.

1. Panel members are listed on page 4.
2. The full report is available at: http://europa.eu.int/comm/research/water-initiative
3. For details, see the panel's background report: *EU-INCO water research from FP4 to FP6 (1994-2006) – A critical review.*
4. *EU-INCO water research from FP4 to FP6 (1994-2006) - A critical review,* page 9.

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CHAPTER 10
Communicating research

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THE REVIEW PANEL was asked to evaluate how effectively the EU-INCO-sponsored water researchers were committed to communicating the results of their research.

The panel asked the question in relation to five target groups: first, those involved in political processes and in relevant policy-making institutions, including those in the water sector. Second, those in the technical domain of water resource management and in the delivery of water supply and sanitation. Third, local water users. Fourth, scientists and students in secondary and higher education. Fifth, those working in the private sector to provide water services, as well as those using private water services.

The most consistent effort to communicate results was within the technical scientific community. Communication with the education area and local users was also effective. Least efforts were made with the institutional and policy domain and to the private sector (although communications here do show strong upward trends from very low bases in FP4). Unfortunately, these target groups are particularly important if the research is to result in sustainable water management.

The coordinators and the research teams communicated their results with good intent. Many were aware of the political challenge of communicating, and it is in this area that the panel pointed to underlying problems.

Policy-makers do not want to know

"Although we are making strenuous efforts to inform policy-makers in partner countries, it is difficult to get access to them or persuade them to visit study sites. Local officials have been much better, but they rarely change policy. On an international level, we have become members of the WHO International Network to Promote Household Water Treatment and Safe Storage and this seems to be starting to influence policy in donor governments"[1].

M-L. Sabrié © IRD

Effective communication

Fruitful communication takes place when each person is willing to listen, understand where others are coming from and change his or her mind as a result. It may be easy to describe, but it is rarely easy to achieve – especially when the participants' interests and perspectives do not coincide. This is necessarily the situation in communicating research about managing and allocating water resources.

The panel found that EU-INCO is asking researchers to communicate their results without taking the

Communicating with farmers in ways they understand

Farmers and scientists in peri-urban Nanjing, China.

"The village is located downstream of Hanoi City. Untreated wastewater – an important nutrient source but with potential hazards – is used as the only source of irrigation water.

"The Vietnam Environment and Sustainable Development Institute (VESDI) has been arranging local stakeholder meetings at village level involving farmers and local authorities. This is a collaboration with the National Institute for Soils and Fertilizer (NISF) in Vietnam and the Swedish University of Agricultural Sciences (SLU).

"The main purpose so far has been to give feedback to the local people on a questionnaire survey, related to characterising the farming systems and the importance of vegetable production for local livelihoods. We have also presented the results from studies of biophysical flows of nutrients and heavy metals in the water vegetable farming systems...

"During this year, stakeholder workshops are planned with different actors who are responsible for, or impacted by, wastewater management, first at different decision levels such as village, district and city. After that, round-table discussions will be facilitated between stakeholders at different levels.

"We have developed Bayesian models of farmer decision support tools that combine local and scientific knowledge. For example, farmers' evaluation of the previous crop, soil type and growth of the present crop are used together with information about soil amendments to estimate nutrient status. They then suggest appropriate fertilisation strategies, and predict resulting yields and nutrient losses to surface water courses. These tools have been developed with local people in terms that they understand"[2].

politicised nature of the process into account. The mindsets of the recipients (water users, water managers and the water policy community) are crucial in determining whether they will take new knowledge on-board. Too often, projects have disseminated their results without trying to understand these mindsets sufficiently.

If the results are to have a greater impact, the information must reach the right level of government. New information must also be able to penetrate civil movements in ways that initiate dialogue. And markets must find it easy to pick out aspects of the research that enable innovative solutions.

The panel found that FP7 water-related research should pay particular attention to the feasibility of communication, possibly as an element of the research itself. Projects should have adequate budgets to promote a higher level of communication. This should engage the researchers themselves, but could also be achieved by co-operating with communication specialists. Reporting on the nature and effectiveness of the way projects are communicated (as set up in FP6) should be further strengthened.

Policy-makers vs. educators

"We have the impression that managers and policy-makers do not care much for local populations, insofar as these are demographically limited (500-1 000 people). Their needs, rights and skills are generally ignored. During our projects in Tunisia, we have observed that the rural population which was deprived of their houses and fields as a consequence of the construction of a dam, was simply paid with new houses at the periphery of a town, irrespective of their rural origin.

"On the other hand, educators, who interact directly with the local population, are interested in information about the locality, the environment and the cultural traditions. Any information about the locality is appreciated by them, and they are ready to transfer it to the scholars. Educators always ask for informative material. At Tabarka (Tunisia) an NGO for rural development has offered facilities to disseminate information locally"[3].

Coordinators' comments

Coordinators made the following comments about effective communication:

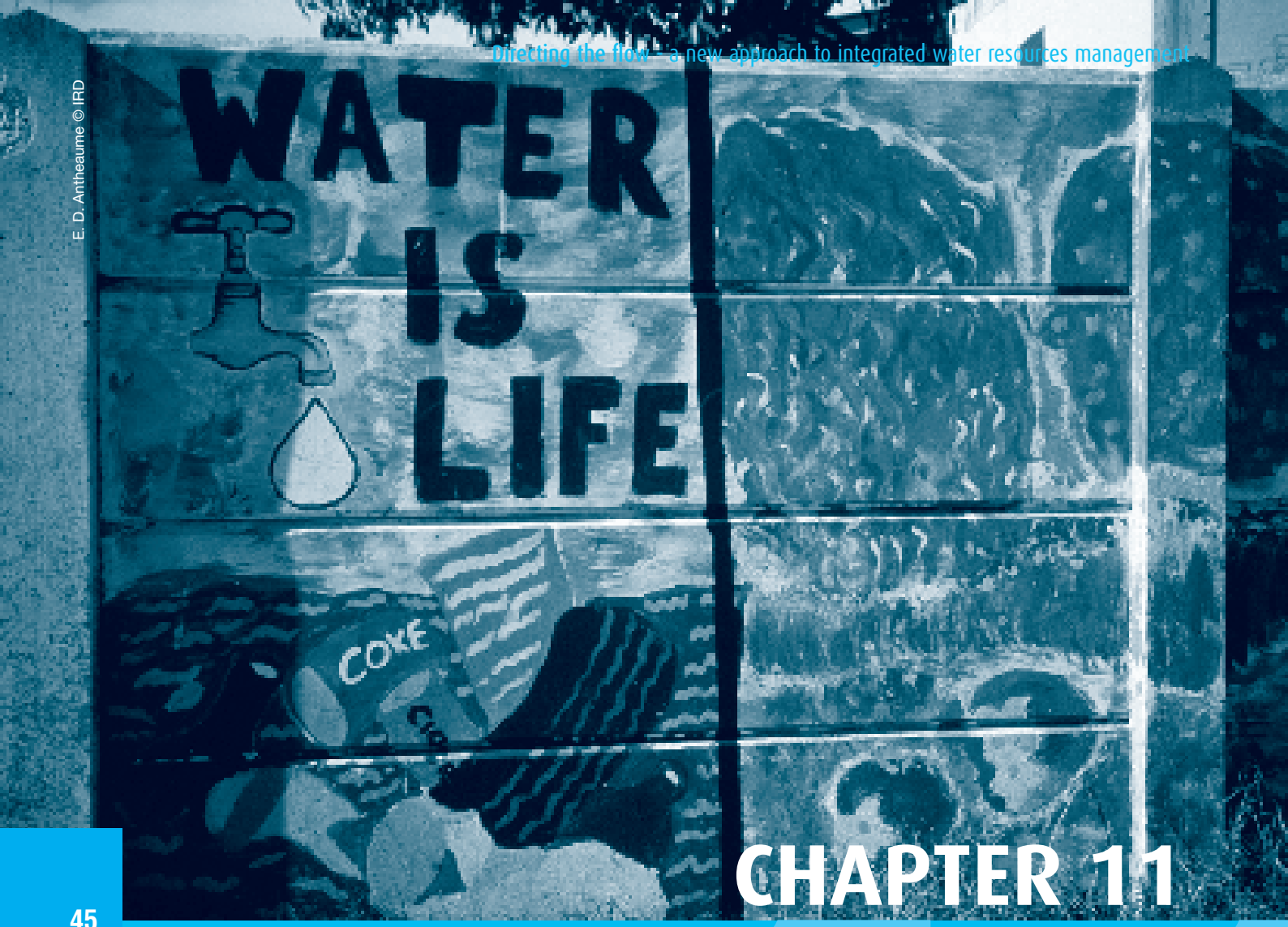
1. Among project teams:
It is important for water professionals to increase their understanding of the broader social, economic and political context. Other participants (social and economic scientists) need to be better informed about water resources issues and challenges.

2. Project leadership with policy-makers:
Data and results should be translated into a readable, concise language to policy-makers, which is able to sensitise them to water resources management challenges.

3. Project team with local residents:
In order to convey science and research findings to ordinary people to change their attitudes, projects should be relevant to the problems of daily life.

4. Regional communication:
Researchers need to develop common understanding among the cross-sectoral country team members of the water issues, challenges and management.

1. EU-INCO REAL project, FP5: ICA4-CT-2002-10005: Systems research on small groundwater-retaining structures under local management in arid and semi-arid areas of East Africa.
2. RURBIFARM – Sustainable farming at the rural-urban interface. An integrated knowledge-based approach for nutrient and water recycling in small-scale farming systems in peri-urban areas of China and Vietnam. EU-INCO project ICA4-CT-2002-10021.
3. EU-INCO MECO project, FP4: IC18-CT98-0270: Mediterranean coordination and dissemination of land conservation management. The project partners were from Italy, Morocco, Portugal, Tunisia and the UK. www.meco.unifi.it
   EU-INCO MEDCORE project, FP5: ICA3-CT-2002-10003: From river catchment areas to the sea: a comparative and integrated approach to the ecology of the Mediterranean coastal zone for sustainable management. The researchers were from Denmark, Egypt, Greece, Italy, Malta, Portugal, Spain, Tunisia and the UK.
   www.dbag.unifi.it/medcore/index_en.html
   EU-INCO WADI project, FP6: INCO-CT2005-015226: WAter supply watersheD planning and management: an Integrated approach. The researchers came from Algeria, France, Greece, Italy, Lebanon and Morocco.



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CHAPTER 11
Impact of the research

'Water is life' campaign in Guguletu, Cape Town, South Africa.

THE REVIEW PANEL was asked to evaluate the impact of EU-INCO-sponsored water research.

It concluded that, considering the organisation's small budget, "EU-INCO water research has had a disproportionate impact. EU-INCO is widely known as an international research sponsoring body. Its goals and its model of coordinated research are respected in partner countries, albeit with reservation in relation to accounting. Most importantly, it provides a tested model for engaging in coordinated international research at a moment in history"[1].

The panel's vision of fully adequate or "constructively engaged" IWRM would have all the different stakeholders (from government, private industry and non-governmental organisations, as well as water users) putting forward their views, listening to the others and understanding where they are coming from. All must contribute to making the research robust in finding sustainable ways forward, as solutions which are not based on the reality of people's lives and competing interests will not be viable over the long term. Water management is a political process, and this must be recognised. The panel found that EU-INCO-sponsored research has not yet embedded these ideas into its conception or its impacts.

The panel reported that having the resources to turn a good idea into a funded policy is seriously political. At no stage has EU-INCO, or other equivalent agencies, made these socio-political challenges an explicit focus of research concern or funding.

While concluding that the impact of the research has been greater than expected, given the budget, the panel also pointed out that knowledge can take decades to become evident in policy. This review is being completed about seven years after FP4, as FP5 projects are ending and when FP6 projects are getting started. It is not possible to measure the impact of a five-year project on impacts that span decades.

From Southern Africa to Northern Ireland

There are about 3 000 fishermen in Maputo Bay, and the shrimp they catch are Mozambique's highest export earner. The number of shrimps varies from season to season – in particular, growing dramatically a couple of months after the catchment area (the Incomati River) has had heavy rain. One EU-INCO project has been trying to understand why this should be.

This research focus is different from past projects. River management has traditionally been concerned with the way people in the catchment extract and use water. Events in the catchment have not been studied in ways that will predict how they will affect economically important coastal resources[2].

The project tried to remedy this by modelling the biophysical processes of the catchment in a way which could be relevant to other coastal areas in Africa and beyond. The aim was to produce a tool – a model – which could help them solve their problems of managing water and other necessary resources.

The researchers discovered that, after heavy rain in the catchment, the river's salinity dropped. The resulting nitrogen fixation drove the production of organisms which formed food for the shrimp.

The model is being applied to lochs in Northern Ireland, in an effort to understand how the processes in waters flowing into the lochs from rivers and the sea affect coastal waters. This will allow local people to predict how activities in incoming waters will affect fish populations in the sea and fishermen's livelihoods.

UNESCO traditional knowledge world bank

The knowledge gained in the project on foggara[3] (traditional water-catchment systems of arid and semi-arid regions; see Chapter 7) and extensive prior work by Pietro Laureano, the coordinator, has resulted in the establishment of the UNESCO traditional knowledge world bank (www.tkwb.org). The purpose of the bank is to document traditional water management practices around the world, to promote creative cultural industries, and to protect sites.

Another result has been the setting up of an Oases Safeguard Association, recognised by the Algerian government as the official body controlling the work in the Sahara desert. This association is the initiative of the Sud Timmi Society, a small private body located in Adrar, in southern Algeria. Its associates are the descendants of people who made Saharan drainage tunnels, and are themselves strongly involved in local production. The Society has developed innovative, appropriate techniques, which can be locally managed, for maintaining drainage tunnels. It has shown that it is inappropriate to use cement to maintain traditional drainage tunnels as this harms both their aesthetic qualities and their ability to harvest water.

Oasis at Timimoun (Algerian Sahara). The water-sharing system at the surface outlet of the foggara.

Mediterranean management

Natural beach on the northern coast of Tunisia.

The Mediterranean is the only internal sea bordered by different continents: Europe, Africa and Asia. Its coasts are diverse: some low, some high, some sheltered, some exposed. Some of its beaches stretch for miles while others are tiny. Some are pristine; others, degraded by tourism. Fishing villages, coastal cities, ports, natural reserves, mass tourism resorts and élite tourism enclaves all cling to the shoreline.

Starting in 1998, EU-INCO has supported a sequence of three projects[4] for the study and management of these coastal ecosystems, and of the services they provide. The study sites are in Morocco, Tunisia, Egypt, Italy, Malta and Spain.

Communication has become more effective since 1998. In the first project – MECO – the flow of information was mainly within the network, and there were problems integrating the work of the different disciplines and roles. The second project – MEDCORE – was able to integrate these elements and gave more attention to the flow of information to the outside, trying to establish co-operation with other bodies. WADI is just starting and now aiming at establishing an exchange of information with local stakeholders, and possibly with stakeholders at national and international levels.

The collaboration has had an impact beyond its scientific domain. Its results have been used to influence several decisions about the ecosystems studied. The layout of the Tétouan-Smir Highway in Morocco has taken into account the importance of the marshes and the Smir lagoon, highlighted by the MECO project, among other studies. The management plan developed in MECO for the site of Zouara in north-west Tunisia was used to block the construction of a proposed tourist resort, which would have had negative impacts on the dune system.

1. The full report is available at: http://europa.eu.int/comm/research/water-initative
2. EU-INCO Catchment2Coast project, FP5: ICA4-CT-2002-10059: Sustainability of coastal resources which support urban and rural economies: the case of Maputo Bay – Incomati River. The project partners were from Mozambique, the Netherlands, Portugal, South Africa and the UK.
   http://www.catchment2coast.org/home.php
3. EU-INCO Foggara project, FP5: ICA3-CT-2002-10029: Inventory, analysis and enhancement of traditional water techniques of European and Saharan drainage tunnels. The project partners came from Algeria, Italy, Morocco, Spain and Tunisia.
   http://www.ipogea.org/foggara/foggara.htm
   See also: Laureano, P., 2005. *The water atlas. Inventory of traditional knowledge to combat desertification.* Paris, UNESCO.
4. EU-INCO projects MECO/MEDCORE/WADI. For details of these projects, see Chapter 10.

CHAPTER 12
Practical steps to water justice

For researchers

There is a common idea that research leads to new knowledge which is best communicated through publications at the end of the project, and which then changes the world[1].

The real world does not work like that. Decision-making is not always rational and linear. It does not wait for research outputs. And outputs do not necessarily lead to outcomes. Disseminating research is not the same as having the target audience learn from that research.

Research which will influence policy needs to have scientific legitimacy. It has to be relevant to non-academic groups: government, non-governmental organisations and other stakeholders. It also needs to have been carried out by methods which are fair and open to scrutiny.

The first of these criteria will be met by the professional expertise of the researchers themselves. The others will be satisfied if researchers identify the relevant decision-makers and ask them about their concerns before they begin their project. If they engage with the stakeholders' questions at the beginning, not only will they ensure that their findings are relevant to current practice, but they will also create ownership amongst decision-makers for the research itself. If they consult widely with all shades of opinion, they will insulate themselves from charges of being unduly influenced by any one interest.

Researchers who work in this way are building relevance into the research process, and ensuring that there will be an influential audience for their findings.

Presentation of research

When researchers present their work to other academics, they follow the conventions of academe. They need to present it differently to non-academic audiences. Stakeholders want to know how the findings can help them in their tasks: developing a new policy, engaging with citizens to improve conditions on the ground, and so on. This sort of presentation needs to start from the stakeholders' problems rather than the academics' concerns. Findings should be simplified, condensed and directly relevant to the practical tasks in hand.

Most researchers welcome enquiries from the public about their projects. This can result in a fruitful learning process about how to explain results in ways which speak to stakeholders and the public at large.

The media can be a powerful tool for spreading research-based options for addressing global problems. Researchers should learn to work with journalists for a mutually beneficial outcome.

For governments, industry and the public

Our goal is the sustainable use of water. One means to achieving this goal is economic development which will buy options and opportunities for sustainability.

To push this along, people in developed economies can pressurise their governments to achieve the United Nations Millennium Development Goal of committing 0.7% of GDP to official development assistance by 2015. They can try to raise the importance of safe water, sanitation and health for all on the political agenda.

Ethical consumerism can be a powerful tool for change. Bottled water sales are worth an estimated $50 billion worldwide. Consumers can encourage companies who sell it to donate some of their profits to clean water projects in developing countries.

Rice field in Sumatra.

Agriculture is by far the biggest user of water: 70-80% of the world's water goes to grow crops. Substantial savings in water used for agriculture could make a real difference to global water use. A vegetarian diet uses less than half the water needed to raise grain-fed cattle. At the personal level, we can become vegetarian.

Agriculture can also become more water-efficient through the use of less wasteful irrigation techniques such as drip irrigation. Private companies can produce the necessary equipment and governments can subsidise farmers who buy it, to speed the transition.

Private industry and governments can support research into the development of plants which can tolerate drought and brackish water, into cheaper ways of desalination – something EU-INCO is already doing.

We can use domestic water more efficiently, and promote the introduction of water meters and water pricing in rich countries.

The picture that EU-INCO research paints is the way water is intricately linked to all other areas of life: social, economic, environmental and political. There is no such thing as a 'water sector'. The most important determinant of effective water management is political will, as underlined by the EU Water Initiative. Pressure groups, business and governments alike need to realise that change will only come about if the political wind is behind it. This means that any campaign for change must be prepared for a long haul – but for a worthwhile goal[2].

1. This section draws on work by Alister Scott of TheKnowledgeBridge, www.theknowledgebridge.com

2. See: http://europa.eu.int/comm/europeaid/projects/water/index_en.htm

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European Commission

EUR 22018 – Directing the flow - A new approach to integrated water resources management

Luxembourg: Office for Official Publications of the European Communities

2006 – 52 pp. – 21.0 x 29.7 cm

ISBN 92-79-01024-7

Web resources

EU Water Initiative research: *http://europa.eu.int/comm/research/water-initiative*

EU Water Initiative: *http://www.euwi.net*

EU Water Facility: *http://europa.eu.int/comm/europeaid/projects/water/index_en.htm*

UN and associated links:

- UN Division for Sustainable Development, including WSSD Plan of Implementation *http://www.johannesburgsummit.org/default.htm*
- Millennium Project Task Force 7 on Water and Sanitation: *http://www.unmillenniumproject.org/html/tforce_07.shtm*
- Unesco Water, including the World Water Assessment Programme for Development, Capacity Building and the Environment: *http://www.unesco.org/water/*

Selected regional initiatives:

- Euro-Mediterranean Information System on the know-how in the Water Sector: *http://www.emwis.org/default.htm*
- Portal for Euro-Med water research projects: *http://www.medaqua.org/*
- African Ministers Conference on Water (AMCOW): *http://www.africanwater.org/amcow_declaration.htm*
- GLOWA-Volta home page: *http://www.glowa-volta.de/*

Other initiatives and projects:

- 4th World Water Forum, Mexico - 16-22 March 2006 - Local action for global challenges: *http://www.worldwaterforum4.org.mx/index.asp*
- Global Water Outlook to 2025: *http://www.ifpri.org/media/water_summaries.htm*
- Global Water Partnership: *http://www.gwpforum.org/servlet/PSP*
- World Water Council: *http://www.worldwatercouncil.org/*
- World Commission on Dams: *http://www.dams.org/*
- Traditional Knowledge World Bank in Water Management: *http://www.tkwb.org*
- Nan Shui Bei Diao – China's South-North Water Transfer Project: *http://members.aol.com/anglochine/nsbd.htm*
- IRC - International Water and Sanitation Centre: *http://www.irc.nl/*
- Gender and Water Alliance: *http://www.genderandwateralliance.org/english/main.asp*
- EMERALD – Environmental Management Exchange and Resource Alliance for Local Development: *http://www.urban-emerald.org*
- Water Supply & Sanitation Collaborative Council: *http://www.wsscc.org/home.cfm*
- Fundación SOLON, Civil Society Movement Bolivia: *http://www.funsolon.org/*
- SAFFIRE – Strategic Alliance For Freshwater Information, Resources and Education, including gender perspectives: *http://www.water-saffire.net/water_gender.asp*

KI-NA-22018-EN-C

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ISBN 92-79-01024-7