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▲*The Challenge Program on Water and Food (CPWF) works on the links between water, food and poverty in developing countries.*

International Cooperation *and Partnerships*

Research laboratories in the Languedoc-Roussillon region share many programmes with each other and with other scientific partners in France, Europe and the rest of the world, especially countries in the South. This has been underlined in several of the previous chapters. However, given the extensive diversity of the water sector and its crucial importance in the day-to-day life of human societies, the labs are also open to other economic and public stakeholders at regional, national and international level. Hosting the leading French scientific community of multi-disciplinary water specialists, the region has seen the arrival or emergence of several joint organisations fostering many discussions and exchanges. These organisations can be grouped into two categories: those working in the economic sector and involved in policy-making – the State, its agencies and local authorities – and those representing and managing scientific activities at national or international level.

Actions with the economic sector are being developed with the support of local authorities and the government through two competitiveness clusters: the "Water" and "Risks" clusters. The regional water sector is especially rich in innovative SMEs, while at the same time benefiting from the expertise and representativeness of major French groups whose international presence is a particularly useful asset. Two interfacing structures complete this web of organisations: *Transferts LR*, facilitating contacts between SMEs and laboratories and *VERSeau Développement,* mediating between scientific labs, public decision-makers, international institutions and economic relays, especially the competitiveness clusters and water companies, most of whom are part of the regional SWELIA organisation.

The second set of partnerships pursues scientific goals with scientific associations having chosen to set up their headquarters in Montpellier and/or in which the regional scientific community is highly involved. This is the case of the International Water Resource Association (IWRA) and the International Association of Hydrological Sciences (IAHS), at the international level, and of the *Association Française pour l'Eau, l'Irrigation et du Drainage* (AFEID), at the national level. Furthermore, two major international organisation programmes are entirely or partly coordinated from Montpellier: the Challenge Programme on Water and Food of the CGIAR (Consultative Group for International Agricultural Research) and the International Hydrology Programme (IHP) of UNESCO.

Pierre Chevallier & Marie Mojaisky
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International Cooperation *and Partnerships*

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"Water" *competitiveness cluster*

Both at regional and international levels, the quality and quantity of available water resources depend on global changes, with a rise of climatic uncertainty and anthropogenic pressures to produce more food, energy, etc. These considerations led to the creation of a technology-centred, worldwide "Water" competitiveness cluster. The main goal of this cluster is to assess and manage water resources, both from the quantitative and qualitative points of view, using the associated eco-technologies, for the benefit of all uses: drinking water supplies, sanitation, farming and industrial uses, energy and leisure activities.

Thus, the ***"Water" Competitiveness Cluster*** is active at different levels, linked to the various stages of the water cycle (from water drawing to its return to the natural environment after different uses). Four strategic areas are targeted:
❶ Identification and use of water resources.
❷ Concerted management and uses in contexts with high pressure on water resources.
❸ Reuse of water from all sources.
❹ Institutional and societal approaches in terms of stakeholders and decisions.

In order to fit to markets of water products/services and water demand, characterised by a high internationalisation, and to changing regulations, the cluster has adopted a global outlook. 2015 will see the term of the European Water Framework Directive and it is also the deadline to achieve the United Nations Organisation's Millennium Development Goals. By 2015, the ambition of the "Water" competitiveness cluster is to effectively contribute to the "better management of water resources and uses subjected to global changes" through new, more suitable and integrated water products/services.

The "Water" cluster was approved in May 2010 by the French Inter-ministerial Committee on Local Development. It includes the Languedoc-Roussillon, Midi-Pyrénées and Provence-Alpes-Côte-d'Azur regions. It leads the coordination with the two other water clusters in France: HYDREOS (continental water management) in Alsace and Lorraine regions and DREAM (water and environments) in Centre region.

The "Water" cluster seeks to create value through innovative projects in the field of water use and management (economic growth, employment, creation and development of SMEs, SMIs and intermediate-sized enterprises). It gathers skills, questions and answers, in order to provide suitable solutions to the many issues relating to water resource management. It promotes the involvement of water stakeholders in international water market dynamics.

▲ *Coastal Monitoring.*

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"Risks" cluster: *designing pragmatic* solutions to risk-*management problems*

The ***"Local Vulnerability and Risk Management" cluster,*** also referred to as the **"Risks" cluster**, has supported the emergence of collaborative Research and Development projects since 2005 in the Provence-Alpes-Côte d'Azur and Languedoc-Roussillon regions. This cluster addresses issues linked to chronic and accidental hazards in specific areas, from prevention to post-crisis management, and hence covers all stages of the risk wheel.

Many projects labelled by the "Risks" cluster (and funded by national, regional and local organisations), deal with the risk of flooding. For example, the HYDROGUARD project *(see page 42)*, developed by the SME *ESECO System* and supported by the French Inter-ministerial Single Fund (FUI), aims to develop a reliable, autonomous and automatic system for monitoring waterways and the coastline. This system will allow local authorities to ensure sustainable management of water bodies and areas. It relies on an infrastructure fitted with equipments to monitor and continuously check the water resource and coastal erosion. Such equipments are able to make local forecasts based on scientific models, hence providing information particularly useful upon crisis (floods, accidental pollution, winter storms, etc.).

Two other projects, linked to flooding and submersion, have recently received support from FUI. The first project, KRHU (standing for "karst, runoff and humidity"), led by P*redict Services*, seeks to improve karstic flooding forecasts by providing on-call services (forecasters, analysts, etc.) with a crisis management tool based on relevant ground saturation and karst indicators. The second project, LITO-CMS, led by *BRL Ingénierie,* focuses on forecasting and real-time management of coastal flooding and submersion. It aims to alleviate local authorities' current lack of available and precise information about tidal surge risks. The impact of tidal surges on coastal river flows is not taken into account in current services.

Transferts LR: *fostering water* innovation in the *Languedoc-Roussillon* region

Created in 2005 by the regional authority and the government, and today supported by Europe and local general councils, the ***Transferts LR*** association contributes to the competitiveness of Languedoc-Roussillon firms through innovation and technology transfer. Its main activity is to foster innovation, technology transfer and the integration of new know-how and skills in regional companies. It networks with all economic development stakeholders.

Several *Transferts LR* actions concern water and involve research laboratories and firms of all sizes, some of which belong to the SWELIA group (group of companies working in the water sector) and/or are members of the "Water" competitiveness cluster. The association's actions target:

- The knowledge, prevention and management of hydrological, health and water pollution risks;
- The concerted management of water resources (including unconventional resources) and their uses, weather forecasting tools and combinations of indicators for the characterisation and monitoring of water bodies and events;
- The water treatment, purification and sanitation by-products reuse processes;
- Transport networks;
- Water and energy.

Pilot experiments are carried out in laboratories, technology halls (LBE, EMA, UM2), specialised institutes (Risk Sciences Institute in Alès) or private centres of excellence (IBM Water management) in Languedoc-Roussillon. Methodologies are often developed in real operating conditions, on site or in a public facility. They involve the French Water Agency, the government offices concerned and local authorities' technical service providers. •••

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Transferts LR provides concrete, multi-disciplinary and lasting support for the setting up and performance of innovative technological projects. It takes part to firms' early project design, it establishes relations with the concerned research laboratories, it sets up and monitors projects. The products/services developed have regional, national and European applications. It belongs to the *"Europe Enterprise"* network (over 600 members), which is particularly helpful when looking for European partners and setting up business meetings with specialised companies in other European districts. *Transferts LR* provides scientific advice to project funders for technical evaluation of the projects.

The dynamic approach of the region's very small and small to medium-sized enterprises and the synergy between research laboratories and major groups give rise to tangible, integration-focused projects offering high added value and meeting users' needs. They correspond to substantial investments (amounting to between tens of thousands and several million Euros), and are carried out with the support of French regional authorities (notably the Languedoc-Roussillon region), *Oséo*, the European Regional Development Fund and the government (FUI fund, *EcoIndustrie* and ANR).

Between November 2010 and November 2011, this support targeted ten collaborative projects (with a duration of 24 to 36 months and investments of 1.2 to 4 million Euros), headed by consortiums of various sizes concerned with the development of water eco-technologies, water management (approved by the "Water" cluster), risks of flooding and tidal submersion (approved by the "Risks" cluster), and marine environment biodiversity monitoring (approved by the "Sea" cluster). Other projects, led outside the clusters, concern water treatment, protection of water abstraction systems, and reuse of treated waste water.

VERSeau Développement: *an interfacing and* dedicated coordination *association*

Founded in 1983, the ***VERSeau Développement association*** gathers members from research organisations, industries and local authorities, working together to foster projects focusing on water management (institutional, technical and legal aspects).

VERSeau Développement aims to strengthen and improve water management through key missions:
- Carrying out consultation and facilitation missions between the scientific, industrial and public partners;
- Contributing to the running and promotion of scientific and technological networks;
- Putting to good use the results of research or development programmes;
- Helping with the implementation of public water policies;
- Performing expert studies and providing advice and training.

These missions are accomplished through activities of management and coordination of networks and projects and programmes in the field of water, through the provision of expertise, the organisation of events, etc.

VERSeau Développement gives support to local authorities (and government offices) for the design and setting up of public policies, to local companies and industries working in the water sector and to research and training institutes. To do so, it carries out expert studies, search for partners, supervision of trainees and leads projects such as the promotion of the Languedoc-Roussillon sanitation network quality charter.

VERSeau Développement calls for its international experience for the implementation of European cooperation projects, especially in the Mediterranean basin, Central Europe, Caucasia and Central Asia, for the support of the decentralised cooperation of the Hérault General

▲ *On-site water analysis.* © N. Arnaud

Council (in Tunisia and Morocco) and for the animation of scientific international networks.

In 2008, *VERSeau Développement* organised the XIII[th] World Water Congress of IWRA (International Water Resources Association, *see page 59*) in partnership with the *Institut Languedocien de Recherche sur l'Eau et l'Environnement* and ENJOY Montpellier, and in association with international private, scientific and institutional stakeholders. *VERSeau* has also hosted the executive office of IWRA since April 2010.

IWRA: International *Water Resources* association

IWRA is an international network of multidisciplinary experts on water resources. This non-profit, non-governmental, educational organisation was established in 1971. IWRA provides a global forum for professionals, students, individuals, corporations and institutions concerned with the sustainable use of the world's water resources. The objective of IWRA is to improve the understanding of water issues through education, research and information exchange among countries and across disciplines. IWRA is deeply committed to the sound management of water resources thanks to a better understanding of the physical, ecological, chemical, institutional, social and economic aspects of water.

To this end, the association:
- Provides an international forum for water resource issues;
- Performs advanced research on water resources;
- Promotes water education notably by improving global access to relevant data and information;
- Enhances the quality of knowledge used in decision-making;
- Improves exchanges of information and expertise;
- Networks with other organizations to advance common interests and goals.

Since 1973, the IWRA World Water Congress has been held every three years in different cities across the world. Each edition has a central theme linked to current water issues. Thus, the XIV[th] World Water Congress was organised in Porto-de-Galinhas (Brazil) in 2011 and focused on "adaptable water management". The next edition will be co-organised in 2014 with the University of Granada (Spain).

Since 1975, *"Water International"* is the IWRA's official journal, published by an international publisher since 2008. The journal is a key source of information in terms of research and international policy on water resources. Articles and technical memos in *"Water International"* focus on water management, policy and governance and target a broad inter-disciplinary readership. The journal keeps members informed and connected to a network of academic and operating members across the entire world by publishing important information from conferences, reviews, books, discussions, etc.

IWRA recognises the major contribution to water management made by organisations, professionals and researchers. This is why, during the IWRA World Water Congress, individuals, authors and organisations receive awards for their contribution to improving the state of water resources in the world. •••

IAHS: International *Association of* Hydrological Sciences

The ***International Association of Hydrological Sciences***, IAHS, is a scientific organisation serving hydrological sciences and the international community of hydrologists. Founded in 1922, the association has over sixty national committees and over 5,000 individual members from 130 countries. IAHS goal is to promote hydrology as an earth science and a founding pillar of water management. Its main activities are to initiate and coordinate international research on hydrological issues, to provide a medium for discussing and publishing hydrological research, to support hydrological sciences in developing countries and to train hydrologists.

The association's ten international commissions focus on various aspects of the hydrological cycle, on water resources and on specific technologies. IAHS publishes the *"Hydrological Sciences Journal"* in English and French (8 issues a year) and conference proceedings as part of the *"Red Book Series"* (350 volumes published). Many Montpellier-based hydrologists have become involved in IAHS and continue to work for the association. Currently, for example, Éric Servat (HSM) is the President of the International Commission on Surface Water, Frédérique Seyler (Espace-DEV) is the Vice-President of the International Commission on Remote Sensing and Gil Mahé (HSM) is an associate member of the International Commission on Water Resources Systems.

AFEID: Managing *water for sustainable* agriculture

The French ***Association for Water, Irrigation and Drainage (AFEID)*** is a non-profit, general-interest association created in 1954. AFEID represents French expertise on issues of water supply and rural development. Its members are individual experts and organisations: farming professionals, regional development structures, research organisations, R&D offices, associations and foundations.

AFEID offers an ideal forum for exchanging ideas about water supply and rural development issues. The association contributes to debates on water-related farming and environmental challenges by regularly organising regional or national meetings and international conferences.

AFEID is the French chapter of the International Commission on Irrigation and Drainage (ICID). It takes part in the commission's working groups and annual conferences, and contributes to publications of ICID "Irrigation and Drainage" review. As part of the *Partenariat Français pour l'Eau* (French Water Partnership), AFEID helps to prepare and expose the French position before major authorities and at international conferences, especially World Water Forums.

AFEID is committed to an approach based on technical cooperation together with the *Agence Française de Développement* (French Development Agency) and the French Ministry of Foreign and European Affairs within the framework of public aid for development.

In France, AFEID works on common themes with the Scientific and Technical Association for Water and the Environment, the *Société Hydrotechnique de France* (French Hydrotechnical Association) and the French Water Academy with the support of the French Ministry of Ecology, Sustainable Development, Transport and Housing and the French National Agency for Water and Aquatic Environments.

The association's organisation is based on a technical committee divided into thematic working groups that guide the association's thinking and work: the right water quality for the right use; environmental engineering for restoring waterways; economic, financial and fiscal instruments for water management; the future of water under global changes pressure; participatory management of irrigation and co-engineering; experience sharing about irrigation system management; underground water resources management.

Research on water in *agricultural production* systems at CGIAR

Since 2010, Montpellier has hosted the headquarters of the Consortium of the ***CGIAR (Consultative Group on International Agricultural Research).*** CGIAR is a strategic partnership gathering 64 public and private donors, supporting 15 international centres working in collaboration with hundreds of government, civil society organisations and private businesses

▲ *Modern irrigation techniques in the Tafilalet palm grove, Morocco.*

© T. Ruf

around the world. Currently, research on water in agricultural production systems is mainly addressed through two CGIAR programmes: the CPWF (Challenge Program on Water and Food), running since 2002 and the "Water, Land and Ecosystems" programme, implemented in 2012.

▶CPWF: Challenge Program on Water and Food

Since 2002, the CPWF has been exploring the link between water, food and poverty in developing countries. This programme fosters innovation in the field of water, with the goal of reducing poverty, improving food security, strengthening rural communities and maintaining ecosystem services. To fulfil this objective, the CPWF uses a novel research and development approach that brings together scientists, development specialists, policy makers and rural communities in various water basins.

The CPWF has always produced many innovations, notably in ten "pilot" basins including the Andes and São Francisco in South America; the Limpopo, Nile and Volta in Africa; the Ganges, Indus, Karkheh, Mekong and Yellow River in Asia. These basins cover 13.5 million km² and accommodate roughly 1.5 billion people, half of whom are among the poorest in the world.

In 2011, the CPWF published the conclusions of a vast study on water, food and poverty in these ten basins. According to Simon Cook, director of the CRP5 programme, *"the most surprising discovery is that, in spite of the pressure exerted on our basins today, there are some relatively direct ways to meet our development needs and alleviate the poverty of millions of people without exhausting our most precious natural resource"*.

Indeed, there are enough resources to meet the population needs up until 2050, but the path towards sustainability depends on policies and institutions, especially with respect to benefit-sharing.

Below is a summary of some of the major findings of this study:

- There is only a limited connection between poverty and water. The challenge is much more complex than water scarcity alone. Water scarcity leads to populations competing for water and to the unequal sharing of the products and services from basins (water, food, energy and regulation of ecosystem services).
- Considerable gains in farming productivity can be achieved in rain-fed agriculture zones, especially in Africa. The CPWF has observed that only 4% of available water in these areas is used for agriculture and breeding. With modest improvements in Sub-Saharan Africa, two to three times more foodstuffs could be produced. Similarly, an increase in productivity is not only dependent on improving technology, but also on improving markets (infrastructures, access, etc.). •••

▲ *Traditional irrigation system in Tunisia.* © R. Calvez

- Farmers are increasingly exposed to risks linked to irregular climatic conditions and to market instability.
- It is important that new technologies and policies strengthen farmers' resilience (their ability to deal with difficult situations by adapting or transforming their activities) and improve their productivity.
- Water management is usually based on a sector's needs without taking into account the fact that water is used for other purposes (agriculture, industry, etc.).
- Water resources should be managed at basin level, rather than at country or sector level. This institutional split can indeed generate conflicts and unfair policies. New approaches to benefit-sharing should be identified rather than focusing only on allocating water to different sectors.

▶CRP5: The CGIAR Research Programme "Water, Lands and Ecosystems"

According to forecasts, the earth's population will reach 9 billion inhabitants by 2050. Agricultural production will obviously have to be intensified to meet the increased food demand. However, it will not be possible to intensify agriculture to the detriment of our environment, without the risk of producing an irreversible impact on the ecosystems underpinning farming. This is the challenge underlying the ***CGIAR's "Water, Lands and Ecosystems" programme:*** how can we increase farming productivity while preserving the environment and reducing the poverty of millions of rural families? Coordinated by IMWI (International Water Management Institute), this programme relies on the resources of the 15 CGIAR centres and many external partners as part of an integrated approach to research on the management of natural resources. The programme notably focuses on three critical issues: water scarcity, land degradation and ecosystem services. Underlying these primary issues are other all-pervasive questions: food security, poverty reduction, nutrition and health.

The programme will examine how changes in external factors influence production systems and the way in which management responses to these changes in turn affect ecosystem services: what are the impacts on natural resources with respect to the basin and landscape? How can this information be used to improve decisions in terms of land and water management and policies?

The programme addresses five strategic research themes:
- Irrigated systems
- Rain-fed systems
- Harvesting and reuse of resources
- Hydrological basins
- Information systems

And two cross-cutting themes:
- Ecosystem services
- Institutions and governance

Each theme aims to promote the resilience of the ecosystems while increasing the services they provide and minimising externalities. The objective is to improve the adaptation of agricultural and pastoral production systems to current environmental and anthropogenic changes.

FRIEND: Flow Regimes *from International and* Experimental Network *Data*

FRIEND is the flagship programme of UNESCO's International Hydrological Programme (IHP). It is shared between roughly ten regional groups across the world and involves over 100 participating countries. The goal is to promote collaborative international research in order to develop a better understanding of hydrological variability and similarity across time and space through the mutual exchange of data, knowledge and techniques at regional level. The advanced knowledge of hydrological processes and flow regimes gained through FRIEND helps to improve the methods applicable in water resources planning and management.

The major research topics studied in each FRIEND group vary according to regions and mainly concern erosion and sediment transport, eco-hydrology, low flows and underground waters, hydrological modelling, the impact of global change on flow regimes and water resources. A shared database has been set up in each regional group and is accessible to associated researchers, via the websites developed. Various activities have been developed as part of FRIEND under the aegis of UNESCO: scientific workshops, international conferences, training, scientific discussions, etc.

Hydrologists of the regional scientific community take part to this major

international programme. Jean-François Boyer (HSM) coordinates the databases of several regional groups: MEDFRIEND (Mediterranean basin), FRIEND-AOC (Central and Western Africa), and FRIEND AMIGO (Latin America and the Caribbean). HydroSciences Montpellier (Éric Servat then Gil Mahé) has been in charge of the overall coordination of MEDFRIEND since 1999. HSM has also been in charge of the technical and financial coordination of FRIEND-AOC for almost ten years and continues to act as a key partner for this community of African researchers. Finally, Éric Servat chaired the FRIEND Inter-Group Coordination Committee from 2002 to 2006 and continues to sit on the committee together with Gil Mahé.

The "Water for All" Chair *for universal access to* water and sanitation

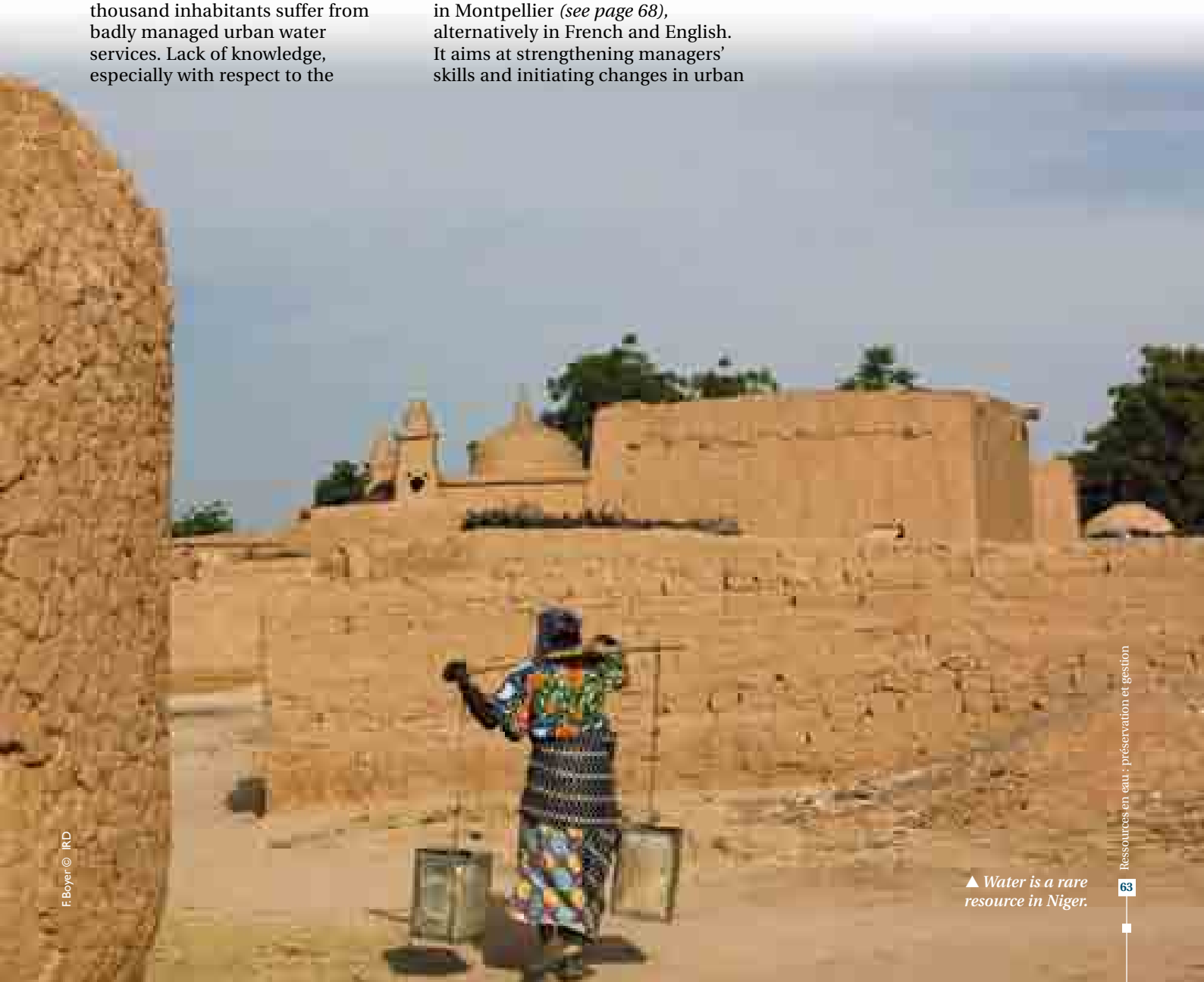
Thousands of cities with several thousand inhabitants suffer from badly managed urban water services. Lack of knowledge, especially with respect to the management of urban water and sanitation services, can prevent the Millennium Development Goals from being reached in the poorest countries. Based on this observation, a "Water For All" education and research chair was set up by the *Suez Environnement* Foundation and ParisTech in June 2009.

Hosted by *Institut de France* and managed by two of the ParisTech schools (AgroParisTech and Mines ParisTech), the chair was born from a wish to initiate a long-term partnership on the development of access to water and sanitation in developing, emerging or transitional countries.

The "Water For All" chair promotes the spread of knowledge, know-how and operational practices for managing urban drinking water and network sanitation in these countries. To do so, the chair delivers an AgroParisTech International Executive Master training course in Montpellier *(see page 68)*, alternatively in French and English. It aims at strengthening managers' skills and initiating changes in urban water services. Another of the chair's roles is to create a network of auditors and professionals largely involved in all stages of the training course.

The chair is also involved in setting up an international reference centre by linking the training course to a research programme dedicated to developing access to water and sanitation. The centre's scientific structure and content are designed to tie in with the Mines ParisTech and AgroParisTech research units (Scientific Management Centre, *UMR G-EAU*, etc.). The research axes focus on:

- Facilitating universal and sustainable access to water and sanitation services;
- Analysing the conditions for accessing these services;
- Studying the governance of drinking water and sanitation services in developing and emerging countries. ■



F. Boyer © IRD

▲ *Water is a rare resource in Niger.*