IWRM

INTEGRATED WATER RESOURCES MANAGEMENT:
FROM RESEARCH TO IMPLEMENTATION

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IWRM

INTEGRATED WATER RESOURCES MANAGEMENT:
FROM RESEARCH TO IMPLEMENTATION

Introduction

Fig. 1: Water is of vital importance. → Photo: www.iStockphoto.com/MShep2

BACKGROUND

Water is mankind's most important resource – water is life. Humans need water for drinking, for washing, for irrigation of croplands, for the production of commodities and cooling of power plants. Communities need sufficient quantities of it to enable economic and social development. The use of water means that large quantities of soiled wastewater arise. The treatment of wastewater so that it can be channelled back into the natural water cycle without detriment represents one of the most important tasks of modern civilization, and thus it is a central challenge for development assistance.

At present there are enormous deficits in terms of water supply and sanitation as well as the ecological status of waters. Currently, about 900 million people suffer from drinking water shortages and about 2.6 billion people live without safe sanitation (World Water Assessment Programme 2012). About 1.5 million children die each year due to water-borne diseases (Black et al. 2010). These issues particularly affect emerging and developing countries. Poor water quality represents the main problem for industrial countries and in the expanding industrial regions of emerging countries, affecting social prosperity and the ecological situation. The expected changes in the climate and the way land is used as well as population growth in many parts of the world will exacerbate the problems.

In response to these threats, the international community is undertaking concerted efforts towards sustainable water resources management. Thus in 2000, national representatives emphasised the enormous relevance of this topic and established challenging millennium development goals for improving access to water and safe sanitation: The number of people living without access to clean drinking water and without basic sanitary services should be halved by the year 2015 (United Nations 2000).

Enormous investments in water infrastructures are necessary in order to achieve these goals. A study by Deutsche Bank Research estimates that about 400 to 500 billion Euros must be invested annually in the global water economy (Heymann et al. 2010). The most urgent tasks are the development of integrated strategies and concepts and the adaptation of technologies to local conditions. The aim is to achieve optimal distribution and usage of water without causing a quantitative depletion or qualitative deterioration of resources. The high level of academic and technological skills available in Europe, and especially in Germany, can help to solve these water problems in a systemic way. To this end, the German Federal Ministry of Education and Research (BMBF) has developed the funding initiative 'Integrated Water Resources Management' (IWRM).

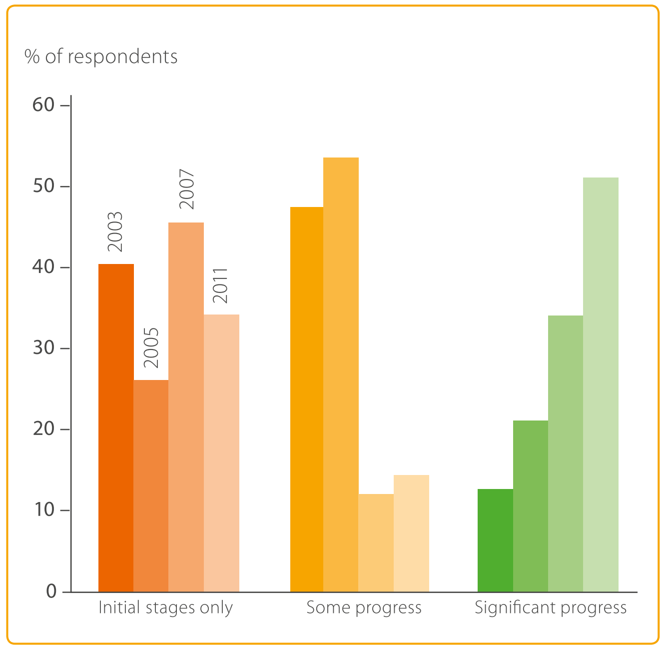

Fig. 2: Worldwide progress in the development and implementation of IWRM. → Source: UNEP 2012, based on: Global Water Partnership 2006 and UN-Water 2012

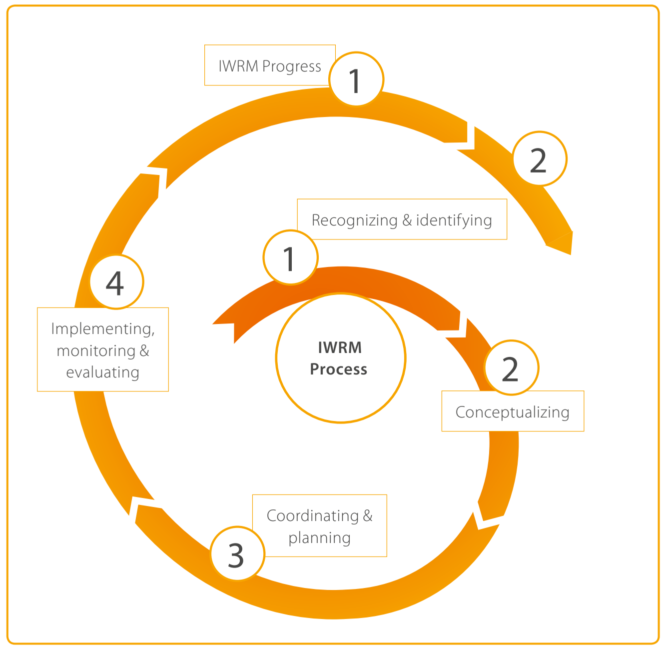

Fig. 3: The cyclical nature of Integrated Water Resources Management. → Source: UNESCO 2009

APPROACH

The concept of Integrated Water Resources Management is anticipated to make a vital contribution towards meeting the challenges ahead. It was established as early as 1992 as an international guiding principle within the framework of the Dublin Principles and Agenda 21. This concept is based on the sustainable quantitative and qualitative management of the interacting components – surface waters, aquifers and coastal waters – in order to support not only social and economic development but also to preserve ecosystem functions. Ecological, economic and social objectives must be linked together. This means that the active participation and cooperation of different social and private stakeholders in the planning and decision-making processes is a necessary condition for sustainable management of water resources. Integrated Water Resources Management has already advanced to become a guiding principle in water management, and it has spawned many technical and conceptional innovations. It is the visible evidence of a paradigm shift from sectoral thinking towards integrated concepts. Enormous progress has been made during recent years in the development of integrated management plans, but their implementation is lagging behind. According to a United Nations survey, 65 % of 133 countries have developed Integrated Water Resources Management plans, while only 34 % report an advanced stage of implementation (UN-Water 2012, Figures 2 and 3).

Fig. 4: Model regions for Integrated Water Resources Management measures funded by the German Federal Ministry of Education and Research.

↗ Definition of IWRM

IWRM is a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (Global Water Partnership 2000).

BMBF FUNDING INITIATIVE IWRM

On the basis of the sustainability goals set by the international community, the German Federal Ministry of Education and Research (BMBF) has launched the funding initiative 'Integrated Water Resources Management'. Under this initiative, new approaches and concepts for Integrated Water Resources Management will be developed in suitable model regions of manageable size outside the European Union. The goal is to help improve the local population's access to clean drinking water and reliable sanitation. Industrial partners are to be involved at an early stage in the application of technical solutions in order to facilitate the exploitation of new markets for the German export economy. Another focal point of the funding initiative is to support bilateral and multilateral collaboration in the water sector and to facilitate transdisciplinary and international cooperation between science, industry, administration and supply and disposal practices. This will ultimately benefit Germany as a location for education and research.

Fig. 5: Rice cultivation in Indonesia. ➔ Photo: www.iStockphoto.com/asiafoto

PROJECTS OF THE BMBF FUNDING INITIATIVE IWRM

The German Federal Ministry of Education and Research currently supports seventeen research projects on Integrated Water Resources Management as well as three accompanying scientific projects. The priority regions of the research initiative are shown in Figure 4. The research projects, which started between 2006 and 2010, are joint projects with partners from universities, research facilities and industrial companies. Close cooperation between the joint research projects and partners in the target regions is a basic prerequisite for the development of adapted management concepts and the implementation of action plans. The basis for all projects is an integrated approach which takes all relevant participants into consideration. However, concepts and methods must always be developed in the context of the prevailing geographical, ecological and socio-economic conditions (Table 1, p. 10). The Karlsruhe and Jülich project management agencies are supervising the individual IWRM projects.

CROSS-CUTTING ASPECTS

The research and development activities of the IWRM funding initiative encompass a variety of topics. In order to make active use of synergistic potential, a number of cross-sectoral aspects will be tackled on an interdisciplinary basis. This will facilitate both the exchange between project parties and other participants from politics, administration and the economic sector as well as the collation of results from individual projects. The following cross-sectoral topics are particularly significant: capacity development, instruments for decision support, governance and participation.

TABLE 1: THE IWRM MODEL REGIONS – OVERVIEW OF HYDROLOGICAL AND SOCIO-ECONOMIC FRAMEWORK CONDITIONS

	Area (km²)	Mean annual precipitation (mm/a)	Potential evaporation (mm/a)	Population (No. of inhabitants)	Population density (inhabitants/km²)	Annual rate of population increase (%)	Human development index (2011)*	GDP per capita and year (US$) (2011)**
Guanting Reservoir, China	43,605	350–450	760	approx. 9.1 million	195	< 0.47	0.687	5,430
Miyun Reservoir, China	16,000	500–600	1,200	660,000	40	0.22	0.687	5,430
Shandong Province, China	1,560	550	1,238–1,350	620,000	82	0.5	0.687	5,430
Gunung Kidul, Java, Indonesia	1,400	2,000	1,600	250,000	500	1.48	0.617	3,495
Kharaa, Mongolia	15,000	250–300	800	147,000	10	1.47	0.653	3,056
Tra Noc Industrial Zone , Can Tho Province, Vietnam	2.9	1,635	1,500–1,800	Can Tho: 1.2 million	Can Tho: 855	0.65	0.593	1,411
Lam Dong, Can Tho and Nam Dinh Provinces, Vietnam	Can Tho: 1,400 Lam Dong: 9,800 Nam Dinh: 1,650	Can Tho: 1,600 Lam Dong: 600–2,700 Nam Dinh: 1,700	no data	Can Tho: 1.2 million Lam Dong: 1.2 million Nam Dinh: 1.8 million	Can Tho: 855 Lam Dong: 123 Nam Dinh: 1,109	Can Tho: 0.65 Lam Dong: 1.19 Nam Dinh: 0.12	Vietnam: 0.593	Vietnam: 1,411
Mekong Delta, Vietnam	40,518	1,900	1,500–1,800	17.2 million	426	0.83	0.593	1,411
Region of Khorezm, Uzbekistan	6,800	95	1,380	1.564 million	230	1.7	0.641	1,546
Lower Jordan Valley, Israel/ Jordan/ Palestine	Lwr. Jordan Valley: 10,000 Project area: 5,200	Valley: < 100 Mountain ridges: > 600	Valley: 2,600 Mountain ridges: 1,900	Project area: 2.5 million	420	Israel: 1.9 Jordan: 2.3 West Bank: 3.4	Israel: 0.888 Jordan: 0.698	Israel: 31,282 Jordan: 4,666
Dead Sea, Israel/ Jordan/ Palestine	41,650	Valley: 50 Mountains: 800	2,000	680,000	16	Israel: 1.9 Jordan: 2.3 West Bank: 3.4	Israel: 0.888 Jordan: 0.698	Israel: 31,282 Jordan: 4,666
Zayandeh Rud, Iran	42,000	Down-stream: 50 Upstream: 1,500	1,500	4.5 million	63	1.3	0.707	6,360 ***
Cuvelai-Etosha Region, Namibia	84,589	300–600	2,600	844,500	10	1.7	0.625	5,293
Middle Olifants, South Africa	22,552	500–600	1,300–2,400	1.6 million	70	1.18	0.619	8,070
Volga and Moskva, Russia	Volga: 1,380,000 Moskva: 17,000	Volga: 250 (south) – 800 (north-west) Moskva: app. 600	Moskva: 550–600, up to 1,000 (Caspian Sea)	Volga: 52 million Moskva: 13.5 million	Volga: 38 Moskva: 790	0	0.755	13,089
Western Bug, Ukraine	40,000	700	600	950,000	350	-0.1	0.729	3,615
Brasília, Brazil	5,790	1,600–1,700	990	2.5 million	445	2.5	0.718	12,594
Al-Batinah Region, Oman	12,500	125	2,100	760,454	61	3.3	0.705	25,221

* The Human Development Index is a composite value that gives a measure of the life expectancy, health, educational levels and income levels in a given country. Low values indicate a low standard of living and large values indicate a high standard of living. → Source: http://hdr.undp.org.

** Source: data.worldbank.org (referenced on 1 August 2012).

*** Source: German Foreign Office (estimated for 2011)


Training of engineers in the project IWRM Indonesia. → Foto: T. Akbar, KIT/IWRM Indonesien

IWRM – CROSS-CUTTING ASPECTS

Integrated Water Resources Management involves many different subjects. Within the framework of the BMBF funding initiative four cross-cutting aspects have been addressed in depth in workshops and working groups: Capacity Development, Decision Support, Governance and Participation. The following section sheds light on some of the results of these discussions.

Capacity Development

Fig. 6: Trainees in Palestine compare fresh water with filtered wastewater. → Photo: R. Goedert, UBZ/BDZ

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↗ Capacity = competence, capability, qualification
↗ Capacity Development = development of these faculties

DEFINITION AND SIGNIFICANCE

The implementation of Integrated Water Resources Management remains insufficient in many cases. In addition to an inadequate institutional basis for governance and participation, it is often the lack of necessary competences which lead to unsustainable activities. Existing knowledge concerning water must be continuously passed on, adapted and extended. This involves both the people who use the water as well as the organizations and companies supplying it. In the end, the determining factors are the surrounding social conditions. Therefore, improvements in water management can only succeed as part of a multi-level campaign. In this respect, the capacities of individuals, institutions and society as a whole to appraise, revise and implement the available options are of vital importance.

The process of extending existing competence, strengthening skills, learning from experience, generating new knowledge and then identifying and addressing water-related problems can only be tackled in a comprehensive manner (UNDP 2009, Alaerts 2009). The generic term for all these facets is Capacity Development (CD).

IMPLEMENTATION IN THE IWRM FUNDING INITIATIVE

Within the scope of current research projects, German scientists, technicians and entrepreneurs apply their professional knowledge in order to develop the water sector in the respective partner country within the scope of current research projects. The training and further education measures include, for instance, opportunities for students in universities or engineers and technicians in companies. In addition to human resources development, capacity development encompasses organizational aspects, support for reform processes and consultation services on future development strategies. In the following section, these measures are illustrated using two research projects as examples.

JORDAN, PALESTINE AND MONGOLIA: EARLY ENVIRONMENTAL EDUCATION FOR SUSTAINABLE DEVELOPMENT

Amongst other things, the SMART (p. 54 ff.) and MoMo (p. 36 ff.) IWRM projects include adapted Capacity Development measures. To this end, PhD and Masters programmes, further education measures for water management experts, and teaching units for primary schools in Jordan, Palestine and Mongolia have been developed and implemented. The capacity development programme for schools contains pupil-friendly media and materials and is strictly oriented to the pupils' range of experience and previous knowledge. This module includes water and wastewater analyses and making wastewater filters using simple materials. Also, eco-technological solutions for small-scale, decentralized wastewater treatment can be constructed. The programme enhances participants' appreciation of the importance of wastewater treatment and the possibilities inherent in wastewater recycling. It helps pupils to realize that wastewater is a valuable resource.
→ **www.iwrm-smart2.org** → **www.iwrm-momo.de**

Fig. 7: Measurement programmes are being conducted by Ukrainian and German scientists on the Western Bug (Ukraine). → Photo: IWAS Project

IWAS UKRAINE: ESTABLISHING A RELIABLE WATER MANAGEMENT INFRASTRUCTURE AND IMPROVING RIVER BASIN MANAGEMENT

One research focus of the International Water Research Alliance Saxony – IWAS is to investigate the extent to which thoroughly implemented Capacity Development can promote the introduction of IWRM. A systematic Capacity Development concept has been developed in the model region in the Ukraine (catchment area of the Western Bug). In an initial step, a survey of the existing structures and competences in the water management sector was carried out. This provided the basis for defining scientific, water management and administrative measures, which are also relevant for the local water and wastewater utilities. They include the joint development and implementation of instruction units for IWRM in cooperation with partner universities in the Ukraine. At national government level, support has been provided to promote inter-ministerial dialogue regarding the introduction of IWRM. The processes involved in regional catchment management were revitalized through the inauguration of the Western Bug river basin council and workshops supporting the local administrative bodies. Further important measures involve reinforcement of the Ukrainian Association of Water and Wastewater Companies (Ukrvodokanalekologia) by means of advanced training, a mobile laboratory for wastewater analysis and the transfer of technical standards.
→ **www.iwas-initiative.de**

Decision-making Support

Fig. 8: Rivers are the lifelines of the landscape.
→ Photo: www.iStockphoto.com/negaprion

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↗ An important part of Integrated Water Resources Management consists in reaching 'good' decisions. Research can help to augment knowledge bases and facilitate the structuring of decision-making processes.

DEFINITION AND SIGNIFICANCE

In Integrated Water Resources Management, planning processes are complex and many decisions need to be taken. The decision-makers are confronted with very varied and in some cases opposing usage requirements. So public planning decisions are not made spontaneously, but are the result of a long and thorough planning and decision process. From a practical point of view this means that the first step is to gather together all the information relevant to the decisions to be made and then analyze it. On this basis, alternatives for action are developed, expertises drafted and those who are affected are heard. The final step is to come to a balanced, comprehensive appraisal of the situation.

IMPLEMENTATION IN THE IWRM FUNDING INITIATIVE

The IWRM research and development projects develop and use various instruments and methods that process and provide access to knowledge, structure decision-making processes and recommend courses of action. The various ways of doing this can be illustrated with the help of two examples.

IWRM CHINA – SUSTAINABLE WATER RESOURCES MANAGEMENT IN THE COASTAL REGION OF SHANDONG PROVINCE, P. R. OF CHINA

This project is concerned with the integrated management of the Huangshui catchment area in northeastern China (see p. 30 ff.). Here, the main emphasis is on the provision of support for decision-making in the areas of water management planning and sustainable agriculture. The first step consists in gathering all the decision-relevant information together in a geographic information system. On this basis, water management measures can be selected from a comprehensive catalogue of measures and combined with the aid of special decision tools (Figure 9). The selection is made so as to take account of both socio-economic and ecological conditions. The definition and selection of high-priority combinations of measures is done using a combination mechanism based on various scenarios in order to achieve the maximum cost-effectiveness. The consequences of the decision-making alternatives are investigated using hydro(geo)logical simulations and balancing models. The decision-making tools, models and databases are linked together via appropriate interfaces, forming a complex, integrated decision support system. In order to achieve the respective project goals, close and consistent cooperation with the Chinese partner institutions was extremely important. → **http://wasy.eu/shandong.html**

SMART – INTEGRATED WATER RESOURCES MANAGEMENT IN THE LOWER JORDAN VALLEY

The joint project SMART (see p. 54 ff.) is being carried out in the Lower Jordan Valley, where questions of water management contribute to an already highly sensitive political climate. As a means of preventing conflicts over water usage and promoting the peace process as well as sustainable regional development, the extremely scarce water resources are to be managed jointly by Israelis, Palestinians and Jordanians. Therefore, in this case the search for suitable compromises advances to become a critical factor. Formal decision-making support is provided by means of intensive multilateral communication. The decision-relevant data and information is collected in an information system (ORACLE) with an associated geographic information system, and also via the internet-based DROPEDIA knowledge platform. Special planning and decision-making tools have been developed in order to be able to plan individual measures such as managed aquifer recharging. Decision alternatives are made available in the form of packages of measures, and they can be underpinned using a systematic process for optimizing multiple goals. The respective consequences of given decisions are investigated by means of hydro(geo)logical simulations and balancing models. These systems are being developed as internet-accessible toolboxes. The experience gained through this joint project once more underlines the vital importance of involving stakeholders and decision-makers in the process of achieving acceptable compromises.
→ **www.iwrm-smart2.org**

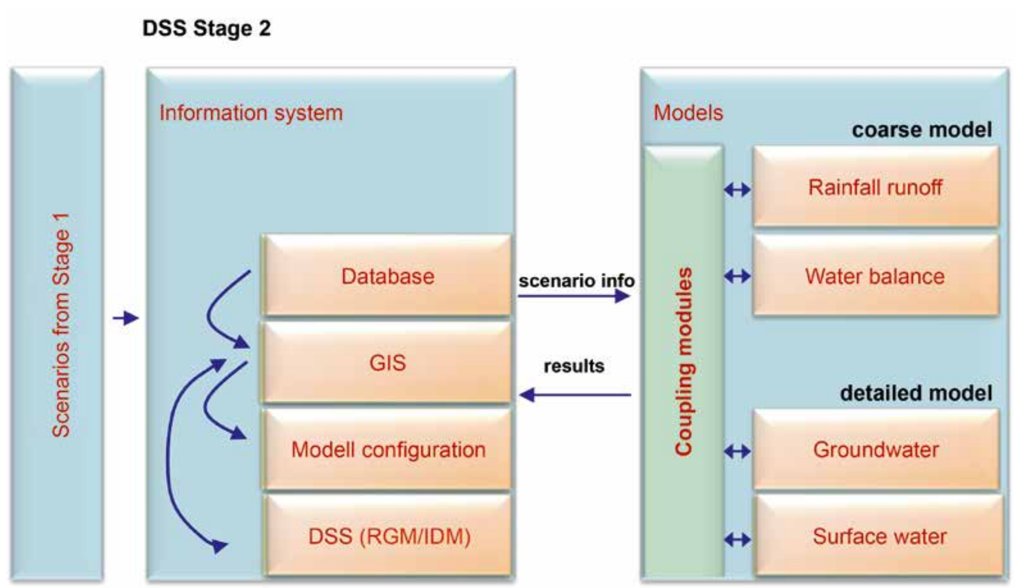

Fig. 9: Schematic model of the decision-making support in the IWRM joint project in China. → Source: DHI-WASY GmbH

Governance

Fig. 10: Dilapidated infrastructures are often the result of inadequate governance. → Photo: L. Horlemann

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↗ The term 'water governance' refers to the 'political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society' (Rogers and Hall 2003).

DEFINITION AND SIGNIFICANCE

The term 'governance' has to do with the question as to who shall make decisions about what, and according to which rules, in the management of water resources. A system of governance consists of a variety of parties (from government, non-government and private agencies), institutions (e.g., formal and informal rules) and forms of interaction (e.g., of negotiating or hierarchical nature). Such a system is also affected by structures such as markets, hierarchies and networks.

Governance plays an important role in IWRM, because it provides the political framework for its implementation. Such frameworks differ greatly from one country to another. There is general agreement that the current global water crisis is caused less by the prevailing physical conditions than by poor governance. For this reason, the analysis and the design of governance is of great importance to achieve sustainable water management solutions.

IMPLEMENTATION IN THE IWRM FUNDING INITIATIVE

Research on governance within the IWRM funding initiative ranges from analysis of the present situation through to in-depth social scientific studies in various disciplines. The situational analyses identify and describe the main participants and institutions involved. Such analyses have been conducted in many of the projects, providing a starting point for the local project work. In certain projects, the social scientific studies also serve to gauge the extent to which the existing governance structures are beneficial or antagonistic to the implementation of IWRM. The following two examples illustrate how context-specific governance solutions are elaborated.

WATER GOVERNANCE IN MONGOLIA – STEPPING STONES TOWARDS IWRM?

In the MoMo project (see p. 36 ff.) the question is addressed, amongst other things, as to whether the existing governance structures are suitable for IWRM. To this end, an analytical framework has been developed that is based on the 'problems of fit and interplay' concept (Young 2002). The empirical studies consist of a comprehensive analysis of the existing laws and policies and over 60 interviews with a variety of participants. The results show that, in addition to other issues, there are deficits in horizontal institutional interplay arising from the fact that six ministries are involved in water management. Problems of vertical institutional interplay arise where the delegation of responsibility is not clearly defined in the administration and where not enough capacity is made available for the implementation of water and environmental policies. The new Water Act that was passed in 2012 and the introduction of councils and administrative bodies at river basin level have set the scene to allow these problems to be addressed – now it is a question of implementation.
→ **www.iwrm-momo.de**

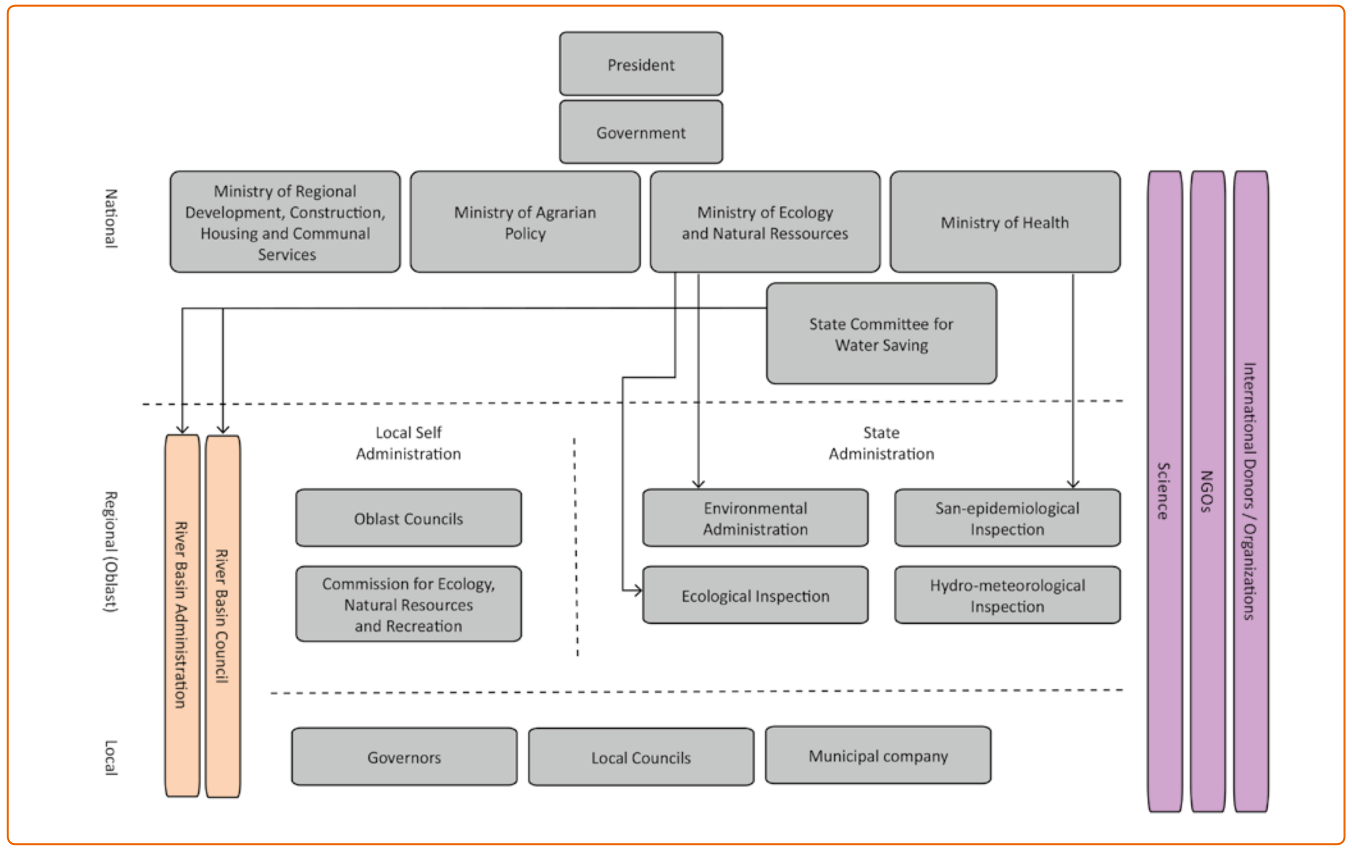

Fig. 11: Central stakeholders in the Ukrainian water management sector. → Source: IWAS Project

THE ROLE OF GOVERNANCE STRUCTURES FOR THE IMPLEMENTATION OF IWRM IN UKRAINE

As part of the IWAS project in Ukraine (see p. 69 ff.), existing management concepts and implementation strategies for IWRM were subjected to study. On the basis of this analysis, recommendations are to be made concerning the continued development of the institutional framework and governance structures. To this end, the governance structures of the water management infrastructure in Ukraine have been analyzed, taking into account current law and historical developments, expert interviews and the available literature on the actual implementation. The results of this research have shown that the unstable political and economic structures in Ukraine present an obstacle to long-term water management planning. The problem is exacerbated by the ongoing deterioration of the water infrastructure and the associated risks for the environment and society. In addition, it transpires that the institutional water management framework conditions are subject to dynamic processes that cannot be explained entirely by current theories of institutional economics. To obtain a better understanding of them, further approaches such as those of social capital and mental models must be explored. → **www.iwas-initiative.de**

Participation

Fig. 12: Interactive planning workshop in Isfahan, Iran.
→ Photo: inter 3 GmbH, Berlin

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↗ Participation comprises all forms of influence pertaining to the design of collectively binding agreements on the part of individuals and organizations not routinely involved in these tasks (Renn 2005).

DEFINITION AND SIGNIFICANCE

Participation represents a vital building block towards successful implementation of IWRM as it stimulates comprehensive and trans-sectoral solutions. Participation has three essential functions: Firstly, it is assumed that participation increases the actor's level of knowledge in respect of the sustainable use of water resources. Secondly, participation can help to balance varying interests in that those involved in the process come to see other points of view, and this in turn forms a basis for intersectoral or cross-border cooperation. Thirdly, participation has a beneficial effect on the degree of acceptance and ownership of the decisions made. Thus the participatory process often proves to be a necessary condition for making decisions transparent and acceptable. Here, participation is to be understood as the involvement of people who are affected by an issue, but are not routinely involved in political decision-making processes. Those affected may be members of the general public, or individual representatives of various water-ralated sectors, politicians or administrators at local levels.

IMPLEMENTATION IN THE IWRM FUNDING INITIATIVE

Participation is also a relevant factor in the IWRM funding initiative of the German Ministry for Education and Research. The programme aims explicitly lay down the need for active participation and cooperation between the various social and private stakeholders in planning and decision-making processes (BMBF 2004). Participation processes are being actively launched, guided or co-organized in all the research projects. Social scientific participation research is being conducted in selected projects. However, in view of the differences in the project aims and the conditions prevailing in the individual project regions, the need to involve the people affected in IWRM gives rise to very varied participation approaches, outcomes and difficulties. A comparison of the different approaches highlights a number of ways in which stakeholders can be involved at given times and to varying extents, and what methods can be used. The following examples illustrate this for two different project regions.

Fig. 13: Participation workshop in Namibia. → Photo: CuveWaters project

INTERACTIVE PLANNING WORKSHOP IN ISFAHAN, IRAN

As part of the Iranian IWRM project (see p. 57 ff.), a water management tool is to be developed for the catchment area of the Zayandeh Rud. This requires that the local experts as well as potential users and decision-makers discuss what information is needed, indicate how further data may be accessed and develop a common understanding of the problem. To this end, the scientists conducted an interactive planning workshop. This provided experts from relevant sectors with an opportunity to describe what they see as the most important challenges connected with managing the catchment area and what they expect of the management tool. As a result, it is to be hoped that acceptance levels will rise, and also that the issue of balancing interests will be actively addressed. An important observation that could be made during these intercultural activities was that, in Iran, establishing small working groups in the workshop was first greeted with scepticism, but in the end found to be very successful. → **www.iwrm-isfahan.com**

PARTICIPATION IN THE PLANNING, CONSTRUCTION AND OPERATION OF WATER SUPPLY AND DISPOSAL TECHNOLOGY IN NAMIBIA

As part of the CuveWaters project (see p. 60 ff.), local stakeholders were involved throughout the entire process, from the selection of sites, in the construction phase and in operational planning. The rainwater harvesting in the village of Epyeshona provides an example of this. The village was selected in cooperation with the rural water supply authority. A community was identified that declared its interest in testing rainwater utilization. By means of community workshops, the water use patterns and the problems involved in supplying water were analyzed and then the technologies were discussed with the villagers and the authority. Before construction began, the village community and the project team decided on the criteria for selecting the households that would be entrusted with using the pilot plants. Another factor of importance was the degree of commitment of the workers during the construction phase. For the implementation phase, the focus is on the usage, maintenance and monitoring of the plants. → **www.cuvewaters.net**

Solar plants for groundwater desalination in Namibia. → Photo: CuveWaters project

RESEARCH PROJECTS ON IWRM

Projects on Integrated Water Resources Management have been funded in 18 regions around the world. In the following section, the projects, their most important research and development results and the practical implementation of these results are presented.

The Guanting project: Sustainable water and agricultural land use in the Guanting watershed under limited water resources

Fig. 14: Guanting Reservoir. → Photo: F. Wechsung, PIK

↗ PROJECT DURATION

06/2009 – 05/2013

↗ GEOGRAPHIC LOCATION

Catchment area of the Guanting Reservoir, Provinces of Beijing, Inner Mongolia, Hebei and Shanxi (northern China)

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BACKGROUND AND OBJECTIVES

The region of northeast China is characterized by high economic growth rates, increasing urbanization and continued population growth. Long and persistent periods of drought, severe water pollution, water usage conflicts and decreasing groundwater levels confront the provinces of Shanxi, Hebei and Beijing with serious problems. As a result of climate change, the current situation could intensify drastically. The main aims of and motivation behind the Guanting Project are the protection of sustainable water and land use within the Guanting catchment area, taking into consideration climatic, ecological and economic conditions. The project concentrates at the following aspects:

1) important global change processes including climate change, its regional characteristics and their effects on water resources, water demand and water quality
2) optimization of water quantity management
3) improvement of water quality in watercourses and reservoirs
4) general recommendations for sustainable water management with reference to water quality and quantity

The general recommendations for practicable solutions are based on the results of scenario analyses. The efficiency, potential and advantages of individual measures are assessed by means of a cost-benefit analysis.

MAIN RESULTS

The Guanting Project pursues an integrated research approach based on a multi-stage chain of models. The starting point for subsequent projections is provided by climate modelling, especially for discharge rates, water availability and water quality. Additionally, two different socio-economic development pathways were implemented and combined with the projections for considering a variety of framework conditions.

Water quantity and quality represent limiting factors in many sectors, especially for agriculture and water-intensive industries, and these factors influence the economic development and the ecological situation of the region. The results indicate that global warming is also becoming perceptible in the Guanting region, higher evaporation will strengthen water shortage. For climate modelling, a statistical model (STARS) as

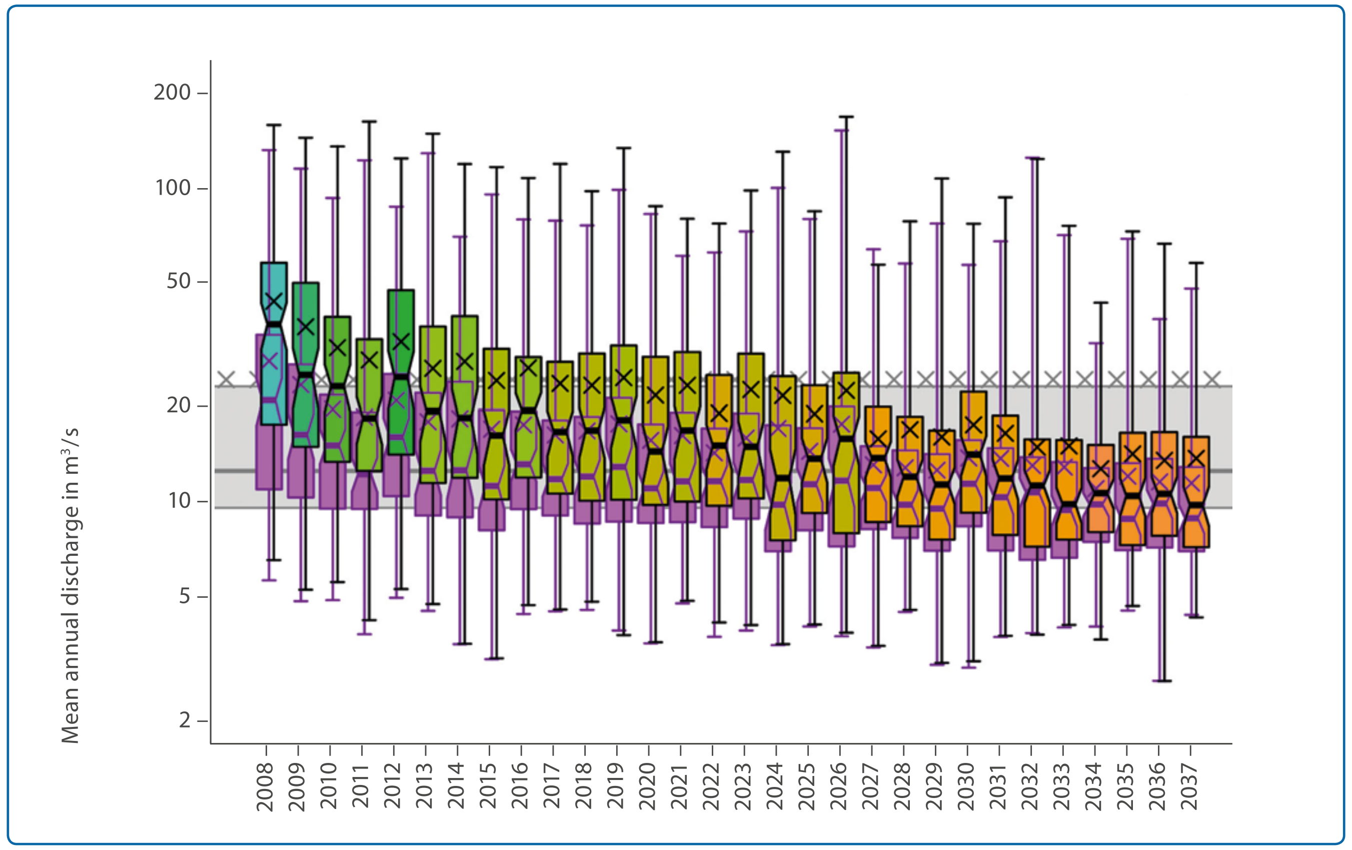

Fig. 15: Distribution of quasi-natural discharges 2008 – 2037: Impact comparison on decrease of water availability for millet (coloured boxplots in the foreground) and maize (purple boxplots in the background).
→ Source: T. Conradt, PIK (also available via InfoSYS Gaunting)

well as a dynamic climate model (CCLM) were used. Depending on the implemented pathway, the decrease in water availability is predicted to be either moderate or dramatic. Similar findings apply to the water quality projections. Agriculture will be the sector most affected by climate change. The simulated water transfers and the targeted implementation of the irrigation storage facilities do not cover the whole area. Also, the supply of constant water quantities for the area's industrial needs has a higher priority (WbalMo model). Calculations made for the agricultural sector using the SWIM eco-hydrological model show that measures such as changing the main crop species and sustainable soil conservation can reduce the negative effects. In the long term, the use of water-saving technologies is to be recommended, even though this requires major financial investments.

Reservoirs formerly constructed for flood protection are now proving to be useful for securing water availability during dry periods and are becoming increasingly important. Detailed estimation of the regional hydrological potential is possible by classification of important reservoirs into five geographic-limnological types, together with water quality scenario analysis and water quantity balances (WBalMo model). The MONERIS model indicates that a more economical use of fertilizers, better erosion protection and especially the construction of decentralized and centralized waste water treatment plants will reduce the input of nutrients significantly. The objective is to achieve an enhanced ecological status even under conditions of climatic change.

Possible options and combinations of measures must, on the one hand, be evaluated according to their costs and expected benefits. On the other hand, the priorities of the Chinese stakeholders must be taken into account through research and surveys, for these also affect the feasibility of the measures. Calculations to date indicate that sustainable water management will only be possible through a significant reduction in water consumption and input of nutrients. Potentially beneficial options include the large-scale abandonment of crop irrigation with corresponding compensation schemes, the use of water-saving technology and the expansion of waste water treatment plants, erosion protection and retention areas.

↗ MAP OF THE PROJECT REGION

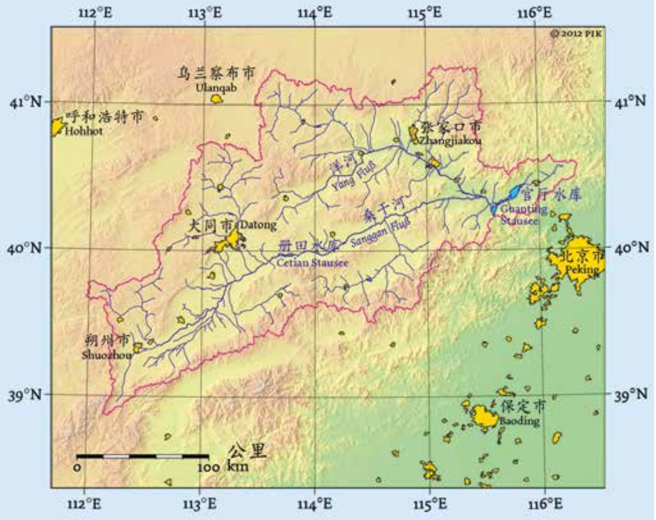

Fig. 16: Guanting catchment area. → Source: T. Conradt, PIK

IMPLEMENTATION

The development of and detailed descriptions of the different options based on all the model results serve to provide support to locally responsible persons and promote cooperation with them. Farmers and entrepreneurs as well as government institutions can exercise a positive influence on the use of resources, especially water. The aim is to implement a package of the most promising options – with the active support and participation of all stakeholders.

The ArcGIS-based database InfoSYS Guanting is an important tool for presenting the project results. Relevant research results, basic data on the catchment area as well as climate and socio-economic data can be retrieved via the internet at any time.

In addition, model training courses lasting several days were given as part of the project to explain the models to Chinese students and young scientists, both in Germany as well as in China. The main emphasis was laid on explaining the basics and modelling methods of the STARS (climate) and SWIM (eco-hydrology) models. These courses form the basis for long-term exchange processes in which the results and the models can be improved through concerted efforts.

↗ INFORMATION ABOUT THE PROJECT REGION

- Location: catchment area covering four provinces – northeast part of Shanxi (approx. 34 mill. inhabitants, 157,000 km², capital: Taiyuan) and northwest part of Hebei (approx. 71 mill. inhabitants, 190,000 km², capital: Shijiazhuang); small parts of Beijing and Inner Mongolia included
- Size of the catchment area: 43,605 km²
- Average temperature: 6 – 7 °C
- Precipitation: mean approx. 350 – 450 mm per annum
- Climate: characterized by warm and humid summers and cold and dry winters
- Hydrography: two main rivers drain the region from west to east: to the north the Yang He, in the south the Sanggan He. These two rivers join to form the Yongding He. The Guanting Reservoir lies on this river at the edge of the region. To date, this reservoir extends over approx. 100 km²; in 1989 it had a storage capacity of 4.16 bill. m³.
- Population: approx. 9.1 mill.
- Agriculturally used area: 20,000 km², of which approx. 4,100 km² under irrigation
- Cities in the catchment area: Datong (1.7 mill. inhabitants) and Shuozhou (0.7 mill.) in the western part of the catchment area in Shanxi Province (Datong is one of China's most important coal-mining centres) and Zhangjiakou (0.9 mill.) in the east of Hebei Province

↗ PROJECT PARTNERS IN GERMANY

- Potsdam Institute for Climate Impact Research e. V. (PIK), Potsdam
- DHI-WASY GmbH, Berlin
- Leibniz Institute for Freshwater Ecology and Inland Fisheries (IGB), Berlin
- Institute for Applied Freshwater Ecology GmbH (IaG), Seddiner See

↗ PROJECT PARTNERS IN CHINA

- Hebei Research Institute of Water Resources (HRIWR), Shijiazhuang
- Shanxi Water Resources Research Institute
- Haihe River Water Conservancy Commission (HWCC), Tianjin
- Beijing Hydraulic Research Institute (BHRI)
- National Climate Centre (NCC), Beijing

Development and implementation of a scientifically based management system for non-point source pollution control in the Miyun Basin near Beijing

Fig. 17: Terrace cultivation in the subcatchment Sheyuchuan; mixed crops of sweet chestnuts and maize. → Photo: M. Gebel

↗ PROJECT DURATION

10/2009 – 12/2012

↗ GEOGRAPHIC LOCATION

Beijing and Hebei Province, China

↗ CONTACT

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BACKGROUND AND OBJECTIVES

The Miyun reservoir is the main source of drinking water for Beijing. However, the quality of its water is steadily declining. The main reasons for this are over-fertilization, monocultures, intensive livestock production and uncontrolled waste disposal. This is exacerbated by insufficient wastewater cleaning and excessive withdrawal of water combined with declining precipitation levels. Over the past 20 years the water level of the reservoir has fallen by about ten metres. The former lake bed is now used for intensive agriculture.

To secure the water supply of the Beijing agglomeration, integrated management of the resources in the Miyun catchment area is essential. As a first step towards reaching this goal, the project group analyzed the water and solute pathways in the catchment area, placing particular emphasis on non-point pollution sources from agricultural areas and settlements. These investigations were underpinned by the establishment of a hydrological measurement network in representative subcatchments. Important elements of the network include lysimeters, hydrological field measurement equipment and stream gauges. This multi-scale monitoring approach is used to quantify important elements of the hydrological balance in the study area. At the same time it serves to calibrate the IWAN process-based hydrological model for subcatchments. The meso-scale, web-based STOFFBILANZ GIS model is then deployed with the aim of quantifying water and solute flows in the entire Miyun catchment area. This bottom-up approach allows the research group to test different management strategies and establish the foundation for a sustainable management scheme for the Miyun reservoir.

Another key aim of the project was to determine and evaluate the wastewater treatment situation in rural areas. In addition, the project group undertook the task of devising concepts for and finding practical ways of reducing nutrient input into the reservoir from settlements.

Fig. 18: Installation of the rotating biological contactor (RBC) sewage treatment plant in Taoyuan. → Photo: Beijing Water Authority

Fig. 19: New compost toilet in Huangyukou – rear view with drying chambers after construction. → Photo: Beijing Water Authority

MAIN RESULTS

After the monitoring system had been fully installed, evaluation of data series covering more than one year in some cases, depending on location and purpose, could be commenced. The lysimeters have been generating continuous high-quality data since the end of April 2011. All other measurement systems that have been installed now work reliably as well.

The lysimeters revealed that seepage water is present, leading to a degree of groundwater recharge that had not been anticipated in the area. The seepage water carries a heavy load of nitrogen and phosphorus, so there is an acute risk of nutrient transport into the Miyun reservoir via a subterranean (groundwater) pathway.

It was found that individual rainfall events in the study area give rise to quite marked hydrological responses. For example, heavy rainfall amounting to 140 mm within four hours on 24 July 2011 led to a marked increase in surface runoff and, as a result, soil erosion and the transfer of substances into surface waters. At the same time, the lysimeters recorded a significant increase in the amount of seepage water. It could be observed that just a few rainfall events were responsible for most of the pollutant transport into the reservoir. The measurement data were used to calibrate the WaSIM-ETH water balance model, which is a component of the IWAN model.

The monitoring results confirm the need to model the episodic character of the rainfall pattern and the processes which this sets into motion with a high degree of resolution on a meso-scale (STOFFBILANZ model) in order to identify critical source areas, transport pathways and loads reliably. Therefore simulations of the water balance (FAO-ETc, curve number) and of soil erosion (USLE-M) on a 24-hour basis were carried out. The calibration of the processes is carried out in the study areas. A good level of correlation could be observed between the evaporation and flow data from the lysimeters and the computed data obtained using the FAO-ETc approach. Further modelling was also carried out for the Sheyuchuan study area, which serves as a link between process-based modelling and meso-scale balance modelling. The areas of the former lake bed that are now dry and used for intensive agriculture have been identified as critical source areas for nitrogen, sediment and phosphorus input into the reservoir. The models indicate particularly high rates of surface runoff and erosion on gently sloping, well connected areas.

IMPLEMENTATION

Even though wastewater from Chinese mega-cities is largely treated in modern, fully biological sewage treatment plants, the situation in rural areas is dismal. Following a survey of the current situation, two different ways of reducing nutrient input were proposed and pilot plants established to illustrate them.

A rotating biological contactor (RBC) plant manufactured by the company IBB Umwelttechnik Barth was installed at the outflow of a public toilet in the Taoyuan waterfall recreation area. Prior to that, the sewage was treated mechanically in a pit and subsequently disposed of by allowing it to infiltrate into the soil. The RBC plant is intended to demonstrate the effectiveness of small biological treatment plants and also as a training facility. It is technically relatively simple, stable in its operation and designed for regions with quite large temperature ranges and with variable loads of pollutant in the wastewater.

Secondly, a pilot toilet facility based on the ecological sanitation (ECOSAN) principle was erected on the car park of a museum (with restaurant) near the agricultural village of Huangyukou, northwest of the Miyun reservoir. The main feature of this type of toilet is the fact that it functions as part of a closed nutrient cycle. Urine and faeces produced in the toilet are separated and removed without flushing with water. Urine is collected in storage tanks and the faeces in drying chambers below the toilets. After 6 months of storage the urine can be used as a macro-nutrient agricultural fertilizer. After 18 months to 2 years of decomposition, the faeces can be spread over the fields as an agent to improve the soil fertility. The water used for washing hands after toilet use seeps vertically through a soil filter. For thinly populated rural areas not connected to a municipal sewage system, this sanitation concept represents a comparatively odourless, economical and ecological solution.

↗ MAP OF THE PROJECT REGION

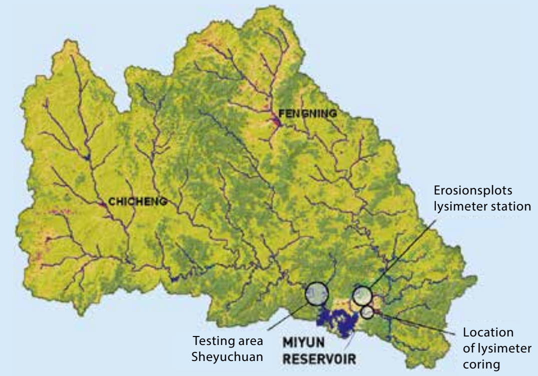

Fig. 20: The Miyun Reservoir northeast of Beijing.
→ Source: M. Gebel, GALF

↗ INFORMATION ABOUT THE PROJECT REGION

- Location: District of Miyun (Beijing) as well as parts of Hebei Province, outlet of the catchment area approx. 100 km northeast of the centre of Beijing
- Catchment area size: approx. 16,000 km^2
- Characteristics: negative climatic water balance, many temporary flood channels, luvisols, cambisols and fluvisols (arable lands) or regosols (mountainous areas), altitudes from 100 – 2000 m
- Population: approx. 660,000
- Climate: temperate continental climate with dry-cold winters and humid-warm summers; annual mean temperatures 6 – 11 °C; precipitation 500 – 600 mm, of which over 80 % in the rainy season (June – August)
- Land and water usage: approx. 10 % of the catchment area is arable land, mainly maize as monoculture, terraced crops in combination with fruit or chestnut plantations, maize on slopes, natural vegetation in mountainous areas, Miyun Reservoir for drinking water, aquaculture in smaller rivers

↗ PROJECT PARTNERS IN GERMANY

- Helmholtz Centre for Environmental Research – UFZ, Department of Soil Physics
- Rostock University, Institute of Environmental Engineering (UIW)
- Society for Applied Landscape Research (GALF)

↗ PROJECT PARTNERS IN CHINA

- Beijing Water Authority (BWA)
- Beijing Soil and Water Conservation Center
- Beijing Capital Normal University (CNU)

IWRM joint project, China – sustainable water resources management in the coastal area of Shandong Province

Fig. 21: Land usage in the project area as a major water balance factor. → Photo: J. Hirschfeld

↗ PROJECT DURATION

06/2008–12/2011

↗ GEOGRAPHIC LOCATION

Shandong Province, China

↗ CONTACT

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BACKGROUND AND OBJECTIVES

The Huangshuihe river basin represents a paramount example for water conflicts arising from demands from a rapidly growing population, industry and agriculture combined with piecemeal water management measures. This situation can only be resolved through integrated water resources management (IWRM). Over-exploitation of water resources has resulted in the intrusion of salt water into the groundwater. Water shortage hampers the development of industry and agriculture as the population's main sources of income. In addition, pollution levels impair the ecological situation and lower people's quality of living.

In this joint German-Chinese project, traditional German expertise in water resources management along with new developments especially relating to the EU Water Framework Directive were linked up with research activities in the coastal region of Shandong Province. The overall aim of the project measures is to bring about a fundamental improvement in the water resources situation.

MAIN RESULTS

In the planning phase, a methodological approach and a decision support system (DSS) were established for planning sustainable IWRM measures. These tools also allow for the selection of cost-effective measures and provide support for political decision-making processes. The system contains a catalogue of all existing and potential measures for sustainable water management. The data basis was provided through a survey of the water usage situation leading to estimation of the water balance and formulation of socio-economic decision criteria. The scientists drafted concepts and pilot plants for saving and recycling water in households, in industry and in agriculture, as well as for dealing with the saltwater intrusion. Current Chinese standards as well as the existing monitoring system were scrutinized and suggestions for improving the latter were put forward. In the implementation phase, the concept was elaborated, pilot facilities were established and stations were installed to monitor groundwater levels, groundwater quality and the discharge situation.

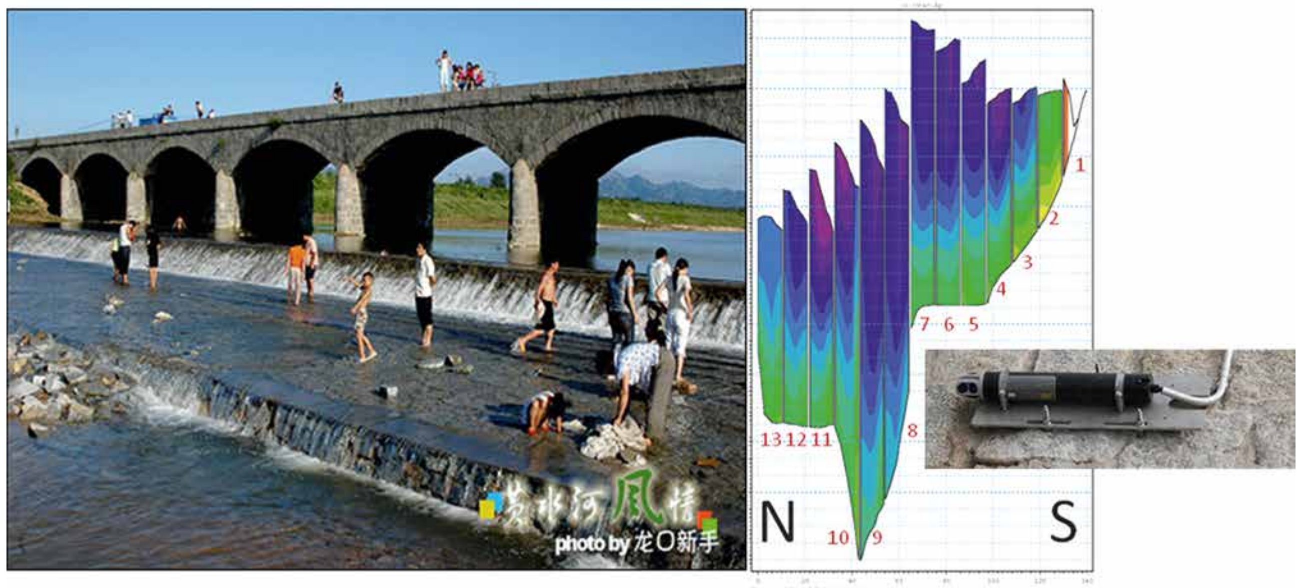

Fig. 22: Prior to the installation of the flow measurement system, the flow conditions were simulated at this bridge using MIKE3. → Source: http://image.baidu.com, DHI-WASY GmbH

IMPLEMENTATION

The project results have been implemented on scientific, technical and economic levels. It was the first time that the complete range of water usages had been considered together. In order to secure up-to-date and integrative water management standards, socio-economic analysis methods (such as an extended cost-effect analysis) were also demonstrated, discussed and applied in practice.

The Chinese partners assessed the catalogue of measures as a basis for the DSS with respect to its acceptance potential for the affected inhabitants. The aim was to pare down the large number of possible combinations to include only realistic and acceptable variants. Then, with the aid of the DSS it was possible to plan measures while varying the weighting placed on individual criteria. In addition to this, the scientists developed a complete groundwater and surface water model as well as a detailed interactive irrigation balance. Results obtained from this also contributed to suggestions for improved environmental monitoring. The essential economic advantages of the DSS consist in its use for identifying anticipated effects, cost-effectiveness and acceptance levels. For instance, the water efficiency achieved in a pilot project for grape production could be improved. On the technical level, innovative technology to monitor groundwater levels and quality were developed in Germany and installed on site. Specific knowledge pertaining to groundwater replenishment, rainwater utilization, the re-use of purified wastewater in wheat cultivation and alternatives for cleaner and more efficient production of pulp and paper was generated and disseminated by means of pilot projects. Altogether, the Chinese IWRM project achieved more than simply helping to establish a climate of holistic, strategic thinking and planning amongst local authorities and experts. It also presented them with economically efficient and socially responsible combinations of measures. Moreover, the results of the joint project are restricted neither to the region nor to the project lifetime. Not only individual components such as the catalogue of measures or the interactive water balance tool can be used again and elsewhere, but so can the completed models – not unimportant in view of the predicted demographic and climatic changes to come. Thus the whole process can, in principle, be transferred to other regions and

↗ MAP OF THE PROJECT REGION

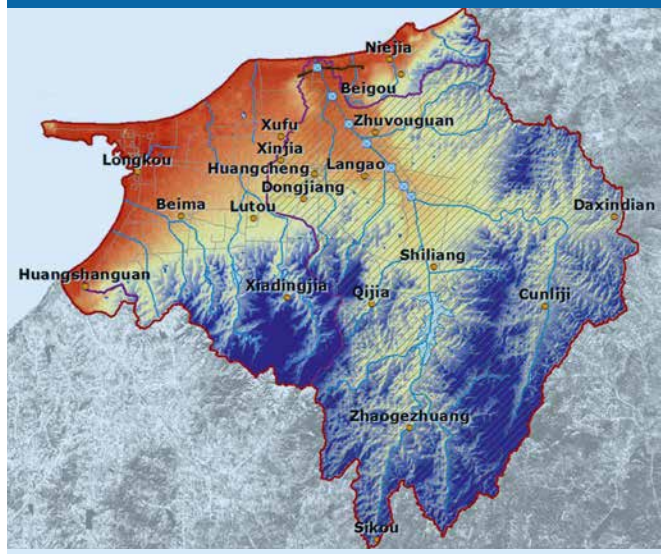

Fig. 23: Project region in the Huangshui catchment area, Shandong Province. → Source: DHI-WASY GmbH

scales. All that needs to be done is to gather the necessary data and analyze the local institutional framework conditions. The equipment for monitoring water quality (saltwater intrusion), groundwater levels and discharge volumes, as well as the pilot water saving facilities are to remain in use.

The German partners also gained valuable scientific contacts which can be used in future projects. Conversely, presentations and demonstrations for Chinese partners in Germany attracted a great deal of interest and prompted many inquiries. New contacts and the intensification of existing contacts in China for partner companies helped to disseminate information on proprietary software. The scope of the environmental device technology business sector was broadened. In conclusion, it has proved possible to lay a solid foundation for the future planning of water management measures.

↗ INFORMATION ABOUT THE PROJECT REGION

- Location: catchment area of the Huangshuihe (1,034 km^2) in the northwestern part of the peninsula and Shandong Province
- Coastline: 64 km
- The Huangshuihe flows through the district of Longkou (longest river: 55.43 km in length)
- Population: 620,000
- Climate: warm, semi-humid monsoon climate with four distinctive seasons and a marked rainy period from July to September.
- The flow directions of both the groundwater and surface waters are predominantly from the hilly regions in the south and east to the coastal region in the northwest.
- Most of the water flowing from the catchment area is used in industry and agriculture as well as for drinking water for humans and animals. The remainder flows into Bohai Bay.
- Water consumption: 2005–2007 approx 156 million m^3/year (irrigation 73 %, domestic 10 %, industry 16 %, environment 1 %)

↗ PROJECT PARTNERS IN GERMANY

- Institute for Ecological Economy Research (IÖW), Berlin
- DHI-WASY GmbH, Berlin; as subcontractor: UGT (Environmental Equipment Technology), Muencheberg
- Ruhr-University of Bochum, Chair of Hydrology, Water Management and Environmental Engineering, Bochum
- Schlegel Consulting Engineers GmbH & Co. KG, Munich and Prof. W. F. Geiger, UNESCO Chair in Sustainable Water Management, Beijing/Munich

↗ PROJECT PARTNERS IN CHINA

- Shandong University (SDU), Institute for Hydrology and Water Resources, Jinan
- Shandong Agricultural University (SDAU), School of Water and Civil Engineering, Taian
- Shandong Water Conservancy Research Institute (WCRI), Section of Water Resources Research, Jinan
- Longkou Water Authority (LKWA), Longkou
- Shandong Construction University (SDJU), Jinan

Integrated Water Resources Management in Gunung Kidul, Java, Indonesia

Fig. 24: Dried-out surface waters (Telaga) during the dry season (May – October). → Photo: JLU/IWRM Indonesia

↗ PROJECT DURATION

06/2008 – 08/2013

↗ GEOGRAPHIC LOCATION

Gunung Kidul District, Indonesia

↗ CONTACT

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BACKGROUND AND OBJECTIVES

More than 25 % of the world's population lives on carbonate rock and/or depends on karst aquifers as their source of water. Due to the high infiltration rates and the fact that surface storage is difficult or impossible, karst areas are very often characterized by a severe shortage of water. At the same time, there are large underground water resources, but these are difficult to access and can only be exploited at high cost. Also, the water is vulnerable to contamination due to the low filtration capacity of carbonate rock. The karst region of Gunung Sewu is subject to all the problems mentioned above. 1,400 square kilometres in size, it is situated in the District of Gunung Kidul, Yogyakarta Special Province, on the south coast of the island of Java.

The Indonesian government has undertaken great efforts in recent decades to exploit the underground water resources – so far without lasting success. In order to improve the living conditions for the inhabitants, a German-Indonesian network of scientific institutions is working on the development of innovative technologies and management strategies. By implementing them together with German and Indonesian industrial partners and public authorities in pilot schemes, comprehensive transfer of knowledge can be achieved. Particular consideration has been given to the hydrological, ecological, socio-economic and socio-cultural boundary conditions pertaining to the project region.

MAIN RESULTS

Comprehensive knowledge of the local natural conditions is an important prerequisite for the development of appropriate technologies and IWRM strategies. In view of the sparse data available at the beginning of the IWRM Indonesia project, the project group first carried out numerous studies to assess the specific requirements and boundary conditions. These investigations involved, amongst others, hydrological examination by means of palaeoclimatological, speleothematic and geophysical methods as well as tracer studies. As a result, the group has been able to develop concepts and technologies adapted to local conditions, such as water-powered pumping systems for using the water in karst caves and integration of a simultaneous real-time data processing model to optimize the water distribution system. In addition,

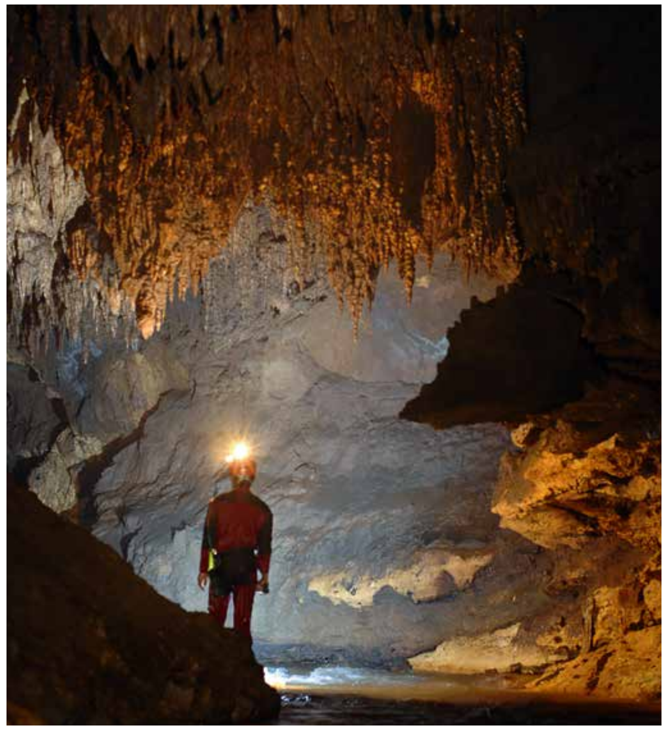

Fig. 25: Underground river and cave systems with continuous water yield. ➔ Photo: ASC-KIT/IWRM Indonesia

Fig. 26: Data collection as basis for simulation studies regarding the optimization of the water distribution network and its structural implementation. ➔ Photo: KIT/IWRM Indonesia

water and wastewater treatment technologies suited to tropical (karst) regions and various concrete-mixing recipes for optimizing the maintenance of concrete structures have been developed. The group devised the concrete mixtures in such a way that locally available raw materials can be used. All the results have been collected in a web-based geographic information system (GIS) and will be handed over to the Indonesian partners at the end of the project.

IMPLEMENTATION

The implementation of the technologies was accompanied by assessment methods such as Life Cycle Assessment (LCA: 'ecological balance sheet'), Life Cycle Costing (LCC) as well as Social Life Cycle Assessment (SLCA). During the entire project phase, local communities as well as the relevant public authorities (e.g. agencies and universities) have been involved. The project has enabled comprehensive knowledge transfer to take place through workshops, awareness raising campaigns and bilingual manuals and posters. Numerous developments have been made and tested within IWRM Indonesia that can be transferred to other regions throughout the world.

In recent years, German and Indonesian partners have constructed, amongst other things, a water supply plant that has been operated continuously since mid 2011 by the Indonesian operators. According to a survey conducted by the Justus Liebig University Giessen, this meant that, for the first time, water was continuously available during a dry period. As a means of disseminating the technical know-how surrounding various water supply technologies, a second plant has been constructed as a demonstration object at the University of Gadjah Mada in Yogyakarta since September 2012. As part of the catalogue of capacity development measures, this plant is to be used as a 'field laboratory' by project partners, local companies and students in future.

Also, initial measures for restoring and optimizing the existing piping system were carried out as part of the project in early 2012. The group installed a monitoring system that continuously registers the current operating conditions. Further measures are under way, including the integration of the underground hydro-power plant mentioned above into the optimized distribution network and the installation of new pipe networks. As early as 2011, a pilot plant for wastewater treatment in urban areas was installed at the hospital in Wonosari, Gunung Kidul. The plant processes the hospital's wastewater for disposal in an ecologically and hygienically appropriate way. At the end of 2012, a second plant was constructed that not only treats the wastewater, but also produces gas and electricity for domestic use in a rural environment. Also, water treatment concepts suited to centralized (slow sand filtration), semi-centralized (hygienization) as well as local (ceramic filtering) applications have been developed and implemented. In parallel, restoration work on water cisterns was carried out in cooperation with the local population. This involved use of the newly developed recipes for the materials. The capacity development measures that always accompany the newly implemented technologies, concepts and strategies are crucial for their successful implementation. The focus is placed on public awareness and good governance. This promotes a generally high level of awareness for the problems involved in the project area at all social levels.

↗ MAP OF THE PROJECT REGION

Fig. 27: Location of the Gunung Sewu karst area on the island of Java, Indonesia. ➔ Source: JLU/IWRM Indonesia

↗ INFORMATION ABOUT THE PROJECT REGION

- Location: Gunung Sewu karst region, Gunung Kidul, Yogyakarta Special Province, island of Java, Indonesia
- Catchment area size: approx. 1,400 km^2
- Characteristics of the catchment area: cone karst area; underground highly vulnerable to contamination, no natural surface run-off or rainwater storage potential due to highly karstified underground, interconnected underground caves with river systems, acute water shortages for local population during the dry season because of the lack of surface water

↗ INFORMATION ABOUT THE PROJECT REGION

- To date no successful, sustainable exploitation of underground water resources on the part of the government
- Lack of holistic water resources management regarding water extraction, water distribution, quality monitoring/assurance, wastewater treatment and protection of water resources
- Population: approx. 250,000
- Climate: tropical, winter monsoon
- Main land and water usage: agriculture, livestock farming

↗ PROJECT PARTNERS IN GERMANY

- Karlsruhe Institute of Technology (KIT)
- Justus Liebig University, Giessen (JLU), Department of Geography (IfG)
- Water Technology Center (TZW)
- KSB AG, Frankenthal
- IDS GmbH, Ettlingen
- COS Systemhaus OHG, Ettlingen
- Geotechnisches Ingenieurbüro Prof. Fecker und Partner (GIF) GmbH, Ettlingen
- CIP Chemisches Institut Pforzheim GmbH
- HUBER SE, Berching

↗ PROJECT PARTNERS IN INDONESIA

- Ministry of Public Works (DPU)
- State Ministry of Research and Technology (RISTEK)
- Education Ministry (DIKNAS)
- National Planning Authority (BAPPENAS)
- Yogyakarta Special Province State Government (Pemda DIY)
- Kapubaten Gunung Kidul State Government (Pemkab GK)
- National Atomic Energy Authority (BATAN)
- Universitas Gadjah Mada, Yogyakarta (UGM)
- Universitas Sebelas Maret, Solo (UNS)
- Universitas Islam Indonesia, Yogyakarta (UII)
- Institut Teknologi Sepuluh November, Surabaya (ITS)
- Universitas Pendidikan Nasional, Yogyakarta (UPN)
- Acintyacunyata Speleological Club (ASC)

Integrated Water Resources Management in Central Asia: Model region Mongolia (MoMo)

↗ PROJECT DURATION

08/2006–12/2013

↗ GEOGRAPHIC LOCATION

Kharaa catchment area, Mongolia

↗ CONTACT

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→ **www.iwrm-momo.de**

Fig. 28: Winter conditions in the investigation area: Most rivers are frozen over from November until April. → Photo: D. Karthe, UFZ

BACKGROUND AND OBJECTIVES

The Kharaa river basin is representative of large parts of Central Asia with respect to the many challenges facing water resources management. The highly continental climate limits the availability of water, while mining activities, intensive animal husbandry and irrigation create a large water demand. Also, the transformation process from a socialist system towards democracy and a free-market economy led to the neglect of water infrastructures. To this day, even cities are only partly connected to central water supply, sewage and waste water treatment. A considerable proportion of the water supplied is lost due to leakage. In the periurban ger (yurt) settlements, wastewater is frequently discharged into surface water bodies or seeps into the ground without prior treatment.

From the administrative point of view, responsibility for water resources management is shared between a number of institutions including the National Water Committee, the National Water Authority (that is currently being restructured) and newly established river basin councils. However, the tasks and competences of these institutions are not always clearly defined and tend to overlap. At the same time, there is a lack of qualified staff. In order to provide for a sustainable improvement of this situation, a joint German-Mongolian project has been established to develop an integrative management concept and implement selected pilot measures.

MAIN RESULTS

For the Kharaa river basin, the available surface and groundwater resources in the catchment area were quantified more precisely than before. Scenario forecasts to identify trends in climate, land cover and water usage were developed. These indicate that a significant increase in water consumption is to be expected due to irrigation and the expansion of mining activities, higher temperatures and forest cover losses, which could result in declining surface and groundwater generation. Significant pollutants and their sources have been identified by means of physico-chemical analyses, supported by the investigation of a number of bioindicators. This allowed for the first comprehensive assessment of the state of the aquatic ecosystems of the Kharaa and its tributaries.

Nutrient input was found to be connected to erosion processes and sewage treatment plants. The historical and current use of mercury and cyanides in gold mines gives rise to additional contamination risks. Elevated levels of arsenic were discovered in surface water and drinking water samples, underlining the need for effective monitoring and risk management. The scientific findings obtained in the project now form the basis for the development of a river basin management plan.

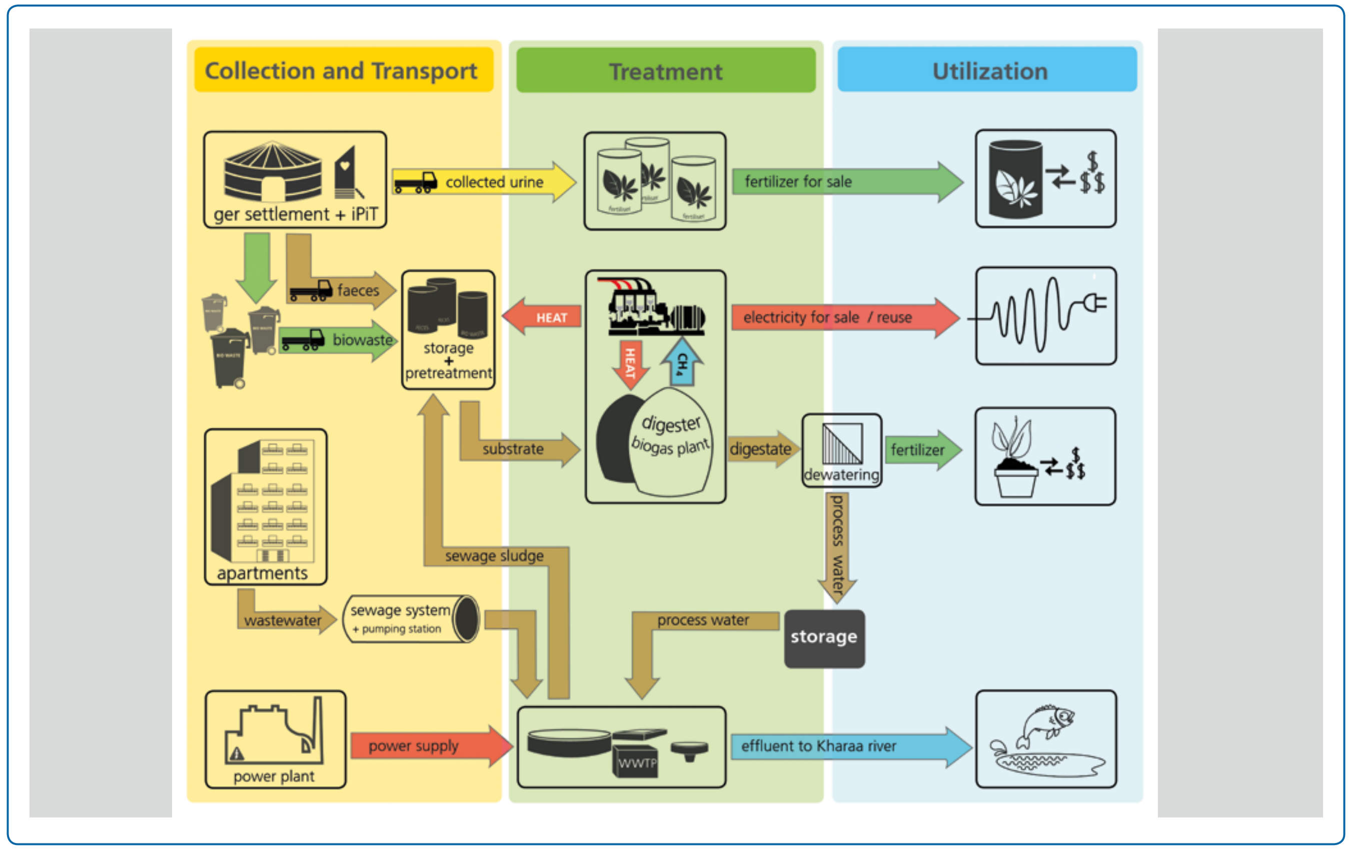

Fig. 29: Integrated concept for the disposal and reuse of municipal wastewater and faeces from ger settlements → Source: Bauhaus-Universität Weimar

IMPLEMENTATION

The implementation of an Integrated Water Resources Management for the Kharaa river basin is currently based on three main pillars: a comprehensive monitoring concept, technical pilot measures and multi-level capacity development.

In order to monitor the water quality of the Kharaa river in real time, three monitoring stations were set up along its course. The quality data are made available via an online database. This allows both for the detection of sudden changes in water quality as well as the registration of long-term trends. As part of the project, scientists from the National University, the Mongolian Academy of Sciences and representatives of environmental authorities and associations are being trained in the operation and maintenance of the stations and in the interpretation of the data. Technical innovations are focussed mainly on urban water management. An innovative leak detection method was apllied to reduce the high losses in Darkhan's municipal supply network. Moreover, three pilot wastewater treatment plants have been operating since mid 2011. The experience gained so far shows that both an SBR reactor as well as a small sewage plant equipped with special biofilm carriers are robust and reliable solutions for the extreme climatic conditions encountered in the region. An experimental wastewater treatment plant with integrated wood production was constructed on the premises of the Technical University of Darkhan and is used for both research and educational purposes. The ger settlements of Darkhan were supplied with a dry toilet system providing considerable hygienic advantages. It is integrated into a holistic system for recycling the collected faeces.

Even though the pilot operation and its evaluation are still in progress, they have already attracted considerable interest at national, regional and local levels including plans to duplicate these solutions.

↗ MAP OF THE PROJECT REGION

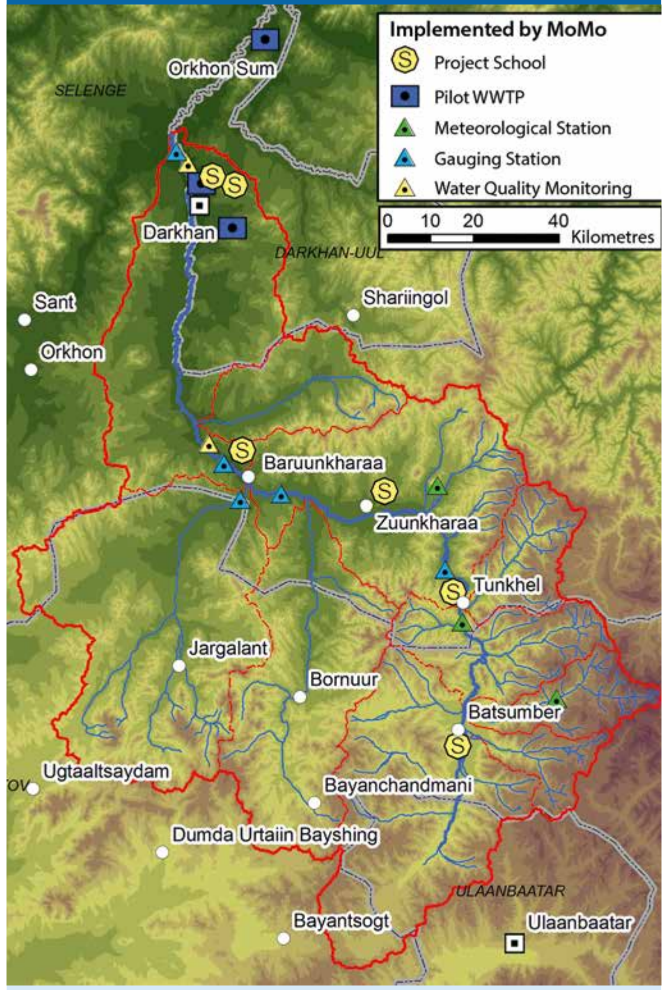

Fig. 30: The Kharaa catchment area with the locations of the implementation measures → Source: IWRM MoMo project

↗ INFORMATION ABOUT THE PROJECT REGION

- Location: eastern Central Asia
- Catchment area size: approx. 15,000 km²
- Catchment area characteristics: forested, mountainous terrain (taiga) with relatively high runoff generation in the upstream section; in the mid and downstream sections predominantly steppe and more intensive anthropogenic use; heterogeneous settlement structures (nomadic to urban); mining and agriculture of major economic significance
- Population: approx. 147,000
- Climate: highly continental climate, resulting in limited water availability and very cold winters
- Main land and water usage: forestry, animal husbandry, irrigated agriculture, mining, urban settlements in the mid and downstream sections

↗ PROJECT PARTNERS IN GERMANY

- Helmholtz Centre for Environmental Research – UFZ
- Fraunhofer Advanced System Technology Centre (FhAST)
- Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin
- German Development Institute (DIE)
- University of Kassel, Center for Environmental Systems Research (CESR)
- University of Heidelberg, Chair of Physical Geography
- Department of Urban Water Management and Sanitation, Bauhaus-Universität Weimar (BUW)
- TU Ilmenau
- Training and Demonstration Centre for Decentralized Sewage Treatment (BDZ)
- Bergmann Clean Abwassertechnik GmbH (BCAT)
- Passavant-Roediger GmbH
- p2m berlin GmbH
- seeconsult Germany GmbH
- geoflux GmbH
- Dr.-Ing. Pecher und Partner Ingenieurgesellschaft mbH

↗ PROJECT PARTNERS IN MONGOLIA

- National University of Mongolia (NUM) including the Environmental Education Centre
- Mongolian University for Science and Technology (MUST)
- Agricultural University of Darkhan (AUD)
- Mongolian Academy of Science (MAS); Institute for Meteorology and Hydrology (IMH), Tsegmid Institute for Geography
- Mongolian Ministry for Education, Culture and Science (MECS)
- Mongolian Ministry for Nature, Environment and Tourism (MNET)
- Mongolian Ministry for Roads, Transport, Construction and Urban Development (MRTCUD)
- Mongolian Ministry of Finance (MoF)
- National Mongolian Water Authority (WA)
- National Water Committee (NWC)
- Darkhan-uul Aimag Province
- Darkhan Sum and Orkhon Sum District Authorities
- Darkhan Communal Water Supply Organization (USAG)
- Undurkash Ltd.
- Kharaa River Basin Council

Economic and ecological restructuring of land and water usage in the Khorezm region of Uzbekistan – A pilot project in development research

Fig. 31: Uzbekistan is undergoing a process of social and economic transformation. → Photo: ZEF, Bonn

↗ PROJECT DURATION

11/2001 – 12/2011

↗ GEOGRAPHIC LOCATION

Khorezm Province in northwestern Uzbekistan

↗ CONTACT

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BACKGROUND AND OBJECTIVES

Making a contribution to sustainable development of the Aral Sea region by means of research and capacity building – these were the main aims of a ten-year research programme conducted by the Center for Development Research (ZEF) of the University of Bonn. The initiative was carried out with the support of UNESCO and many other partners. Around 100 international researchers from the natural, social and economic sciences conducted interdisciplinary, implementation-oriented research between 2001 and 2011. The research centre was located in the province of Khorezm, in northwest Uzbekistan, about 250 kilometres from the present-day shores of the Aral Sea. For centuries, agriculture has provided the most important economic basis in Khorezm and for the livelihoods of most of its population. Uzbekistan has a continental, arid climate, making irrigation a necessity for agricultural production. This applies to the region of Khorezm, and an area of around 265,000 ha is furnished with an irrigation and drainage infrastructure. However, it is old and inefficient. This leads to poor productivity regarding the water-based and land resources.

The governance system in Uzbekistan is state-centric, and cotton and wheat production are subject to a state-imposed quota system. Despite large-scale agricultural activities, unemployment and poverty rates are high.

Under soviet control, the irrigation areas in Uzbekistan were almost doubled, which has contributed to the present ecological and economic problems in the region. The difficulties have continued to intensify as a result of the economic transformation process following Uzbekistan's independence in 1991. The overall aim of the ZEF-led project was to devise sustainable development options for land and water use in Khorezm. Also, land degradation was to be combated, greenhouse gas emissions mitigated and rural incomes increased. The scheme was designed as a pilot project whose research results could be transferred for use in other regions of central Asia.

It was clear that only an interdisciplinary approach could analyze the multi-layered problems in the region and then formulate solutions. Further trans-disciplinary research was carried out regarding:

Fig. 32: Members of a water users association discuss irrigation channels. ➔ Photo: B. Ismailova

1) the inclusion of local stakeholders at an early stage,
2) the local performance of technical, economic and institutional analyses at various levels (e. g. field, farm, water users associations and farmer's cooperatives, regional government)
3) testing of project innovations according to the follow-the-innovation (FTI) method, together with local decision makers; continued development in line with local practice

MAIN RESULTS

Firstly, the scientists investigated the reasons why the irrigation and drainage systems functioned so badly. Simulations in irrigations models led to improvements in water management (e. g. water distribution plans). New, high-resolutioin satellite images (RapidEye) of the Khorezm region provided details of the land use, so that crop yields could be estimated as well. The interdisciplinary research team also searched out the technical, economic and institutional weak points in the water management system, and issued recommendations for several levels: The scientists strengthened the role of local water consumer organizations and improved internal decision-making processes. This gave the users a greater sense of responsibility. In addition to this, they developed technologies aiming towards more economical use of water and economic incentive systems for the consumers.

In order to enhance the way soil and land resources are used, one of the project aims was to increase the diversity and sustainability of the cultivation systems. The researchers optimized fertilizer management for the state-required crops such as cotton and wheat, as a result of which the loss of nitrogenous fertilizers through volatilization and leaching decreased. These procedures help the environment, increase farmers' income, and conserve natural resources. The team also experimented with alternative forms of land use with the aim of using resources more efficiently. Through mixed-tree plantations on salt-affected cropland, the ecosystematic performance could be improved (e. g. using leaves from trees as cattle fodder and fruit as food). Planting trees on marginal areas produced direct economic benefits for the farmers (e. g. through wood and fruit production) without infringing on the regional production from arable land.

Measures to develop a laser-guided land leveller for irrigated areas were very successful. The methods have now been taken up by local farmers.

Economists simulated the effects of changes in cotton policy by studying the value chains and water footprints of various crops and adapted them to local conditions. They found out that the region can increase its earnings by producing and processing cotton-based products instead of exporting the raw material. This saves water and benefits the environment.

IMPLEMENTATION

In addition to the scientific results, the success of the project can also be seen at both individual and institutional levels in terms of capacity building. As decision-makers and communicators, more than 50 PhD students and 120 MSc students will be able to disseminate the insights gained. The research results have been passed on in the form of scientific articles, books, chapters of books and impulse papers and at conferences and expert meetings. A UNESCO chair has been established at the State University of Urgench.

A decade of research and education in Khorezm has demonstrated that sustained, interdisciplinary efforts bear ample fruit – when the results are disseminated and implemented on a large scale. Further activities will therefore focus on strengthening the individual and institutional capacities of those local partners who have taken on responsibility for the research and implementation processes. A number of the innovations are to be adopted into national agricultural policies. However, the final success of the project will depend on the establishment of the required legislative and institutional framework. Only when this has been achieved can sustainable development to the benefit of man and nature be possible in the Aral Sea region.

↗ MAP OF THE PROJECT REGION

Fig. 33: Province of Khorezm, Uzbekistan, in the catchment area of the Aral Sea. ➔ Source: ZEF, Bonn

↗ INFORMATION ABOUT THE PROJECT REGION

- Location: northwest Uzbekistan on the lower reaches of the Amu Darya, the largest river feeding the Aral Sea
- Catchment area size: 0.7 million ha
- Characteristics of the catchment area: agriculture is the most important economic sector; cotton and wheat are the most important agricultural commodities
- Population: 1.564 million
- Arid climate
- Irrigated agricultural area: 0.265 million ha

↗ PROJECT PARTNERS IN GERMANY

- Center for Development Research (ZEF), University of Bonn
- German Aerospace Centre (DLR)/Remote Sensing Data Center (DFD), Oberpfaffenhofen, in cooperation with the remote sensing unit at the University of Würzburg

↗ PROJECT PARTNERS IN UZBEKISTAN

- Ministry of Agriculture and Water Resources (MAWR)
- State University of Urgench (UrDu)
- Tashkent Institute for Irrigation and Mechanization (TIIM)
- Interstate Commission for Water Coordination (ICWC)
- Central Asia Scientific Research Institute of Irrigation (SANIIRI)
- United Nations Educational, Scientific and Cultural Organization (UNESCO)
- International Center for Agricultural Research in Dry Areas (ICARDA), Syria
- International Maize and Wheat Improvement Center (CIMMYT), Mexico

AKIZ joint research project – Integrated wastewater concept for industrial zones illustrated for the Tra Noc Industrial Zone, Vietnam

Fig. 34: Life next to and on the water – floating markets in Can Tho.
→ Photo: IEEM, Witten

↗ **PROJECT DURATION**

11/2009 – 04/2014

↗ **GEOGRAPHIC LOCATION**

Industrial Zone of Tra Noc, Can Tho City, Vietnam

↗ **CONTACT**

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Fig. 35: The industrial zone Tra Noc in Can Tho. → Photo: IEEM, Witten

Fig. 36: Drying shrimp shells in the Tra Noc industrial zone.
→ Photo: IEEM, Witten

BACKGROUND AND OBJECTIVES

There are more than 200 registered industrial zones (IZ) in Vietnam that have no sustainable and functioning wastewater system. As a solution for this precarious situation, an integrated wastewater concept for industrial zones (AKIZ) is under development within the framework of the BMBF joint research initiative. The Tra Noc industrial zone in Can Tho serves as a model that can be applied to other zones. The project involves cooperation between German and Vietnamese universities and industrial partners on integrative concepts for centralized and decentralized technological waste water treatment, with a focus on linking up technical and financial planning.

The researchers are demonstrating near-to-source detoxification, energy recovery and recovery of valuable materials using pilot plants. This requires that existing, efficient high-tech solutions for industrial wastewater treatment be adapted to the local working conditions and a tropical climate. To this end, container-based pilot plants from German industrial partners are being applied in selected factories. A monitoring system for indirect dischargers is to provide the data needed for the technological modifications and for the administrative and financial implementation of the wastewater treatment. Economic studies to investigate why laws and options for the enforcement of current environmental standards and quality requirements (which are a basic prerequisite for the use of advanced technologies from Germany in Vietnam) fail to be implemented are to pave the way for the development of a sustainable solution for wastewater systems. All aspects are to be integrated into a comprehensive management concept for industrial zones. This will model the sustainable technical and economic operation of the wastewater system including decentralized wastewater treatment, the operation of the central sewage treatment facility, the tariff and a financing model.

In addition to this, the group is developing guidelines for integrated wastewater concepts in industrial zones that will benefit both German and Vietnamese decision makers. The final aim is to enable sustainable implementation on the part of Vietnamese partners.

MAIN RESULTS

The coordination of all project partners as well as the consolidation of results for the development of the management concept is covered by sub-project 1. Numerous capacity-building measures for the local environmental authorities and industrial zone managers as well as workshops have already been carried out. Funding concepts for wastewater infrastructures in industrial zones are being developed in cooperation with donor banks such as the KfW, ADB and the World Bank.

The aim of sub-project 2 is to identify an efficient combination of commonly used processes for detoxification of heavily contaminated industrial wastewater. To this end, various methods such as separation techniques, precipitation and flocculation, adsorption with activated carbon, filtration, biological treatment, chemical and further oxidation with H_2O_2 are being tested in a pilot plant. This allows for the assessment and optimization of the detoxification process. Together with the Gesellschaft für Internationale Zusammenarbeit (GIZ), an incinerator project has been started on the same premises.

In order to demonstrate the feasibility of an anaerobic wastewater treatment system with energy production under real-life conditions, a pilot plant has been designed and tested for a fish-processing company as part of sub-project 3. The pilot plant consists of anaerobic reactors, equipment for the collection and cleaning of the resulting biogas as well as sampling and control units. The biogas provides an energy source that is used for cooling purposes.

The container-based pilot plant of the fourth sub-project has been in operation at a brewery in Tra Noc since the beginning of 2012. The caustic bath used for bottle washing is recovered, including its washing additives, by means of membrane filtration technology. In a second phase, the pilot plant will be operated at a factory where the substances chitin and glucosamine are extracted from shrimp shells. Here, the plant will be used to treat process water resulting from the deproteinization process.

The AKIZ container laboratory of sub-project 5 has been operating in Tra Noc since 2010. Since then, many analytical methods have been developed and wastewater samples from the other sub-projects analyzed. The overview monitor-

Fig. 37: Pass-through reactor for anaerobic sewage sludge – stabilization tests. → Photo: H. Feldhaus, TU Braunschweig

ing carried out in the Tra Noc sewer system shows that the river Hau causes back pressure on it related to daily tidal fluctuations and the dry and rainy seasons. This must be taken into account for the planning of a monitoring system.

In sub-project 6, the pilot plant container has been installed. It is equipped with a batch plant for anaerobic biodegradation tests as well as a continuous flow reactor for anaerobic sewage sludge stabilization experiments, including a newly developed gas measurement process. Futhermore, sewage sludge composting, humification in reed beds, solar sludge treatment and worm composting have been studied.

IMPLEMENTATION

AKIZ is in regular contact with the GIZ and the donor banks (KfW, ADB, World Bank, JICA etc.) with a view to ensuring that the measures that it has developed are implemented in the future. Thanks to this, the project has already made a significant contribution to improving the legal situation through cooperation on the revision of 'Decree 88' that deals with wastewater disposal in urban areas and industrial parks. The common capacity development measures, such as AKIZ and the GIZ have already carried out on several previous occasions, have also helped greatly to strengthen the project participants' sense of ownership.

↗ MAP OF THE PROJECT REGION

Fig. 38: Tra Noc industrial zone in Can Tho in southern Vietnam. → Source: IEEM, Witten

↗ INFORMATION ABOUT THE PROJECT REGION

- Location: Mekong Delta in South Vietnam
- Area: approx. 300 ha, tropical climate
- Industrial zone with approx. 150 industrial firms

↗ PROJECT PARTNERS IN GERMANY

- IEEM – Institute of Environmental Engineering and Management at the University of Witten/Herdecke gGmbH
- HST Systemtechnik GmbH & Co. KG
- University of Stuttgart
- Passavant-Roediger GmbH
- Leibniz University of Hannover
- EnviroChemie GmbH
- Technische Universität Darmstadt
- LAR Process Analysers AG, Berlin
- Technische Universität Braunschweig

↗ PROJECT PARTNERS IN VIETNAM

- VNU University of Science, Hanoi (HUS)
- National Economics University (NEU)
- Southern Institute of Water Resources Research (SIWRR)
- Hanoi University of Civil Engineering (HUCE)
- Vietnamese-German University (VGU)
- Vietnam Institute of Industrial Chemistry (VIIC)
- Institute for Environment and Resources (IER) at the Vietnam National University
- Vietnamese Academy of Science and Technology (VAST)

Integrated Water Resources Management in Vietnam

Fig. 39: Irrigated vegetable fields, Can Tho. → Photo: S. Zaun

↗ PROJECT DURATION

07/2006 – 08/2011

↗ GEOGRAPHIC LOCATION

Lam Dong, Can Tho and Nam Dinh Provinces, Vietnam

↗ CONTACT

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→ www.iwrm-vietnam.vn

BACKGROUND AND OBJECTIVES

The objective of the joint 'IWRM Vietnam' project is the development of a concept for integrated consideration and analysis of water management issues (water resources, water demands, water and land use) with a view to formulate recommendations for IWRM measures. The project involves two objectives:

- Development of planning and decision support tools for IWRM at river basin level,
- Adaptation of water technology on local level (drinking water, municipal and industrial wastewater) based on exemplary individual measures.

MAIN RESULTS

A planning level concept with planning and decision support tools was developed for water resources management in the three project regions (Can Tho, Lam Dong, Nam Dinh, see Figure 41). The planning level concept contains the following five levels. The IWRM Vietnam joint project involves tasks defined in planning level 3 (river basin level) and planning level 5 (local level).

1) International level
International scientific discussion; sharing international experience; guidelines for IWRM (e. g. Global Water Partnership)
2) National level
Identification by the Vietnamese authorities of river basins with high problem intensity and a priority need for IWRM measures; legislation (e. g. National Target Program Water; technical and water quality standards; implementation of River Basin Organizations (RBOs) etc.)
3) River basin level
Identification of Water Management Units causing special concern ('hot spots') and in need of high-priority IWRM measures by means of GIS-based evaluation of spatial and statistical information
4) Water Management Unit (WMU) level
Identification of locations for IWRM measures by means of detailed investigations (e. g. field investigation of water balances, water quality, wastewater quantity etc.)

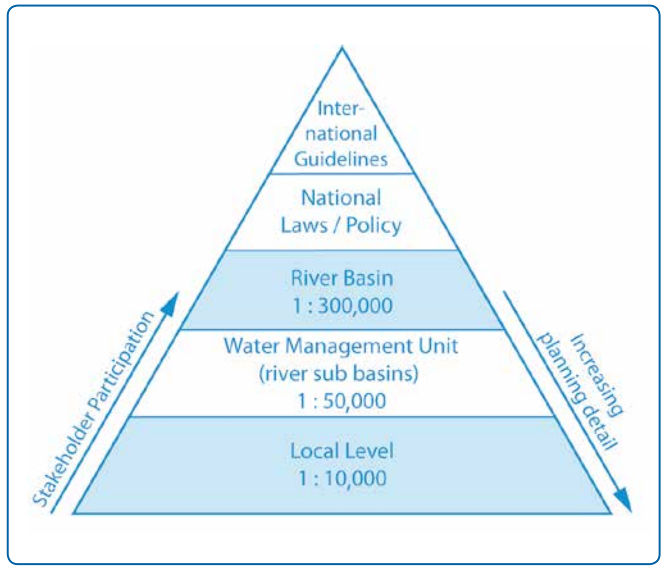

Fig. 40: IWRM planning levels (planning level 3, river basin level: planning level in IWRM Vietnam project). → Source: eE+E, Ruhr-Universität Bochum

5) Local level
   Object planning and implementation of IWRM measures (e. g. monitoring, water supply, wastewater treatment) for priority areas as identified on planning levels 3 and 4

Planning and decision support tools have been developed for the evaluation of water resources on the river basin (planning level 3). They facilitate the identification and prioritization of WMUs with increased problem intensity in terms of quantity (deficit) or quality (contamination risk). High-risk WMUs require more detailed investigations and careful selection of locations for measures.

The identification and categorization of such WMUs is carried out using three planning and decision support tools: the Water Balance Tool, the Contamination Risk Tool and the Ranking Tool.

The Water Balance Tool connects the hydrological and socio-economic information required for the water balance. The various types of demand for water and the available water resources are compared with each other at WMU level. The Water Balance Tool allows for estimation of the water balances for the individual WMUs and of the monthly or yearly water deficits and water surpluses.

The Contamination Risk Tool is used to assess the contamination risk for water resources (ground and surface water) from different contaminants. Three possible contamination paths are taken into consideration:

- Infiltration of contaminants into the groundwater
- erosive runoff and / or erosive discharge of contaminants into bodies of surface water
- direct discharge of contaminants into bodies of surface water

The Ranking Tool is used to prioritize the results from the Contamination Risk Tool and the Water Balance Tool. These rankings help to identify WMUs with increased problem intensity and increased need for action.

The results of the IWRM Vietnam joint project are explained and illustrated in the 'Method Handbook for IWRM in Vietnam on River Basin Level' and in the 'IWRM Atlas – Planning Maps and Tables'.

IMPLEMENTATION

The planning and decision support tools were developed in close cooperation with the Ministry of Natural Resources and Environment (Department of Water Resources Management, MoNRE DWRM) in Hanoi as well as with the provincial authorities of the three project regions, taking Vietnamese legal requirements into account.

Training courses have been held at national and local levels. The Vietnamese partners have already expressed the need for additional and more systematic training courses on the planning and decision support tools.

Individual local pilot measures were developed and applied in the three project areas, for example a web-based GIS for displaying the quality of surface waters (Can Tho) or the drinking water treatment and supply plant in Hoa Bac (Lam Dong Province).

The next phase is to be focussed on the largest river basin within Vietnam, the Dong Nai basin. The Dong Nai river basin includes examples of all the various water management challenges such as drinking water treatment, agricultural contamination potential, industrial wastewater discharge, saltwater intrusion in the coastal area, conflicts of interest (hydropower reservoirs, requirements for natural conservation in national parks, resources exploitation etc.).

↗ MAP OF THE PROJECT REGION

Fig. 41: Overview of the three project regions.
→ Source: eE+E, Ruhr-Universität Bochum

↗ INFORMATION ABOUT THE PROJECT REGION

Can Tho

- Location: Mekong Delta
- Size: 1,400 km²
- Characteristics of the catchment area: delta
- Population: 1,200,000
- Climate: tropical monsoon climate
- Main land and water usage: rice, aquaculture; dense canal and river network (open system, direct connection to the sea)

Methods for the detailed investigation of WMUs with higher problem intensities and therefore a greater need for IWRM measures are to be developed. Seen as a whole, this holistic concept allows for efficient and cost-effective approaches to be adopted towards initiating and implementing IWRM in a systematic way at all planning levels.

↗ INFORMATION ABOUT THE PROJECT REGION

Lam Dong

- Location: southern central highlands
- Size: 15,000 km²
- Catchment area: lowland, high plateau, hill country
- Population: 1.205 million
- Climate: tropical monsoon climate
- Main land and water usage: forestry, coffee, tea, rice (flood plains); many reservoirs along the Dong Nai river (hydro-power)

Nam Dinh

- Location: Red River Delta
- Size: 1,700 km²
- Characteristics of the catchment area: delta
- Population: 1.830 million
- Climate: subtropical monsoon climate
- Main land and water usage: rice, aquaculture, craft villages; polder management (irrigation through pumping stations and sluices)

↗ PROJECT PARTNERS IN GERMANY

- Ruhr-Universität Bochum, Environmental Engineering and Ecology (eE+E)
- University of Bonn, Institute of Crop Science & Resource Conservation (INRES)
- University of Greifswald, Institute of Geography and Geology (IGG)
- Gewitra GmbH, Bonn
- Fraunhofer Institute of Environmental, Safety and Energy Technology (Fraunhofer UMSICHT), Oberhausen
- Ingenieurbüro für Abfluss-Kläranlagen-Steuerung GmbH, Sonthofen (IAKS)
- Moskito GIS GmbH, Dortmund
- IEEM – Institute of Environmental Engineering and Management at the University of Witten/Herdecke gGmbH

↗ PROJECT PARTNERS IN VIETNAM

- Ministry of Natural Resources and Environment, Department of Water Resources Management (MONRE DWRM)
- Ministry of Science and Technology (MOST)
- Research institutes (VIWRR, VAST, SIWRR etc.)
- Departments of Natural Resources and Environment in the three project regions (DONREs)
- Departments of Science and Technology in the three project regions (DOSTs)

WISDOM – Development of a water information system for the sustainable development of the Mekong Delta, Vietnam

Fig. 42: Settlement along a canal, Can Tho.
→ Photo: WISDOM Project

↗ PROJECT DURATION

04/2007 – 02/2014

↗ GEOGRAPHIC LOCATION

Mekong Delta, Vietnam

↗ CONTACT

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→ www.wisdom.eoc.dlr.de

BACKGROUND AND OBJECTIVES

With its flat topography and exposed position towards the sea, the Mekong Delta is one of Asia's most vulnerable regions. Its inhabitants are confronted by a range of challenges, including the expected changes in climate with rising sea levels, as well as salinization of soils and aquifers and extreme meteorological events such as typhoons. Furthermore, urbanization and intensification of agricultural activities (e.g. through aquaculture) present threats to the coastal mangrove belt. The water quality is impaired by wastewater from industry and agriculture.

The aim of the WISDOM project is to develop decision support tools through interdisciplinary research, thereby fostering the development of Integrated Water Resources Management, to design adaptation methods to fit the context of climate change as well as to design strategies for the management of water resources that are suited to such a dynamic region as the Mekong Delta.

MAIN RESULTS

In the first phase of the project (2007–2010), a prototypical water and land information system was developed. The system is web-based and serves as a knowledge cluster for the Mekong Delta through the presentation of the results of various research areas. The WISDOM information system combines data from different disciplines such as hydrology, geochemistry, sociology, geography, computer modelling, information technology and remote sensing. Users are able to visualize information from a variety of sources and also to perform spatial analyses tailored to specific problems related to the Mekong Delta. This makes it very comprehensive, but it remains easy to use. It has been created as an aid towards improving regional cooperation between Vietnamese institutions by facilitating the exchange of information, expertise, and data relevant to the issue of sustainable development of water and land resources. This also includes support for IWRM-relevant planning measures in the region. The WISDOM project addresses numerous applied research questions concerning, amongst others, sustainable water management, the impact of climate change and socio-economic transformation:

Fig. 43: Flooded rice paddy → Photo: WISDOM Project

Fig. 44: Training experts and staff members of regional authorities in the use of the information system → Photo: WISDOM Project

- Understanding of annual flood patterns, as well as identification of settlements affected by the floods,
- Identification of the eco-systematic functions of coastal mangrove forests and their objective economic value,
- Modelling and understanding of potential changes in salinity in the surface waters of the Mekong in case of rising sea levels,
- Quantitative assessment of pesticide, antibiotic, and hormone levels in the water (rivers, aquaculture, drinking water),
- Assessment of the vulnerability of the rural population in the context of climate change or regulatory measures,
- In-depth understanding of planning and decision-making processes, responsibilities and interdependencies in Vietnam.

In addition, the group is conducting numerous training activities and workshops in universities and local scientific institutions. For instance, water quality experts are teaching new methods relating to water analyses. Remote sensing experts are giving instruction on the interpretation of satellite data. Social scientists are conducting numerous field studies and offering participative workshops to local and regional authorities, as well as in the communities of the focus regions. This brings together local participants and water management experts, and also it involves the local population in the discussion of water-related topics. Furthermore, WISDOM promotes various water-related methods such as the analysis of water quality using satellite data or the humification of sewage sludge in the Mekong Delta by involving small and medium-sized enterprises (SMEs).

At the end of the project, 30 Vietnamese and European doctoral candidates taking part in the WISDOM PhD programme and 8 associated stipendiaries will have graduated in water-related study fields. In addition to numerous international publications of research results, an interdisciplinary Springer WISDOM book was published.

↗ MAP OF THE PROJECT REGION

Fig. 45: Overview map of the WISDOM project region, Mekong Delta. → Source: WISDOM Project

IMPLEMENTATION

The WISDOM information system was officially handed over to the Vietnamese Ministries at the beginning of March 2013. The second WISDOM project phase (2010-2014) focuses on the nascent implementation of the information system in Vietnam. It has been facilitated through extensive training activities for Vietnamese IT experts. These experts will then conduct their own training courses on the use of the information system for local authorities in the Mekong Delta, supported by the WISDOM-CIM expert. Emphasis is also being laid on ensuring that the project results, the system and a sustainable information infrastructure are firmly established in the country. To this end, consideration is being given to setting up a separate organization for the operation of the system and updating the information content. The WISDOM information system is a flexible platform, and on the request of the Vietnamese authorities it has already been expanded to include the Red River Delta in northern Vietnam. The system can easily be adapted for use in other regions.

↗ INFORMATION ABOUT THE PROJECT REGION

- Mekong Delta: 40,000 km²; Mekong Basin: 795,000 km²
- Characteristics of the catchment area: Mekong River (4,350 km in length); riparian states China, Myanmar, Thailand, Laos, Cambodia and Vietnam
- Population: 17 million in 13 Mekong Delta provinces (of a total of 63 provinces in Vietnam)
- Climate: tropical climate with a rainy season from June to November and a dry season from December to May
- Important land and water uses: agriculture (rice, fruit, aquaculture)

↗ PROJECT PARTNERS IN GERMANY

- German Aerospace Centre (DLR)
- United Nations University – Institute for Environment and Human Security (UNU-EHS)
- University of Würzburg – Institute of Geography – Department for Remote Sensing
- Helmholtz Centre Potsdam – German Research Centre for Geosciences (GFZ)
- Centre for Development Research at the University of Bonn (ZEF)
- Earth Observation and Mapping GmbH & Co. KG (EOMAP)
- Vienna University of Technology – Institute for Photogrammetry and Remote Sensing (IPF)
- HYDROMOD Service GmbH (HYDROMOD)
- lat/lon enterprise for Spatial Information Systems GmbH (lat/lon)
- IAMARIS Institute for Advanced Marine and Limnic Studies e. V. (IAMARIS)
- Aquaplaner – Consulting engineers for sustainable water management (Aquaplaner)

↗ PROJECT PARTNERS IN VIETNAM

- Southern Institute of Water Resources Research (SIWRR)
- Can Tho University (CTU)
- GIS and Remote Sensing Research Center of the Vietnamese Academy of Science and Technology (VAST/GIRS)
- Geomatics Center of the Vietnamese National University (VNU-ITP)
- Southern Region Hydro-Meteorological Center (SRHMC)
- Southern Institute of Sustainable Development (SISD)
- Sub-National Institute for Agricultural Planning and Projection (Sub-NIAPP)
- Institute for Tropical Biology (ITB)

Helmholtz Dead Sea SUMAR: Sustainable management of water resources (quantity and quality) in the Dead Sea region

Fig. 46: Sinkholes along the Dead Sea shoreline due to groundwater dissolution of salts in the sediments. → Photo: A. Künzelmann, UFZ

↗ PROJECT DURATION

02/2007 – 09/2012

↗ GEOGRAPHIC LOCATION

Middle East, Israel, Jordan, Palestine, Dead Sea, immediate catchment area of the Dead Sea

↗ CONTACT

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→ www.ufz.de/index.php?de=30037

BACKGROUND AND OBJECTIVES

The Dead Sea is shrinking. Over the last two decades the water level has fallen by an average of 1.10 m/year, because less fresh water flows into it than evaporates. This scarcity must be counteracted by new, sustainable methods in water resources management. These must take account of major seasonal fluctuations in precipitation, including years of drought, high population growth rates and at the same time a rising standard of living. Therefore an interdisciplinary joint project including participants from all the riparian states has set itself the aim of developing a new and sustainable management concept for the Dead Sea region.

MAIN RESULTS

The basis for sustainable management concepts is provided by long-term data series and real-time modelling of natural water resources (surface runoff, groundwater runoff, evaporation) in the catchment area of the Dead Sea. As part of the SUMAR project, mass balances have been estimated to obtain both a quantitative as well as a qualitative overview of all the underground and surface flows. New methods have been developed for accurate registration of the sudden, short-term inflows from wadis (flash floods) resulting from local rainfall events. Also, the scientists were able, for the first time ever, to quantify subterranean groundwater inflows.

The continuously flowing rivers of the region (the Lower Jordan and Zarqa rivers) currently still provide the biggest contribution to the water balance of the Dead Sea. However, these quantities are decreasing. A gauging station on the Lower Jordan River has been installed as part of the SUMAR project, allowing the registration of accurate flow and water quality data for the first time. The group also installed several robust monitoring stations in ephemeral wadis, developing calibrated, radar-based methods for the direct measurement of runoff during flood events.

The estimation of subsurface water flows into the Dead Sea presents special difficulties. In addition to isotope geochemistry and trace element studies using rare earths as natural groundwater tracers, as well as inert gas measurements, an aerial survey with an infrared thermal camera was carried out in January 2011 on the western side of the Dead Sea, with the aim of localizing and quantifying cooler and warmer ground-

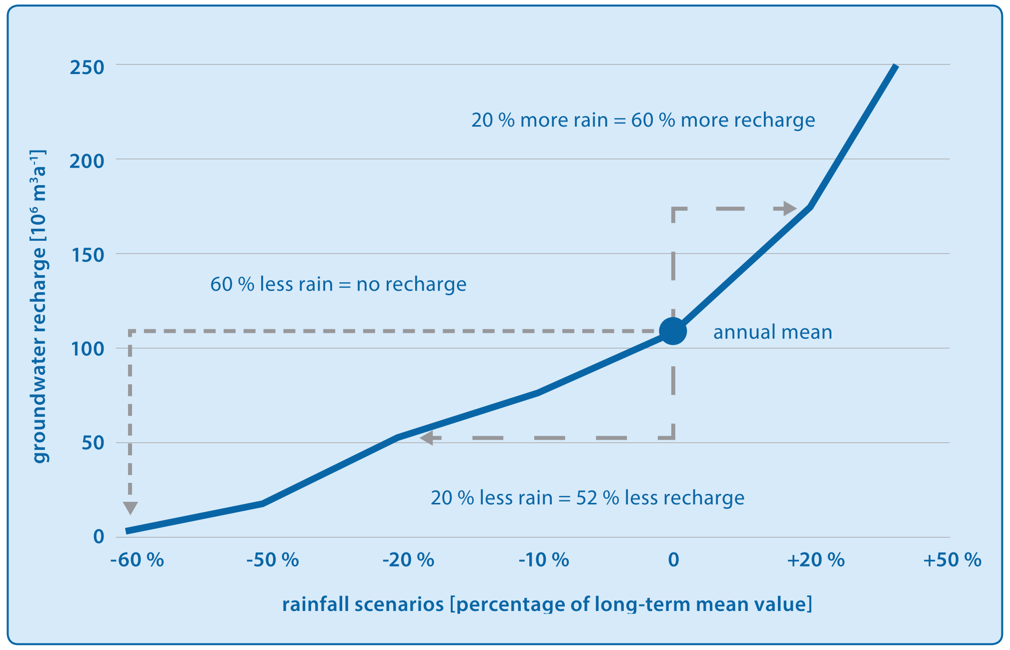

Fig. 47: The figure shows the dependency of groundwater regeneration on precipitation levels. In a dry year with 20 % less precipitation than the mean, the groundwater regeneration rate is 52 % less. If the precipitation is less than 60 % of the mean, no groundwater regeneration occurs at all. → Source: M. Raggat, University of Jordan

water inflows. Here, the temperature difference between the surface water and groundwater is determined. At the time of measurement, the surface water temperature was 22 degrees. The inflowing groundwater has a relatively constant temperature of 25 to 29 °C (except for thermal springs: 40 to 45 °C), so there is a temperature difference in excess of 3 degrees. This contrast means that it is possible to distinguish between the inflowing groundwater with the associated, characteristic thermal plumes and the surrounding water. The project group was able to show that there is a linear correlation between the two. This provides a means of estimating the total groundwater influx.

The thermal images also revealed a diffuse inflow, whereby the groundwater seeps through the sediment and generates similar thermal plumes (see upper section of the thermal image, Figure 49). Also, several submarine sources were located. Divers sampled these so-called upwellings directly. The samples were then subjected to isotopic geochemical analysis to establish their origin. Depending on their depth, most of them could be assigned to the upper aquifer. The springs occur frequently to a depth of approx. 30 m and discharge between a few litres to several hundred litres per second. They form depressions several metres in diameter. For the first time, scientists from the Max Planck Institute for Marine Microbiology in Bremen and the SUMAR group discovered lower forms of life such as bacteria and algal mats in the immediate vicinity of the springs – a sensational find. The findings will be subjected to further study in a subsequent project.

In addition, groundwater recharging rates, surface runoff and groundwater inflow to the Dead Sea were documented for the local catchment area through a combination of water-soil balance modelling (JAMS 2000) and groundwater flow modelling (OpenGeoSys). The results confirm how sensitive the climate of this arid region is: A decrease in annual precipitation of 20 % causes the groundwater recharging rate to decrease by about 48 %. An increase of 2 °C in the annual mean temperature reduces the groundwater regeneration rate by approximately 23 %. Assuming that the water inflow to the Dead Sea remains at current levels (2012), the water level will continue to fall. Equilibrium between evaporation and inflow will be reestablished at a Dead Sea water level more than 100 metres deeper, at less than -500m bmsl. (2011: -425m bmsl.) Since all the water flowing through the region enters the Dead Sea, the groundwater level is falling concurrently. This means that springs fall dry, wells must be drilled deeper and the deeper pumping causes higher energy costs. Also, erosion close to the shoreline is increasing. As salt minerals are dissolved, sinkholes develop. All these aspects are having an increasing effect on tourism, mining and agriculture. Furthermore, the quality of the water is worsening. Increasing anthropogenic strain and the salinization are having a serious effect on usable groundwater quantities.

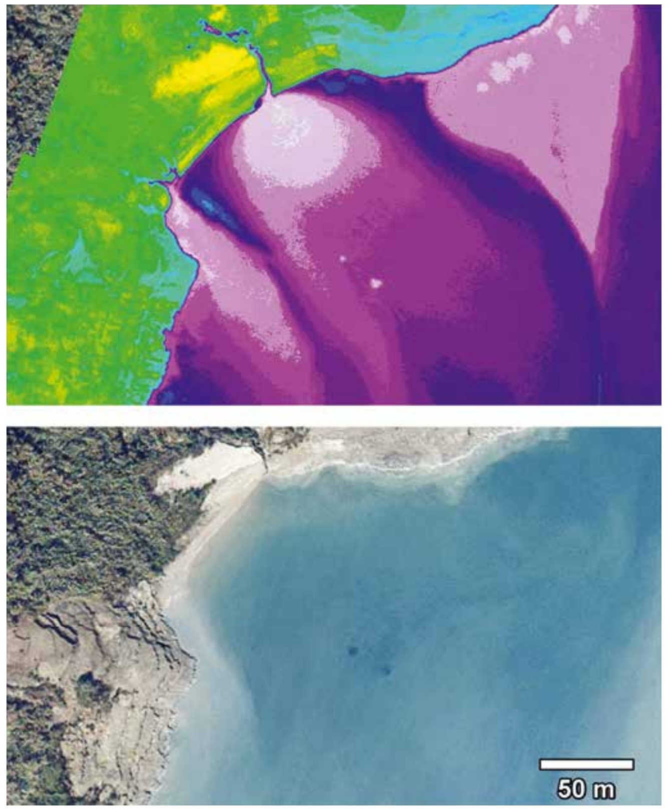

Fig. 48: Thermal image (above) and aerial photograph (below) of the same coastal stretch of the Dead Sea: Warm groundwater (red/white) plumes from the cooler (green/blue) land side are clearly visible. The results were used for exact localization of all groundwater inflows and estimation of the inflow volume.
→ Source: UFZ/BGR, U. Mallast, F. Schwonke

IMPLEMENTATION

The results of the SUMAR project were presented to local decision-makers; they provide a solid foundation for sustainable water resource management in the region. The interest generated by the results of SUMAR stimulated the establishment of a major successor project called 'DESERVE - Dead Sea Research Venue'. DESERVE is supervised jointly by the KIT (Karlsruhe), UFZ (Leipzig-Halle) and GFZ (Potsdam) Helmholtz centres, serving to establish and enhance an infrastructure for future research projects in the region. At the same time, the salient research aspects of the IWRM SUMAR projects are being continued and extended.

↗ MAP OF THE PROJECT REGION

Fig. 49: Project region around the Dead Sea.
→ Source: U. Mallast, UFZ

↗ INFORMATION ABOUT THE PROJECT REGION

- Location: Dead Sea; lowest point: -730 m bsl (in Dead Sea); sea level determined in 2011: -425m bsl; area: 805 km^2
- Catchment area size: approx. 44,000 km^2
- Population: 6 million
- Climate: semi-arid to arid
- Main land and water usage: tourism, agriculture (vegetables, fruit), chemical industry, phosphate mining, magnesium salt production using evaporation pans

↗ PROJECT PARTNERS IN GERMANY

- Helmholtz Centre for Environmental Research – UFZ, Department of Catchment Hydrology
- University of Göttingen
- Federal Institute for Geosciences and Natural Resources (BGR) (Subdepartment for Geo-risk Assessment and Remote Sensing)

↗ ... IN ISRAEL/JORDAN/PALESTINE

- Al-Quds University, Jerusalem, Palestine
- BenGurion University, Beer Sheva, Israel
- MEKOROT Co. Ltd., Tel Aviv, Israel
- EnNajah University, Nablus, Palestine
- Birzet University, Birzet, Palestine
- University of Jordan, Amman, Jordan
- Al-Balqa Applied University, Amman, Jordan
- Palestinian National Water Authority
- Water Authority and Ministry of Water and Irrigation of Jordan

Integrated Water Resources Management in the Lower Jordan Valley: SMART – Sustainable management of available water resources with innovative technologies

Fig. 50: The Jordan Rift Valley, viewed from Jordan on the West Bank.
→ Photo: J. Klinger

↗ PROJECT DURATION

07/2006 – 06/2014

↗ GEOGRAPHIC LOCATION

Lower Jordan Valley – Dead Sea, Israel/Jordan/Palestine, Middle East

↗ CONTACT

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→ www.iwrm-smart2.org

BACKGROUND AND OBJECTIVES

The Jordan region is one of the driest regions worldwide and water is generally scarce. In the SMART project funded by the Federal Ministry of Education and Research (BMBF), water management options concepts adapted to the Lower Jordan Valley are being developed to increase the amount of water available and to improve its quality.

SMART is an acronym for 'Sustainable Management of Available Water Resources with Innovative Technologies'. In this multilateral and interdisciplinary research project, a total of 25 partners from universities and research institutions, industrial partners as well as representatives of decision-making institutions from Germany, Israel, Palestinian Territories and Jordan are taking part.

The overall goal is the development of a transferable approach for Integrated Water Resources Management (IWRM) in the water shortage region of the Lower Jordan Valley. All available water resources are being taken into consideration: groundwater and surface waters, but also wastewater, brackish water and flood water that needs to be treated for use.

MAIN RESULTS

Data that was already available and data gathered in the course of the project form the basis for a publicly accessible semantic knowledge management system (Dropedia) and the data and information system (DAISY) that already contains more than 2 million datasets covering the whole SMART region. With the aid of a trans-boundary groundwater flow model, the hydrogeological processes of both banks of the Jordan will be modeled and the information used for sustainable management of the groundwater system. For the comprehensive assessment of sub-catchments, the local water cycles are quantified by connecting hydrological water balance models with numerical groundwater models. Water resources that are currently not being used (or only to a small extent) are being quantitatively and qualitatively assessed and made available at several sites. At Fuheis in Jordan, decentralized wastewater treatment and reuse e.g. for irrigation purposes is to be carried out at a pilot plant to test various techniques. The technology is already being used in seven single and multi-family dwellings.

In the spring of 2013 a desalination plant will be put into operation in Karame, Jordan. After its installation, the plant will supply around 200 cubic metres of drinking water daily, enough for about 650 inhabitants. In the Palestinian Territories and in Jordan, managed groundwater replenishment is being carried out via wells and seepage basins, and on a large scale at the Wala Dam in Jordan.

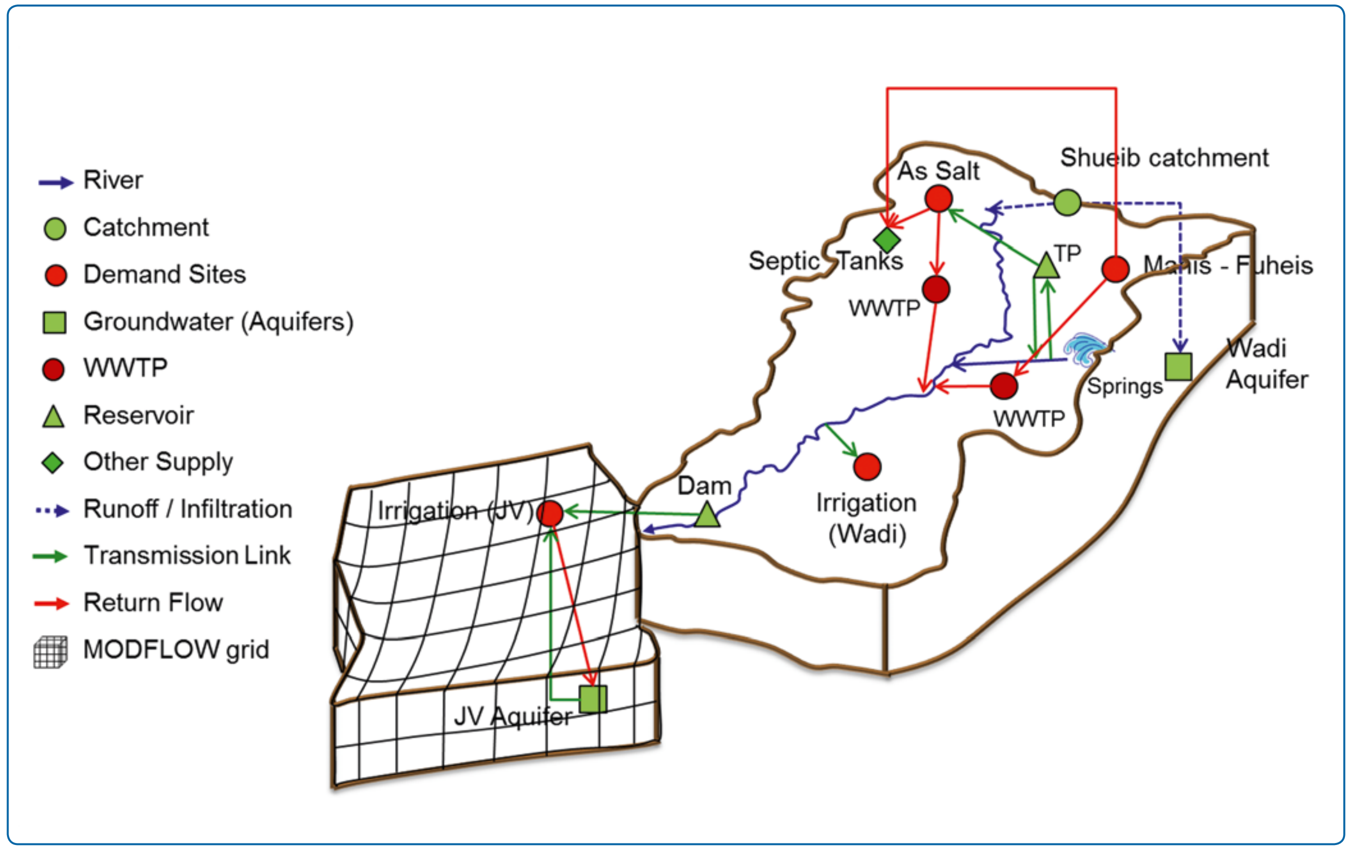

Fig. 51: Schematic representation of the Wadi Shueib model using the WEAP water balancing model.
→ Source: D. Riepl and P. Alfaro, KIT

The evaluation of the techniques involved is being done using parallel hydro-geological surveys such as state of the art monitoring (i. e. measurement of specific parameters in high temporal resolution), tracer tests and the analysis of pharmaceutical residues and in particular trace substances of hygienic relevance. This information helps the regional authorities to draft protection zone plans.

As a flanking measure, the scientists are conducting surveys amongst the inhabitants and drawing up cost-benefit analyses in municipalities and towns and for alternative water management strategies.

A PhD program, a scientific training programme ('Scientific Advanced Training') for the involved researchers from the region and workshops help to promote capacity building and the institutional cooperation between partners in the region. Also, educational programmes for teachers and materials for primary schools are being developed in English and Arabic (WATER FUN) with the aim of raising levels of awareness for cross-border problems and the scope for peaceful resolution of water issues with the younger generation.

IMPLEMENTATION

Two different IWRM concepts have been developed and are being implemented in sub-catchments of the Jordan Valley and in separate case studies. In this, the water management options for action being subjected to investigation take account of social realities, and they are being coordinated with the decision-makers and research institutes concerned on the basis of their national water strategies. This opens up paths towards effective and sustainable water management.

Decentralized sewage treatment plays a major role here. Following successful commissioning of pilot plants, the project National Implementation Committee for Effective Decentralized Wastewater Management in Jordan (NICE) at the Ministry of Water and Irrigation Amman, Jordan is now developing a strategy for the implementation of decentralized waste water treatment plants in Jordan.

↗ MAP OF THE PROJECT REGION

Fig. 52: Overview of the Jordan region with the riparian states Jordan, Israel and Palestine. The catchment areas on which the SMART research is concentrated are highlighted in colour.
→ Source: H. Neukum & J. Klinger, 2012

↗ INFORMATION ABOUT THE PROJECT REGION

- Location: Lower Jordan Valley, around 100 km from the Sea of Galilee in the north to where the Jordan enters the Dead Sea in the south; includes the 8 – 15 km wide Jordan Valley floor and the side valleys (wadis); topographic altitudes: -420 m bsl in the Dead Sea to 1,200 m above sea level
- SMART study area: 5,000 km^2
- Urban areas: Jericho, Jerusalem, Hebron, Nablus and Ramallah, Amman, Salt and Madaba
- Climate: semi arid, precipitation 50 – 150 mm/a
- Land use: mainly agriculture; sparsely populated
- Israeli and Palestinian water consumption (western catchment of Lower Jordan): approx. 275 million m^3/a, 95 % from groundwater and springs
- Water consumption in Jordan: around 350 million m^3/a, approx. 40 million m^3/a from groundwater and springs; some surface runoff is stored in reservoirs and used directly for irrigation purposes together with treated and untreated wastewater

↗ PROJECT PARTNERS IN GERMANY

- Karlsruhe Institute of Technology (KIT), Institute for Applied Geosciences (AGW), Dept. of Hydrogeology
- Helmholtz Centre for Environmental Research – UFZ, Department UBZ – Centre for Environmental and Biotechnology, Depts. of Catchment Hydrology and Economics
- University of Göttingen, Faculty for Geoscience and Geography, Geoscience Centre, Department Applied Geology (GU)
- DVGW test laboratory at the Engler-Bunte-Institute, Chair of Water Chemistry and Water Technology, Karlsruhe Institute of Technology (KIT)
- DVGW – Water Technology Center (TZW) Karlsruhe
- University of Heidelberg, Faculty of Chemistry and Geosciences (HU)
- Training and Demonstration Centre for Decentralized Waste Water Treatment (BDZ)
- ATB Umwelttechnologien GmbH, Porta Westfalica, (ATB)
- HUBER SE, Berching
- Stulz-Planaqua GmbH, Bremen

↗ PROJECT PARTNERS IN JORDAN

- Ministry of Water and Irrigation, Amman (MWI)
- Jordan University, Amman (JUA)
- Al-Balqa University, Salt (BALQA)
- ATEEC, Amman, Jordan (ATEEC)
- ECO-Consult, Amman (ECO)
- NAW - Nabil Ayoub Wakileh & Co., Amman (NAW)

↗ PROJECT PARTNERS IN PALESTINE

- Palestinian Water Authority, Ramallah (PWA)
- Al-Quds University, Department of Earth & Environmental Sciences, Jerusalem (QUDS)
- Palestinian Hydrology Group, Ramallah (PHG)

↗ PROJECT PARTNERS IN ISRAEL

- Tel Aviv University, Department of Geophysics and Planetary Sciences (TAU)
- Ben-Gurion University of the Negev, J. Blaustein Institute for Desert Research, Beer Sheba (BGU)
- Mekorot Water Company Ltd., Tel Aviv (MEK)
- Environmental & Water Resources Engineering, Haifa (EWRE)

Integrated Water Resources Management in Isfahan (Iran)

Fig. 53: Chadegan Dam on the Zayandeh Rud.
→ Photo: p2m berlin GmbH

↗ PROJECT DURATION

09/2010 – 08/2013

↗ GEOGRAPHIC LOCATION

Isfahan, Iran

↗ CONTACT

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BACKGROUND AND OBJECTIVES

The joint 'IWRM in Isfahan' project started in September 2010 and covers the catchment area of the Zayandeh Rud river. Lack of water represents a major issue in this area. This river is the most important body of surface water in central Iran, exercising a major influence on the quality of life for around 4.5 million people and on the economic development of the semi-arid region of Isfahan.

The overarching goal of the project is to develop a feasible concept for Integrated Water Resources Management in the catchment area of the Zayandeh Rud. In addition to the transfer of modern technology and management instruments, the IWRM process is designed to include participation on the part of the various consumer groups from agriculture, industry and expanding cities as well as the responsible authorities. The successful implementation of this approach is very much in Iran's interests, for it addresses major issues affecting the region; these have intensified since the project started. Water is scarce and the population is growing. Climate change, a higher frequency of dry periods and constantly deteriorating surface and ground water quality due to overdevelopment and pollution of water resources exacerbate the situation. In addition, the intense competition between the different consumer groups presents a major challenge for water management.

By way of tackling the task of providing sustainable management of water resources, the Isfahan project is developing a decision support system that integrates the various consumer concerns. Intensive cooperation with the Iranian partners ensures that progress will continue after the project has officially come to an end.

MAIN RESULTS

Ten interrelated modules are being developed in three different fields and integrated into the decision support system using knowledge maps:

1) Water management tools: main module including the components 'quantitative water resources simulation' and 'qualitative modelling of the main socio-economic factors'
2) Sector analysis: five sectoral modules for agriculture, urban water management, industry, tourism and nature

Fig. 54: Dried-out river bed in the course of the Zayandeh Rud. → Photo: inter 3 GmbH, Berlin

representing the different types of water usage in the catchment area of the Zayandeh Rud

3) Knowledge integration using four modules: Organizational Development, Participation Management, Capacity Building and Public Relations, in which the scientific results of the sectoral modules are summarized, communicated, discussed and combined with recommendations for implementation

In the first project phase, which started 2010, the consortium reviewed and analyzed the current water management situation in the study area with regard to technical, organizational, socio-economic and ecological aspects. This is an important milestone towards obtaining the necessary water management data relating to the agriculture, industry and urban water management sectors. The information for the tools was processed in close cooperation with the Iranian authorities and the Technical University of Isfahan.

The decision support system for the sustainable management of water resources is being developed on the basis of this data pool. It consists of the two interlinked water management tools. The first models are now available, covering hydrology, land use and climate and developed in cooperation with experts from the Technical University of Isfahan. In view of the complex interactions between underground and surface water resources in the catchment area, a groundwater model was integrated into the tool from the beginning of the project.

In preparation of the next phase, existing measurement stations along the river were examined and an overall concept for the monitoring of water quality was developed. The aim is to establish a monitoring system along the river to collect the data needed for simulating the way quality parameters will develop. The concept was presented to and accepted by the Iranian decision-makers. Together with the required technical facilities, information and available data it is scheduled to be available at the beginning of the next phase.

The agricultural sub-project included a workshop on the efficiency of irrigation methods. Its focus was on innovative irrigation technology from Germany, such as membrane tubes for subsurface irrigation. Also, the participants discussed existing and alternative financial options for the implementation of technical innovations in the agricultural sector. As part of the urban water management sub-project, the scientists first conducted pilot projects in the areas of water loss reduction and determination of domestic water usage patterns in an urban district in cooperation with the Isfahan water and wastewater utilities.

IMPLEMENTATION

To facilitate subsequent exploitation of the water management tools, Iranian experts from the different sectors are involved in the development of a homogeneous IWRM decision support system at all stages of the process. The main emphasis is being laid on creating knowledge maps. These integrate all the results gained from the water management tools and the sectoral modules into the decision support system in such way that it can be augmented and developed flexibly according to requirements.

In an initial interactive, participatory workshop including experts from all the different sectors, the decision-makers were, for the first time, able to gain a common, integrated overview of the catchment area and discuss future challenges relating to water resources management. The main result of the workshop is the commonly expressed intention of decision makers to press ahead with the institutionalization of the IWRM. As an initial step, a joint data commission is to be created whose task is to develop a homogeneous data basis and to ensure the continued implementation of the water management tool.

In addition, IWRM is to be underpinned by means of specific measures for capacity development and intensive public relations activity. Amongst other things, there are plans to organize an information exhibition, to be opened in mid 2013, together with an environmental protection NGO in Isfahan. Large wall charts will be displayed at locations along the river.

As well as the integration of water quality issues into the management tool, the agenda for the next phase beginning in 2014 includes transferring results to neighbouring and other countries with similar climatic conditions.

↗ MAP OF THE PROJECT REGION

Fig. 55: Catchment area of the Zayandeh Rud.
→ Source: DHI-WASY GmbH/Isfahan Water Authority

↗ INFORMATION ABOUT THE PROJECT REGION

- Location: Central Iran, catchment area of the Zayandeh Rud river system: 355 km from the Zagros Mountains to the Gav Khuni salt lake
- Area: 42,000 km^2
- Population: 4.5 million
- Climate: semi-arid and arid zones
- Usage: 240,000 ha irrigated agriculture
- Second largest industrial area in Iran

↗ PROJECT PARTNERS IN GERMANY

- inter 3 GmbH – Institute for Resource Management, Berlin
- Institute for Social-Ecological Research (ISOE), Frankfurt am Main
- DHI-WASY GmbH, Berlin
- p2m berlin GmbH, Berlin
- German Water Partnership (GWP), Berlin
- IEEM – Institute for Environmental Engineering and Management at the University of Witten/Herdecke gGmbH
- PASSAVANT & WATEC GmbH, Aarbergen

↗ PROJECT PARTNERS IN IRAN

- Ministry of Energy and Water
- Isfahan Regional Water Company
- Technical University of Isfahan
- Isfahan Environmental Authority
- Isfahan Water and Wastewater Company

CuveWaters – Integrated Water Resources Management in Central Northern Namibia (Cuvelai-Etosha Basin)

Fig. 56: Handing over plants in Iipopo. → Photo: CuveWaters project

↗ PROJECT DURATION

11/2006 – 09/2013

↗ GEOGRAPHIC LOCATION

Central Northern Namibia (Cuvelai-Etosha Basin)

↗ CONTACT

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→ www.cuvewaters.net

Fig. 57: Solar desalination plants in the village of Amarika. → Photo: CuveWaters project

BACKGROUND AND OBJECTIVES

The CuveWaters project aims to develop and implement an Integrated Water Resources Management concept in central northern Namibia. Namibia, the driest country in southern Africa, is particularly affected by water shortages and climate change. CuveWaters will help to achieve long-term improvement in the livelihoods of the people through an IWRM approach adapted to the region.

In addition to the variability of the climate, supplying water is also complicated by the geographic and societal situation in the Cuvelai Basin. Most of the groundwater resources are very salty and traditional hand-dug wells are mostly microbiologically contaminated. Therefore, water from the Calueque Dam in southern Angola is pumped into the region via long-distance pipelines. This makes Namibia dependent on Angola and its prevailing political situation. Furthermore, not all settlements can be supplied in this way. Almost half of the Namibian population lives in this region, the population density is already relatively high and increasing rapidly, and the urbanization process is continuing.

To address these issues, the CuveWaters project partners are aiming to develop a regionally tailored, multi-resource approach for the Cuvelai Basin. The inhabitants are to be provided with improved and sustainable access to water and learn how they can use it more efficiently.

MAIN RESULTS

In the CuveWaters project, German and Namibian partners are working together with the local population to develop and implement various technologies such as rainwater and flood water collection, groundwater desalination and a sanitation concept that includes water reuse in agriculture. The water can be collected from a variety of sources and then allocated to different uses. This is in line with the '3R strategy: reuse, recharge and retain'. 'Reuse' includes the recycling of water, nutrients and energy, thus increasing resource efficiency. Here, 'recharging' means flood water storage. 'Retention' refers to rainwater and flood water collection to improve the living conditions of the population through fruit and vegetable production. Especially through the prevention of evaporation, more water can be made available over longer periods of time.

A key component of the project is its integration into the social context. National, regional and local institutions as well as the population have been involved in the implementation and use of all the technologies. Significant factors in this connection include the adaptation of implementation and operational structures. Capacity development involves technical training as well as the sponsorship of young academics. In the area of governance, CuveWaters is helping various institutions to build up the structures needed for sustainable IWRM in the region. Scientific aspects of the project include methods relating to demand-oriented participation, further community-related approaches, social-ecological impact assessment and the development of scenarios and instruments for planning and decision-making processes.

IMPLEMENTATION

In cooperation with the local population, international teams have built pilot plants at different locations and put them into operation. In the village of Epyeshona, three plants have been built to collect rainwater from the roofs (roof catchments) and one ground catchment. The household tanks with roof catchments each have a capacity of 30 cubic metres. This means that water is available during the dry period, sufficient to irrigate newly planted gardens, so inhabitants can improve their nutritional situation and earn money by selling fruits and vegetables. The ground catchment collects water from a concrete lined area in a tank with a capacity of 120 cubic metres. This supplies water for a greenhouse and open gardens that are cultivated by six households.

In the villages of Amarika and Akutsima, CuveWaters has built four small-scale solar-powered groundwater desalination plants. Through reverse osmosis, a membrane distillation system, evaporation and a multi-stage desalination process, the various techniques supply up to four cubic metres of fresh water a day. Previously, these villages only had hand-dug wells that are microbiologically contaminated and salt-polluted, presenting serious health risks. Desalination reduces such risks.

In the village of Iipopo, the team has built a floodwater storage system. This collects local flood water and stores it for use during the dry period. The system is made of an underground tank with a capacity of 130 cubic metres and two

↗ MAP OF THE PROJECT REGION

Fig. 58: CuveWaters project region and pilot sites.
➔ Source: J. Röhrig, ISOE

ponds (foil-lined pits with roofs to prevent water loss through evaporation) which have storage capacities of 135 cubic metres each. Ten villagers and their families use the water for gardening and for a greenhouse. The water is used very efficiently using a drip irrigation system.
A sanitation concept involving water reuse is planned for implementation in the town Outapi in the first half of 2013. It includes sanitary facilities for individual households, communally used smaller washhouses for four to five households and a public washhouse for about 250 people. A vacuum system transports the wastewater to a treatment plant. The water is purified and then used for irrigation together with the nutrients it contains. A farmers' cooperative cultivates the fields and sells the crops at local markets. Wastewater treatment by-products like sludge and plant waste are fed into a digester to produce biogas and energy. The electricity produced is used in part to supply the operating energy needed for the vacuum sewage extraction and wastewater treatment plant. The research findings from this project and insights gained from its implementation are extremely relevant in view of global problems and the potential for conflicts concerning water resource management. They play a decisive role in the transfer of IWRM knowledge to other regions with comparable challenges.

↗ INFORMATION ABOUT THE PROJECT REGION

- Location: central-northern Namibia, Cuvelai-Etosha Basin
- Catchment area size: 100,000 km²
- Population: 800,000 (this means nearly 50 % of the Namibian population on an area that covers 15 % of the country's surface)
- Climate: driest state in Africa south of the Sahara, semi arid with mean precipitation values that vary widely during the seasons; very high climatic variability; no perennial rivers in the interior (only as border rivers)
- Land usage: cattle grazing, cultivation of millet
- Water usage: irrigation, domestic water, watering cattle

↗ PROJECT PARTNERS IN GERMANY

- ISOE – Institute for Social-Ecological Research, Frankfurt am Main
- IWAR Darmstadt University of Technology
- pro|aqua, Mainz
- Terrawater, Kiel
- Ingenieurbüro für Energie- und Umwelttechnik (IBEU)
- Solar-Institut Jülich
- Fraunhofer Institute for Solar Energy Systems, Freiburg
- Roediger Vacuum GmbH, Hanau

↗ PROJECT PARTNERS IN NAMIBIA

- Desert Research Foundation of Namibia (DRFN)
- Ministry of Agriculture, Water and Forestry (MAWF)
- Ministry of Health and Social Services (MoHSS)
- Ministry of Regional and Local Government, Housing and Rural Development (MRLGHRD)
- Basin Management Committees (BMC) for the Cuvelai-Etosha Basin
- University of Namibia (UNAM)
- Polytechnic of Namibia (PoN)
- Federal Institute for Geosciences and Natural Resources (BGR), Africa Section
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
- Outapi Town Council (OTC)

Integrated Water Resources Management in the 'Middle Olifants' project region, South Africa: Focusing on added value for sustainable IWRM implementation

Fig. 59: The Olifants in South Africa. ➔ Photo: D. Gregarek, IEEM

↗ PROJECT DURATION

08/2006 – 05/2015

↗ GEOGRAPHIC LOCATION

Middle Olifants catchment area, South Africa

↗ CONTACT

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➔ www.iwrm-southafrica.de

BACKGROUND AND OBJECTIVES

South Africa is an arid country in which water-related problems are outstripping the growth rate of the population. More and more people consume water themselves, and they also demand goods and services whose provision entails the consumption of water. Also, the demand is increasing in line with continuing economic development (rising standards of living). Climate change and the refugee problem (especially in the provinces near the Zimbabwean border) cause regional exacerbation of the situation.
South Africa is well suited as an IWRM research project region from other points of view as well: On the one hand it disposes of highly developed technologies and a sufficiently stable administration. On the other hand, South Africa displays all the characteristics of a 'real' developing country, especially in the refugee areas and rural regions. The most important point, however, is that South Africa is seen as being the 'gateway' to the whole African continent as far as the adaptation and dissemination of high-tech concepts are concerned.
The 'Middle Olifants' project area is a river catchment to the east of Pretoria with a large number of high-intensity water consumers: households, large scale farming, mining (including one of the largest platinum mines in the world) and tourism. During dry spells, downstream water users sometimes have to reduce their consumption so as to prevent harm to the population and the ecology (e. g. in the Kruger National Park). Many wastewater treatment plants are not operating, so that untreated wastewater further impairs the water quality.
IWRM South Africa Phase I has produced a complete IWRM concept, consisting of three main modules. These are the Water Resources Module, WRM, for calculating the amount of available water taking account of water quality aspects, the Water Allocation Module, WAM, governing its distribution and the Water Intervention Measures module, WIM, with technical and institutional measures for improving the situation in the target area as a contribution towards more sustainable management of the water resources. WIM also includes a water franchise concept for initiating technology transfer from experienced water supply utilities to local companies.

Fig. 60: The Olifants north of Groblersdal.
→ Photo: T. Walter

Fig. 61: Domestic water supply in a rural community.
→ Photo: T. Walter

MAIN RESULTS

By way of taking account of sustainability aspects, the water available for consumption in the Middle Olifants region has been reduced to 232 million cubic metres per year. This means that the demand for almost 400 million cubic metres per year cannot be met. In order to maximize the economic benefits, the greatest reductions must be achieved in irrigation, but domestic use and use in mining need to be reduced as well. The reduction in the use of water for irrigation is also being accelerated by the South African government (achievement of socio-political aims).

Research results have shown that the conditions for sustainable operation and management of water service utilities have to be improved at first in order to built a basis for further measures. A business format franchising concept for water services ('water franchise') has been developed as a locally based management model. It was possible to draw up this concept in detail with internal project funding and supplementary funding through the IFCI/World Bank, with the town of Matsulu serving as an example. In the Water Franchise concept, local service providers take over operation and maintenance tasks after receiving training from experienced (private) water suppliers. This improves the identification with the project and ensures more autonomous and independent operation and maintenance compared to classic PSP (Private Sector Participation) models. This led to an improved quality of installation and maintenance. Administrative water losses have been reduced from 85 % to 35 %. The franchise concept received a World Bank award in 2006.

Iterative computation of the modules WRM and WAM has shown that integrated management results in better protection and efficient allocation of the scarce water resources in the project region. The root cause of the problems is not water scarcity, but insufficient water resources management. Sustainable operation of the existing water technology plants is crucial for success. In particular in the operation and maintenance of the infrastructure it is less a lack of available technology which is the problem, but rather the deficits in management and a lack of technical abilities. Therefore in the second project phase the greatest additional research efforts should be made in the area of water management measures. Putting the emphasis on WIM, and within that especially on institutional aspects and economics / financing, also appears appropriate in the light of the foci being placed on the BMBF's other IWRM projects and their results, where technical/hydrological measures feature more prominently. So the economic aspect will play a key role in Phase II, for the project participants have recognized that the creation and sustainable maintenance of increased added value in the water sector are factors upon which the entire project, i.e. its implementation and its sustainability, depend.

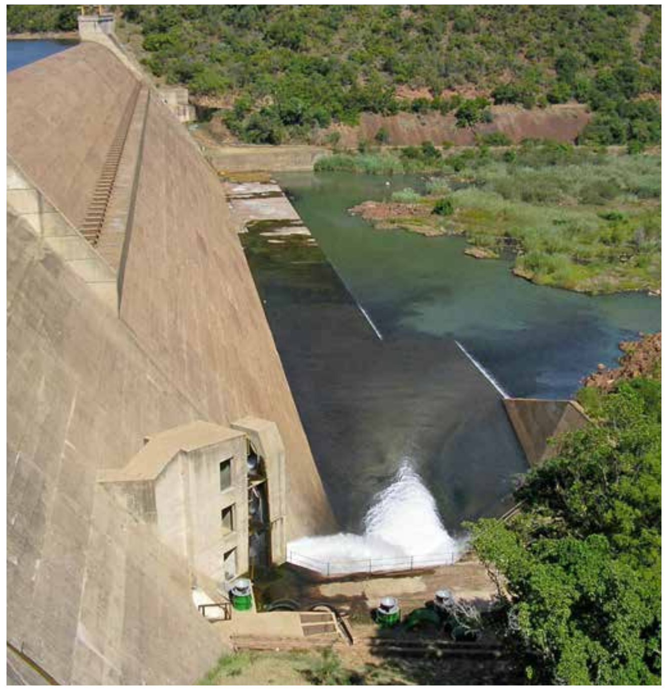

Fig. 62: Loskop Dam. → Photo: M. Bombeck

IMPLEMENTATION

In addition to the partners involved in Phase I, i.e. IEEM (Institute of Environmental Engineering and Management at the University of Witten/Herdecke gGmbH), ZEF (Centre for Development Research at the University of Bonn), HUBER SE, REMONDIS Aqua GmbH & Co. KG and U+Ö (Environmental Engineering and Ecology at the Ruhr-University of Bochum), the team was able to obtain additional support for Phase II from three industrial partners (DHI-WASY GmbH, disy Informationssysteme GmbH, LAR Process Analysers AG). To secure the overall objectives and deal with individual issues, the German partners will maintain the existing close links with the respective South African institutions.

↗ MAP OF THE PROJECT REGION

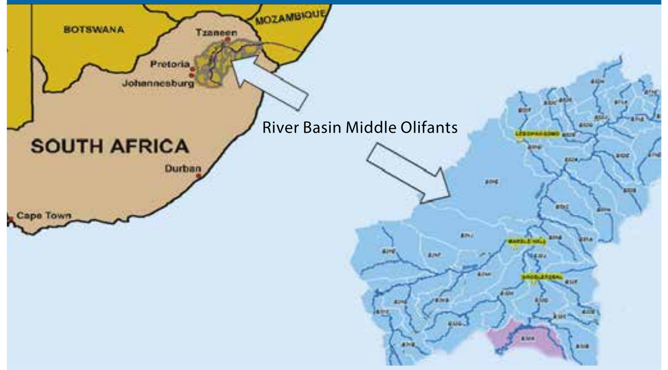

Fig. 63: Location of the project area in South Africa.
→ Source: IEEM & DWA

↗ INFORMATION ABOUT THE PROJECT REGION

- Location: Middle Olifants, a river basin east of Pretoria, South Africa
- Catchment area size: 22,552 km², comparable with the area of the German Federal State of Hesse; length of the main river about 301 km
- Population: 1.6 million
- Climate: semi-arid; large altitude range and continental geographic situation give rise to cold winters (to -4 °C) and hot summers (up to +45 °C)
- Land and water usage: domestic, irrigation, mining (including platinum mines) and tourism

↗ PROJECT PARTNERS IN GERMANY

- IEEM – Institute of Environmental Engineering and Management at the University of Witten/Herdecke gGmbH, Witten
- Center for Development Research (ZEF), University of Bonn
- Ruhr-University of Bochum, Environmental Engineering and Ecology (eE+E)
- DHI-WASY GmbH
- disy Informationssysteme GmbH
- HUBER SE, Berching
- LAR Process Analysers AG
- REMONDIS Aqua GmbH & Co. KG, Lünen

↗ PROJECT PARTNERS IN SOUTH AFRICA

- Department of Water Affairs (DWA)
- Water Research Commission (WRC)
- HUBER Technology (Pty) Ltd.
- Council for Scientific and Industrial Research (CSIR)
- University of Limpopo
- University of Pretoria
- SAB Miller Ltd.

German-Russian cooperation project: Integrated Water Resources Management in the catchment areas of the rivers Volga and Rhine illustrated for problem regions

Fig. 64: Mouth of the river Oka entering the Volga at Nizhny Novgorod → Photo: IWG

↗ PROJECT DURATION

05/2007 – 12/2010

↗ GEOGRAPHIC LOCATION

Volga river basin, regions around Nizhny Novgorod, Moscow, Saratov, Kolomna and Pushchino, Russia

↗ CONTACT

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→ http://iwk.iwg.kit.edu/557_1694.php

BACKGROUND AND OBJECTIVES

The catchment area of the river Volga coincides with the economic and cultural heart of Russia, and about 35 % of the Russian population lives within it. The river has enormous economic potential thanks to its water and energy resources, which have been exploited intensively for decades. Since the mid 1930s, 11 large consecutive hydroelectric power plants along the river Volga and its largest tributary, the river Kama, produce a total of more than 11 gigawatts of power. However, interference in the river system on such a scale causes risks and a conflict potential that can be felt as far as the mouth of the river Volga. This situation and the insights gained from a previous joint project in the problem regions of the Volga and Rhine rivers highlight the urgent necessity for IWRM on a river-basin scale with particular emphasis on urban agglomerations. The purpose of this large-scale, joint German-Russian project was to find sustainable solutions for economically viable and environmentally compatible management of the river Volga and its tributaries. The project group investigated the water balance and water and sediment quality in the Volga and the Oka. They also studied input processes, the ways substances combine and the release of nutrients relevant for eutrophication as well as heavy metals. Both water management and safety aspects relating to hydraulic structures were given attention. On the basis of previous interdisciplinary cooperation projects, comprehensive and coordinated planning instruments were developed with the aim of optimizing the qualitative and quantitative distribution of available water resources.

MAIN RESULTS

Long-term trends for the large-scale water balance were identified using flow series data from the Oka river. These trends involved flood and low-flow situations as well as the flow regime. Hydrological simulation tools were optimized on a region-by-region basis, taking the long-term variability of the flow conditions into account. These tools provide decision-making support for selecting measures, for instance targeted reservoir management for different hydrological situations.

Subsequently, water balance system modules and hydrodynamic and morphodynamic models for selected river sections were developed with the aid of geographic information systems. According to requirements, these tools allow for both large-scale application covering whole barrage cascade sections as well as for local details in high resolution. For urban areas (e.g. Moscow), river management strategies were elaborated and vulnerability analysis methods for water supply networks were developed with a view to optimizing rehabilitation strategies. A supply zone for the Nizhny Novgorod network was selected as a case study for validating the numerical methods and adjusting them to fit local conditions.

Tools for developing a modified life cycle management (LCM) system were developed for the hydraulic structures. The basic areas covered are maintenance (development of an innovative repair procedure), service life prediction (development of an assessment method) and buildings monitoring.

The river water quality at important geographical locations (where the Moskva enters the Oka near Kolomna; where the Oka enters the Volga near Nizhny Novgorod) was investigated between 2007 and 2010 using systematic, year-round sampling. In addition, the scientists analyzed sediments, pore water and water samples for heavy metals and organic nutrients. These long-term investigations provided information on seasonal river water quality variations as well as on the origin of pollutants and nutrients, including the identification of possible point sources. It was possible to classify the degrees of pollution by means of extensive investigation of the eutrophication-relevant nutrients, especially phosphorus compounds.

The input of nutrients and pollutants was analyzed for the catchment area of the Moskva river using the MoRE modelling system. Due to the different origins of nutrients and pollutants, the load patterns develop entirely independently of the volume flows. Nutrient input occurs almost exclusively via sewage treatment plants (> 93 %), while heavy metal or general pollutant input is caused mainly by rainwater drainage. Taking the entire catchment area of the Moskva river into account, more than 75 % of the copper and zinc input results from rainwater drainage, mainly from the city of Moscow. To investigate the high load of dissolved organic carbon (DOC) in the surface waters of the Volga, in-depth sampling was carried out in selected areas: the Lubazhinka catchment in Russia and for comparison the Schaefertal catchment in the Harz Mountains, Germany. The soil water balance as well as surface runoff proved to be the main factors influencing DOC input into the rivers. The winter weather conditions and the occurrence of soil frost in the Lubazhinkha are major contributory factors.

Fig. 65: Volga barrage at Volzhskaya → Photo: KIT/IMB

IMPLEMENTATION

The hydrological and hydraulic methods and simulation tools were implemented by the Russian partner institutions as planning instruments to address complex problems of water resources management including flood protection, navigation, the operation of hydraulic structures, water supply infrastructures and ecological issues. Workshops and courses were carried out to facilitate this. A comparison of the current river water quality with the results from previous studies also provided a basis for making predictions and long-term forecasts for future developments in the Volga catchment area. Important DOC transfer pathways have been identified and sustainable management options developed. The group built up an efficient hydrological measurement network and provided tools (modified versions of the IWAN, ANIMO and MoRE models), as well as training courses for their implementation. It also tested the innovative maintenance procedure for hydraulic structures, including a monitoring concept. These methods and tools are available to both German and Russian operators of hydraulic structures as aids to their maintenance and monitoring and for assessing their service

↗ MAP OF THE PROJECT REGION

Fig. 66: Catchment area of river Volga.
→ Source: www.wikipedia.org (Author: Karl Musser) – modified IWG

↗ INFORMATION ABOUT THE PROJECT REGION

- Volga catchment area: approx. 1.4 million km², annual flow rate of approx. 254 km³/s
- Length 3530 km, 200 tributaries; difference in altitude between source and mouth 256 m
- Study areas: Lubazhinkha, part of the Oka sub-catchment, approx. 100 km south of Moscow; sub-catchment area: 18.8 km²

lives. Of particular significance has been the development of a web-based geographic information system for interdisciplinary environmental monitoring. This enables the integration of interdisciplinary IWRM research contributions to form a practice-oriented planning instrument, facilitating communication with decision-makers and the trans-disciplinary utilization of scientific results and technological developments.

↗ INFORMATION ABOUT THE PROJECT REGION

- Characteristics: transition zone from southern taiga to northern forested steppe, average slope gradient 2° with altitude differences up to 100 m
- Population: < 1,000
- Climate: temperate continental climate
- Mean annual temperature: 4.4 °C
- Annual precipitation: 560 mm
- Land use: agricultural (54 %) and forestry (approx. 1/3)
- Moskva catchment: area about 17,000 km²; length of Moskva: 503 km
- Catchment dominated by glacial geomorphology, transition between southern taiga and northern forested steppe
- Moderately continental climate, mean annual precipitation about 600 mm
- The catchment is partly urban in character; major influence of water resources management on water balance of catchment (reservoir management, water transfer from neighbouring catchments)

↗ PROJECT PARTNERS IN GERMANY

- Karlsruhe Institute of Technology (KIT), Institute for Water and River Basin Management, Institute for Reinforced Concrete and Building Materials
- Karlsruhe Institute of Technology (KIT), Engler-Bunte-Institute, DVGW-Research Center for Water Technology
- University of Heidelberg, Institute for Environmental Geochemistry
- Helmholtz Centre for Environmental Research – UFZ, Department Soil Physics

↗ PROJECT PARTNERS IN RUSSIA

- State University for Environmental Sciences Moscow (MSUEE)
- All-Russian Research Institute for Hydraulic Engineering and Melioration, Moscow (VNIIGiM)
- Nizhny Novgorod State University of Architecture and Civil Engineering and Laboratory in Nizhny Novgorod (GAZ)
- Wodokanal AG, Nizhny Novgorod
- Russian Academy of Science, Institute of Fundamental Problems of Biology, Pushchino (IBBP)
- Lomonosov University Moscow, Faculty of Soil Science, Soil Erosion Dept. (LMSU)
- RusHydro Power Generating Company
- VNIIG (St. Petersburg) and NIIZhB (Moscow) research facilities

International Water Research Alliance Saxony – IWAS

Fig. 67: Bilateral project consultations in Oman.
→ Photo: M. Walther, TUD

↗ PROJECT DURATION

06/2008 – 06/2013

↗ CONTACT

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→ www.iwas-initiative.de

BACKGROUND AND OBJECTIVES

The International Water Research Alliance Saxony (IWAS) is addressing the global challenges concerning water quality in the areas of drinking water and sanitation, agricultural irrigation and the quality of flowing waters, as well as developing specific ecosystem-relevant services to be implemented on an exemplary basis in selected model regions. Locations have been selected in Eastern Europe, Central and Southeast Asia, the Middle East and Latin America that are representative of important international regions in respect of climate, land use and demographic change. The causes of water problems and the relevant boundary conditions vary from region to region.

In Eastern Europe, solutions are being developed to improve surface water quality and meet international environmental quality standards. The basin of the Western Bug in the Ukraine has a transnational catchment area, lying at the edge of the European Union, and it serves as a pilot region for the transition states of the former Soviet Union.

New solutions for the sustainable management of scarce water resources for (semi-) arid regions are being developed in the Middle East. Research is focusing on the high-precision assessment of groundwater renewal rates, the modelling of characteristic aquifer types and the optimization of water usage in irrigation.

In Latin America, the main emphasis is on providing a long-term supply of water for the metropolitan region of Brasília under semi-humid climatic conditions. When the capital of Brazil was founded in 1960, the population was expected to reach 500,000, but today more than 2.5 million people live there – as a result the demand for water will significantly exceed both the resources available and the system capacity in the near future.

The studies in the model regions are being supplemented by four cross-sectoral approaches: scenario and system analysis, technology development and implementation, governance and capacity development. Integrated system analysis is to be used to combine the work being done in the sub-projects so as to synthesise an overall strategy. The basic aim is to develop transferable IWRM methods.

↗ GEOGRAPHIC LOCATION

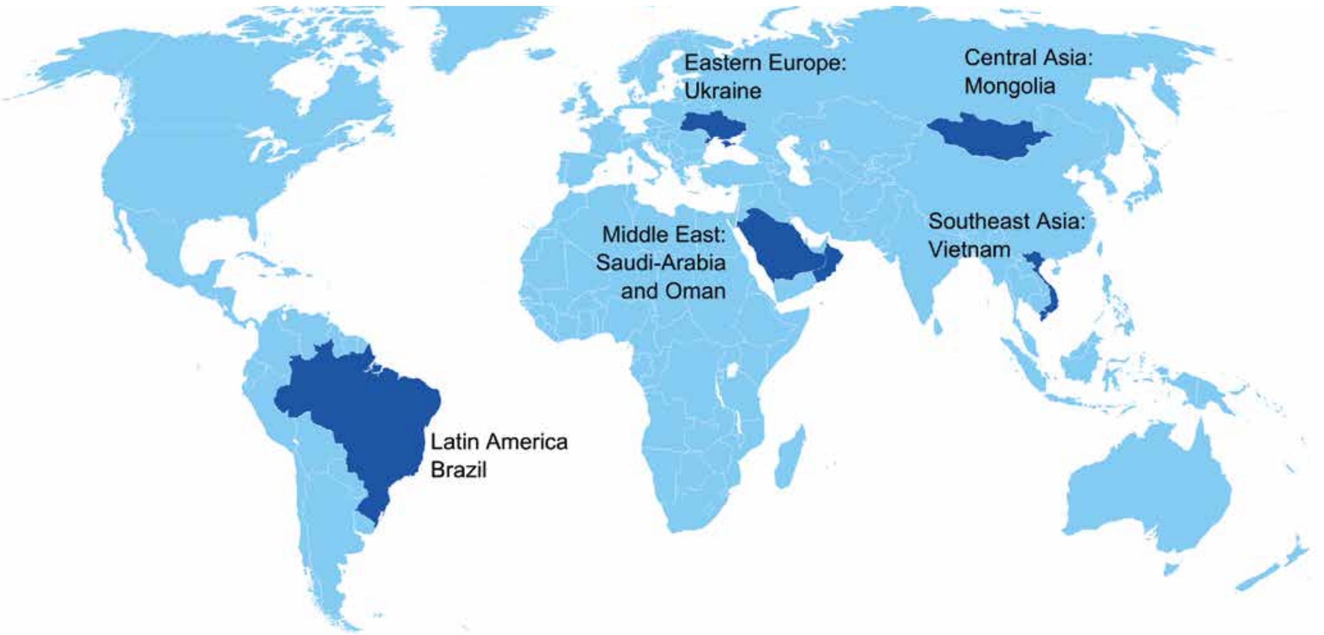


Fig. 68: Study regions of the International Water Research Alliance Saxony – IWAS.
→ Source: B. Helm, TUD

MAIN RESULTS

Through integrated appraisal of the catchment area it proved possible to identify the main pollution sources for the Western Bug. Ineffective sewage treatment plants in the region of Lviv contribute mainly to point-source pollution, and options for cost-effective reduction especially of the organic input were recommended. The water quality problems will increase as a result of projected land use changes and climate change on account of a reduction in the climatic water balance and in the overall discharge. The effects of flanking strategies for river basin and water body management are currently being investigated using a coupled model approach.

As a first step, an observation field was established in the Ad-Dahna desert in Saudi-Arabia in order to measure the soil humidity and convert this to 'true' water content. Also, the infiltration in two test fields was simulated and an integrative groundwater flow model developed. Initial results from the Oman study show that progressive penetration of seawater into coastal aquifers is taking place because of irrigation. Sustainable and socio-economically viable groundwater management is to be achieved through optimized management concepts.

In Brasilia, 80 % of the water supply comes from two large reservoirs. In future, the urban lake Paranoá is to supply approx. 20 % of the water. To achieve this aim despite the high demand for water for agricultural use and especially from urban areas, modern methods of sewage treatment (ultrafiltration, activated carbon adsorption) and drinking water processing (membrane technology) are being studied, as well as ways of reducing the pollutant load in the catchment area.

The IWAS toolbox contains data, methods and models from the regions that can be linked and visualized as required. Key techniques include compensating for scarce data, e.g. by disaggregation of precipitation information, simulating sewage networks and spatial characterization of so-called 'urban structure types'. These can be used to derive IWRM-relevant parameters such as the degree of surface sealing, water consumption or wastewater quantities.

IMPLEMENTATION

The concept development includes the implementation of various technologies. This improves the international competitiveness of German companies in the water management sector. For instance, a multisensor, aptamer-based prototype for fast, simple and cost-effective detection of pathogenic microorganisms in drinking water and wastewater has been developed.

Not only insufficient financial resources, but also restrictive institutional frameworks often prevent essential reforms. Therefore water management governance structures in the Ukraine were analyzed and recommendations for more efficient organization were elaborated. Compared with the EU member states, the structures are fragmented and incoherent. Genuinely effective incentive systems are lacking, e.g. for investment or refinancing of water-relevant infrastructures.

The sustainable implementation of system solutions in the regions hinges on adequate capacity development. For IWAS (in Brasilia in cooperation with AGUA DF), this has been initiated from an early stage for the target groups science and administration, economics and public relations. In the Ukraine, it could be demonstrated that the administrative structures are only of limited suitability for the development of a consistent water quality monitoring strategy.

Workshops were carried out at enterprise level with the aim of founding a professional association – as a result, guidelines for calculating prices that cover costs have been drafted. A 'mobile measuring lab' provides for ongoing training of professionals as well as generating evaluation data on sewage plant processes.

An e-learning module on IWRM has been developed in cooperation with the German secretariat of the IHP/HWRP for the education and advanced training of different target groups (university staff, administrators and decision-makers). It includes 39 thematically and interactively linked, country-specific contributions in English covering six subject areas.

In order to strengthen the coherence between the sub-projects and collate them to a consistent IWRM package, an alternative approach to the representation and transfer of knowledge is being developed that enables water-relevant aspects to be structured and linked.

Fig. 69: Pilot wastewater treatment plant at Lago Paranoá, Brasilia (IWAS AGUA DF). → Photo: S. Gronau, Universität der Bundeswehr, Munich

↗ INFORMATION ABOUT THE PROJECT REGION

Eastern Europe (the Ukraine), Central Asia (Mongolia), southeast Asia (Vietnam), Middle East (Saudi Arabia/Oman), Latin America (Brazil)

↗ PROJECT PARTNERS IN GERMANY

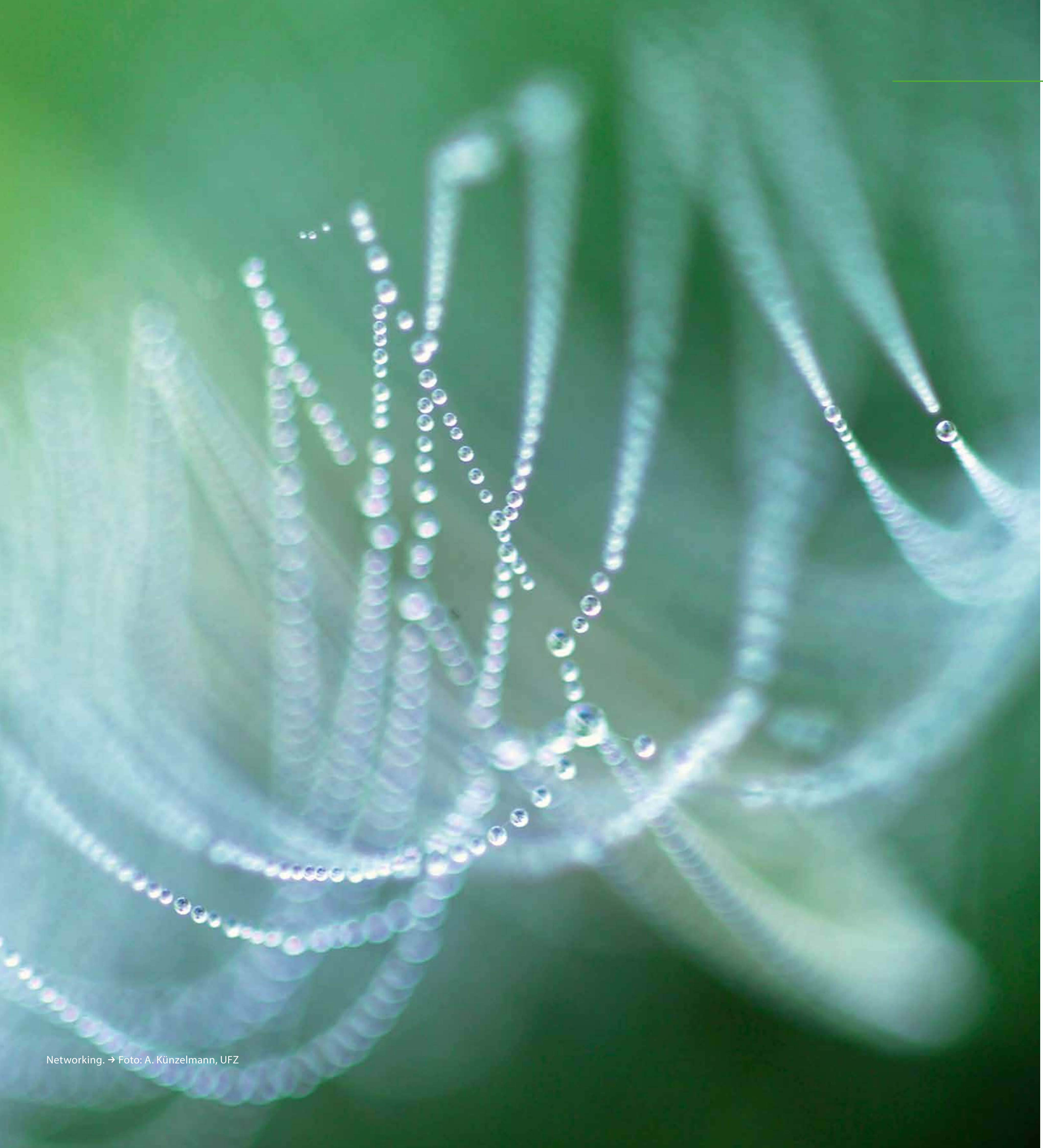
- Technische Universität Dresden (TUD)
- Helmholtz Centre for Environmental Research – UFZ, Leipzig
- Stadtentwässerung Dresden GmbH (SE-DD)
- DREBERIS – Dresden consulting for international strategies
- itwh – Institute for technical-scientific Hydrology, Hanover

↗ PROJECT PARTNERS AGUA DF (FOR BRAZIL)

- Karlsruhe Institute of Technology (KIT)
- Universität der Bundeswehr, Munich
- Sachsen Wasser GmbH, Leipzig

↗ PARTNERS IN THE PARTNER COUNTRIES

- Various cooperation partners: www.iwas-initiative.de



Networking. → Foto: A. Künzelmann, UFZ

ACCOMPANYING PROJECTS

The research projects of the IWRM funding initiative are supported by three accompanying projects. These accompanying projects have the purposes of linking those involved, helping to put research results into practice and developing analysis tools relating to institutions and political boundary conditions.

Support for the BMBF funding initatives IWRM and CLIENT: 'Assistance for Implementation' (AIM)

Fig. 70: Supplying drinking water.
→ Photo: Internationales Büro/Thinkstock

↗ PROJECT DURATION

04/2007–12/2014

↗ CONTACT

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→ http://www.bmbf.wasserressourcen-management.de/en/387.php

↗ SERVICE

AIM

- advises the projects concerning modification of planned activities in respect of strategies for the implementation and dissemination of their results,
- strengthens the networks between researchers and relevant government bodies and decision-makers at various planning levels in partner countries,
- assesses possible implementation of the project results with the aid of investment and infrastructure programmes in partner countries,
- gives support in communication with development banks as potential sources of funds for implementing project results.

Fig. 71: Workshops on the implementation of IWRM concepts and financing strategies. → Photo: R. Ibisch, UFZ

BACKGROUND AND OBJECTIVES

The 'Assistance for Implementation' (AIM) accompanying project supports the IWRM research projects in terms of, amongst other things, their implementation and the dissemination of their innovative conceptual and technical solutions. Here, the important thing is to ensure that practical, economically and ecologically beneficial solutions are worked out not only by scientists and economists, but especially together with stakeholders from the partner countries. AIM provides assistance in dealings with sector-relevant ministries, planning authorities and other relevant government bodies in the respective countries. Nevertheless, substantial investments are often required in order to turn IWRM concepts into reality. These investments – with the possible exception of some pilot installations – do not constitute part of the individual projects. Also, the public and private sectors in the countries concerned are frequently unable to raise the necessary funds on their own. By way of addressing this problem, AIM provides advice to the project staff as to how their solutions can be embedded in infrastructural projects financed by bilateral or multilateral development banks such as the KfW Entwicklungsbank or the Asian Development Bank. The possibility of implementing the results through private entrepreneurship supported by relevant financing institutions and/or by climate protection initiatives or other funded programmes, for example those of the EU or the UN, is also given consideration.

MAIN RESULTS

The dialogue with relevant government bodies on different planning levels has been enhanced for numerous IWRM projects. Such dialogues have helped to achieve a greater degree of harmony with the interests of the partner countries and to improve the chances of implementing the technical and conceptual solutions there. Furthermore, objectives regarding the implementation of the projects have been integrated into the project remits, or separate concepts have been produced to this end. Crucial aspects in this respect include the formulation of the measures as part of an IWRM concept and also the consideration of socio-economic and regulative boundary constraints. This involves cost-benefit analyses, the development of guidelines for the application of the innovative solutions, the preparation of sustainable operating concepts and taking approval procedures into consideration. To facilitate this, e.g. the KfW Entwicklungsbank has been integrated by AIM in thematic workshops of the IWRM funding priority and a special training for the IWRM projects has been conducted together with KfW. In addition, in many cases beneficial dialogues with development banks were initiated that were then continued semi-autonomously in the projects. This has led to the concurrent development of various different approaches for financing projects. For example, with the assistance of MoMo (p. 36) and AIM the city of Darkhan has drafted a proposal to fund a pre-feasibility study as a prerequisite for the replication of the wastewater treatment solutions that have already been developed. The proposal has been successfully submitted to an initiative supported by various institutions in the development cooperation group. Jordan is already taking the results of SMART (p. 54) further and is considering including a new project for the construction of a decentralized sewage disposal plant in the bilateral government-level negotiations for development cooperation.

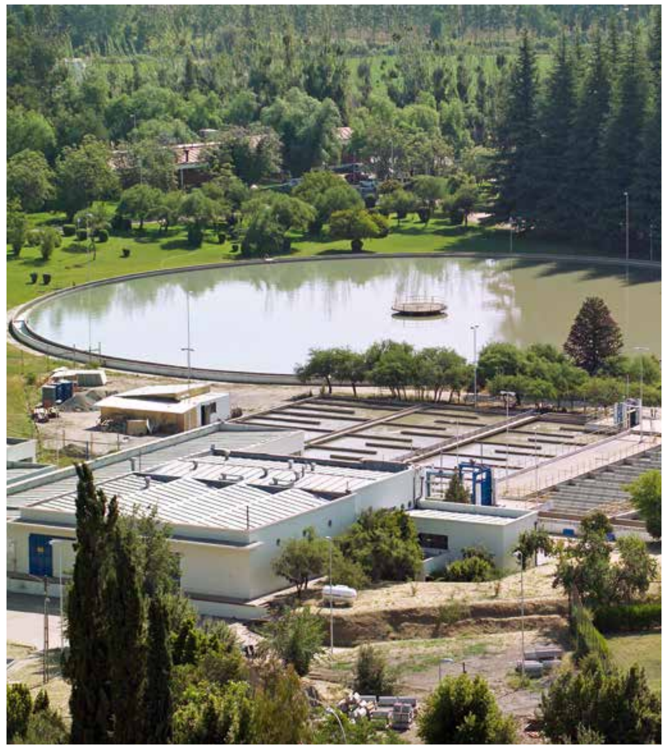

Fig. 72: Implementation of infrastructural solutions.
→ Photo: A. Künzelmann, UFZ

Networking the BMBF funding initiative 'Integrated Water Resources Management'

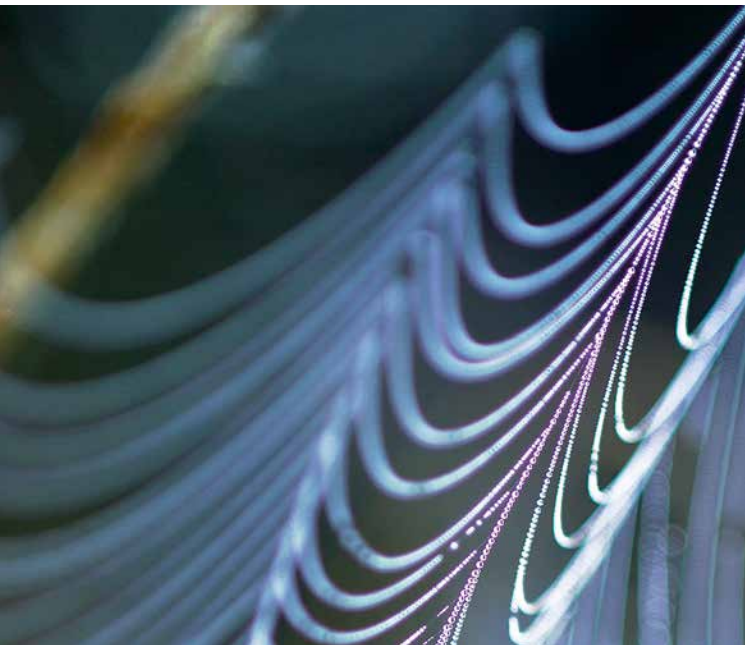

Fig. 73: The UFZ promotes networking between scientists, politicians, administrators and economists regarding Integrated Water Resources Management. → Photo: A. Künzelmann, UFZ

↗ PROJECT DURATION

01/2009 – 06/2013

↗ CONTACT

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BACKGROUND AND OBJECTIVES

The focus of BMBF´s funding initiative IWRM is placed on the transfer of information and technology in accordance with the United Nations sustainability goals. The IWRM projects presented in this brochure are developing adaptable concepts and integrated system solutions in model regions in developing and emerging countries. Considerable efforts are being made to derive generalized guidelines and benchmarks from the regionally specific activities with a view to developing and implementing integrated management approaches elsewhere. To this end, the scientists and decision makers from politics, administration and economics must actively share the experience they have gained from individual projects, draw conclusions from pooled research results and communicate their conclusions to the wider world. Accordingly, the BMBF established a networking and coordinating project in early 2009 based at the Helmholtz Centre for Environmental Research (UFZ). The project objectives were defined as follows:

- Intensification of exchanges between project participants from the IWRM funding initiative and other stakeholders from the fields of science, politics, administration and economics in order to generate synergistic benefits,
- Presentation of the IWRM funding activities and their results to national and international audiences in order to encourage direct exploitation of the research and development results.

Many different activities have been launched:

- Organization of thematic workshops on central cross-cutting topics such as instruments for decision-making support, information management, capacity development, participation processes, analysis of stakeholders and institutions, and on the concepts, financing and implementation of IWRM,
- Organization of thematic working groups, trainings for PhD students as well as seminars at international conferences and exhibitions,
- Organization of an international IWRM conference in October 2011 in Dresden, with more than 350 scientists and in-the-field practitioners from more than 40 countries,

Fig. 74: A dialogue between science and practical application. More than 350 people from 40 countries took part in the international conference on IWRM in October 2011. → Photo: K. Sonntag

- Public relations measures including a comprehensive website, brochures, newsletters, presentations, video clips etc.

MAIN RESULTS

As an accompanying project, the IWRM networking project plays a key role in implementing the strategic aims of the BMBF funding initiative, providing a platform for communication, transdisciplinarity and knowledge transfer. The project encourages intensive dialogue between scientists, administrators and economists on integrative approaches to sustainable water resources management. The following conclusions can be drawn on the basis of these activities:

- The concept of Integrated Water Resources Management is now accepted throughout the globe and has been adopted as part of national water policy in many countries, resulting in the formulation of integrated management plans. This has been confirmed by a recent United Nations study (UN Water 2012). Nevertheless, progress remains unsatisfactorily slow in many areas. The main obstacles are to be found in the lack of an institutional basis for governance and participation and insufficient financing mechanisms.
- The Federal Ministry of Education and Research's IWRM funding initiative is meeting the complex requirements for sustainable water resources management through the development of modern tools for implementation. This involves both local and global challenges. Scientific models have been invented from scratch and implemented in the IWRM model regions. For the first time, these tools make it possible to comprehend entire regional water cycles and their relationships with land use. On the basis of these studies conducted at river basin scale, practical decision support tools have been developed that make complex situations easier to grasp, helping local administrators to manage water resources better.
- One of the key objectives of the IWRM funding initiative was to encourage long-term interdisciplinary and transdisciplinary cooperation between German and foreign partners aiming to find sustainable solutions. That this has been achieved with signal success can be seen in the number of jointly achieved project results and their implementation in the form of pilot and demonstration objects, such as prototype wastewater treatment plants and facilities for drinking water purification. German know-how has been put to good use to improve the local water situation in many areas. The successful technical solutions open many doors to allow German access to the international water market, and the long-term potential is immense.
- The boundary conditions for achieving sustainable management of global water resources are becoming increasingly complex. The task of securing a sufficiency of food, energy and water for an ever-growing population under the increasing pressures of global change represents mankind's greatest common challenge.

Strengthening Integrated Water Resources Management: Institutional analysis as an analytical tool and operative methodology for research projects and programmes ('WaRM-In')

↗ PROJECT DURATION

11/2010 – 07/2012

↗ CONTACT

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Fig. 75: A two-speed, modular research approach.
→ Source: IRS, Erkner

BACKGROUND AND OBJECTIVES

The success of attempts to strengthen IWRM is highly dependent upon the extent to which interventions are tuned to fit the institutional context of implementation. Many IWRM projects, especially those in developing and transition countries, have been criticized recently for failing to address adequately the prevailing political and institutional circumstances at local, regional, national and transnational scales. In future, research and development projects in this field should incorporate continuous analysis of institutional opportunities and constraints as a core feature of their work programmes. The aim is to address these needs by sensitizing researchers and practitioners to the political dimensions and institutional contexts. Such a task requires suitable analytical tools.

The WaRM-In project is addressing these needs by constructing a set of analytical instruments for the systematic evaluation of the institutional and political contexts in which IWRM is to be practised, together with a methodology for its application. Alongside this, recommendations are being provided for programme managers on how to promote projects on water research – within and beyond IWRM. This includes consideration and investigation of the institutional challenges facing IWRM both in development countries and transitional countries and in Europe, whereby some are very similar, others quite different. Of particular relevance here are the consequences in terms of the institutionalization of IWRM principles and practices that have emerged in the European context on account of the Water Framework Directive. With the aid of the analytical instruments to be developed on this basis, IWRM projects are to be refined and expanded both in their planning phases as well as during their implementation.

MAIN RESULTS

To achieve this end, a handbook has been drafted to provide an analytical framework for systematic treatment of specific political and institutional project boundary conditions as well as a methodological guide on how it is to be used during project development and implementation. The handbook is a structured aid based on inductive, 'bottom-up' principles that avoids prescribing explicit, generalizing concepts. Instead, it gives readers the opportunity to choose from a range of tested analytical methods and approaches that have been successfully applied in other projects and can be used as modular components and adapted to the respective local context. The WaRM-In approach has four key elements:

1) Four-stage approach: The approach is characterized by four distinct but interlinked stages containing the main aims, guiding questions, research steps and indicators, as well as recommendations for accessing analytical, methodological and conceptual research findings (Figure 76).
2) Two-speed approach: The approach is suitable both for thorough, in-depth analyses taking considerable time in the main phases of water research projects as well as for 'fast track' treatments, e. g. in pilot studies (Figure 75).
3) Modular approach: Specific research approaches function as building blocks that can be supplemented by or combined with others that have already been documented or tested in practice (open modular principle; Figure 75).
4) Iterative approach: The approach is conducive to iterative and cyclical processes. By working through all four steps again, or selected individual steps, findings obtained in previous cycles can be fed back in and reprocessed, allowing for regular updating of the research design and formulation of aims (Figure 75).

In particular, the handbook aims to achieve two important goals:

- an assessment as to how local solutions can be best promoted taking the institutional framework into account, and
- the investigation of paths leading to the transformation of institutional arrangements so that approaches may also be considered that initially do not fit well into the institutional framework.

The handbook can be adapted in respect of special (research) conditions prevailing in the field and the requirements of its users/of researchers. It is strongly oriented towards involving stakeholders throughout the four-stage process, thus encouraging regular reviewing and updating of research findings to ensure their veracity and usefulness.

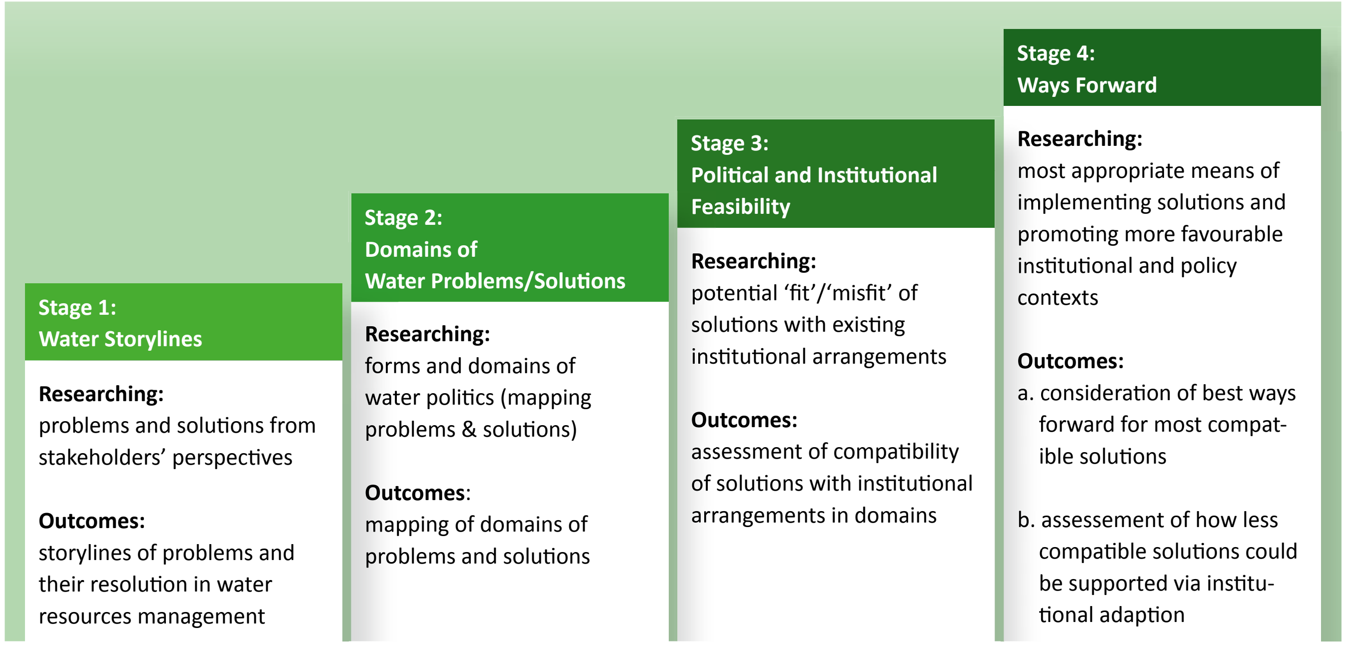

Fig. 76: Four-stage manual design. → Source: IRS, Erkner

Industry meets research: win-win scenarios in the field of Integrated Water Resources Management

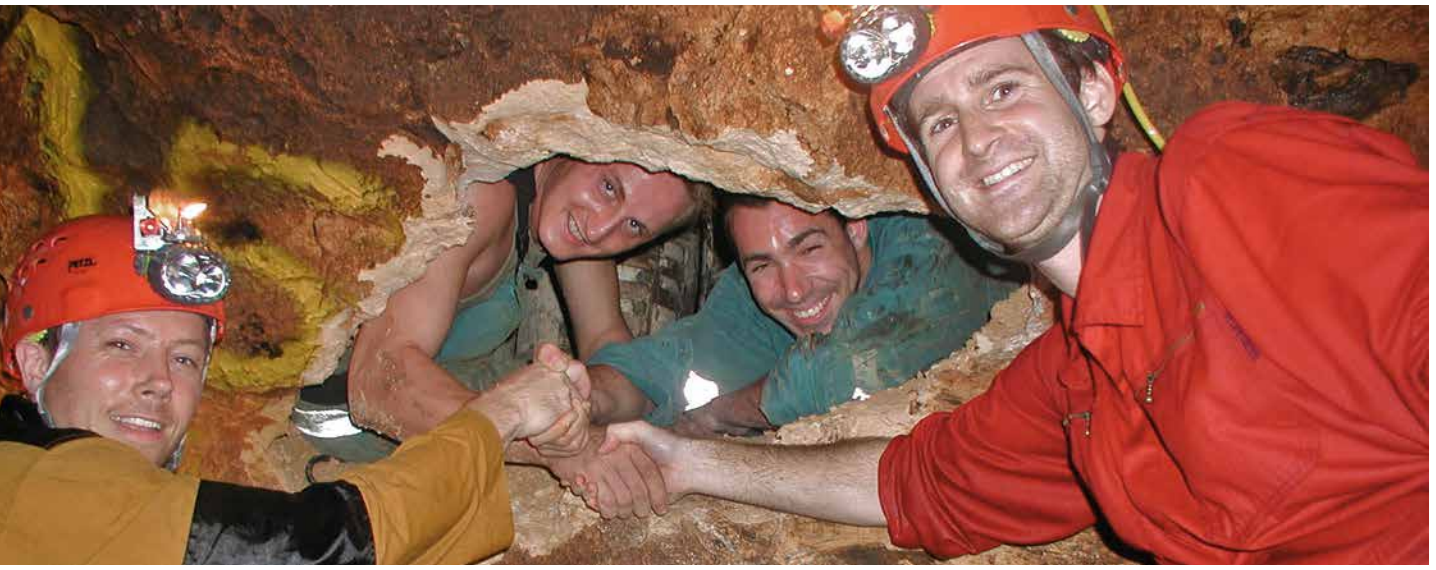

Fig. 77: KIT scientists and Herrenknecht engineers achieve a 'breakthrough': Successful digging of a shaft to a depth of 100 m; cooperation between research and industry, a true win-win situation.
→ Photo: IWRM project Indonesia

In order to manage water resources sustainably, close cooperation is often needed between research facilities and industry – between scientific partners who develop innovative alternatives and partners from industry who are in a position to implement them. Typically, water sector researchers elaborate innovative concepts for, for instance, decentralized wastewater treatment systems or groundwater desalination plants. Industrial stakeholders then provide their economic skills and investment capacity so that research findings can be applied on a large scale. Within a framework of suitable socio-economic and institutional conditions, cooperation of this nature can be of immense advantage, not least to the local people concerned.
But they are not the only stakeholders who can benefit. The process of cooperation between IWRM-related research and industry creates numerous mutual benefits: Particularly the partners from industry emphasise the significance of working together with research groups in politically unstable and poorly developed regions; this is seen as an essential factor towards achieving market penetration. Cooperation is also a prerequisite for addressing questions in depth in a way that is not possible within the limitations of a company infrastructure. Further benefits accruing from close cooperation lie in its potential with regard to staff recruitment and to advertising and promotion under the aegis of prestigious projects. Scientists, on the other hand, emphasise the scope for current and ongoing research opportunities and improved exposure for their products resulting from cooperation with partners in business. The latter factor is especially important to allow new technologies to be tested under real-life conditions. Finally, cooperation with industrial partners often goes hand in hand with valuable access to their production and testing facilities.
However, to ensure that the inhabitants of a project region experience long-term improvements in their quality of life, capacity development measures must always be accorded the same degree of importance as the cooperation between science and industry, and the socio-economic and institutional boundary conditions taken into account. In sum, all these activities can generate a real win-win situation – a 'public-private-people partnership'.

Conclusion

Fig. 78: Water is life.
→ Photo: www.iStockphoto.com/jpbcpa

IN RETROSPECT

Many threshold and development countries are facing major challenges in the water sector, and this applies to industrially developed countries as well. Integrated Water Resources Management represents a comprehensive framework for addressing water-related problems. The German Federal Ministry of Education and Research aims to incorporate the IWRM concept in tailor-made catalogues of measures as part of its funding strategy for integrated water resources management.
The research projects represent a range of approaches and regional foci that all contribute towards this strategy. The common themes running through all projects are their integrative approaches and the multilateral cooperation between project participants from Germany, partner countries, research communities, industry, politics and administrations. On the basis of these principles, the first important steps towards the development and implementation of made-to-measured management concepts have been taken in recent years. The implementation of the research concepts has been greatly facilitated by an accompanying project conducted by the International Bureau of the Federal Ministry of Education and Research that provides targeted advice to the project members. In addition, a flanking networking project has greatly facilitated the exchange of information. The projects presented here show that such cooperation is beneficial not only to the local people concerned and the scientists involved, but also to industrial partners.

THE WAY AHEAD

The main thrust of the IWRM funding initiative is to achieve productive cooperation across international boundaries, groups of stakeholders and individual problem scenarios. How should things proceed from here? What role should IWRM play in future research? What further results are to be expected from the IWRM projects?
IWRM will remain an important concept for sustainable management of water resources in future, but in many cases there is still room for improvement. As far as the current research projects are concerned, further findings pertaining to basic research questions are to come, conclusions to be drawn and solutions to be applied, with each target region and thematic area contributing its own input. Three main aspects are to be mentioned here: the implementation in pilot schemes, the assessment and modification of measures and their application in comparable scenarios elsewhere. As the exploitation of research results gains in importance, so does the need to intensify cooperation between researchers and industrial stakeholders.
The extent to which these common efforts towards attaining sustainable management of water resources in the model regions succeed depends to a great extent on the social and political boundary conditions. This means that both the transfer of know-how as an aspect of capacity development as well as the local, national and international governance infrastructures in the model regions represent crucial factors determining the feasibility of sustainable solutions. Facing these fundamental challenges forms part of a long-term process of reform leading to sustainable water resources management.

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Integrated Water Resources Management (IWRM) – this term is now a global descriptor for modern and sustainable treatment of water resources. This management concept was established as early as 1992 as an international guiding principle within the framework of the Dublin Principles and the Agenda 21. To ensure that current and future activities are supported by means of scientifically proven tools and methods for the implementation of IWRM concepts, the German Federal Ministry of Education and Research has inaugurated an Integrated Water Resources Management funding initiative. This brochure provides information about all the research projects being promoted within the scope of the initiative as well as associated topics.

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