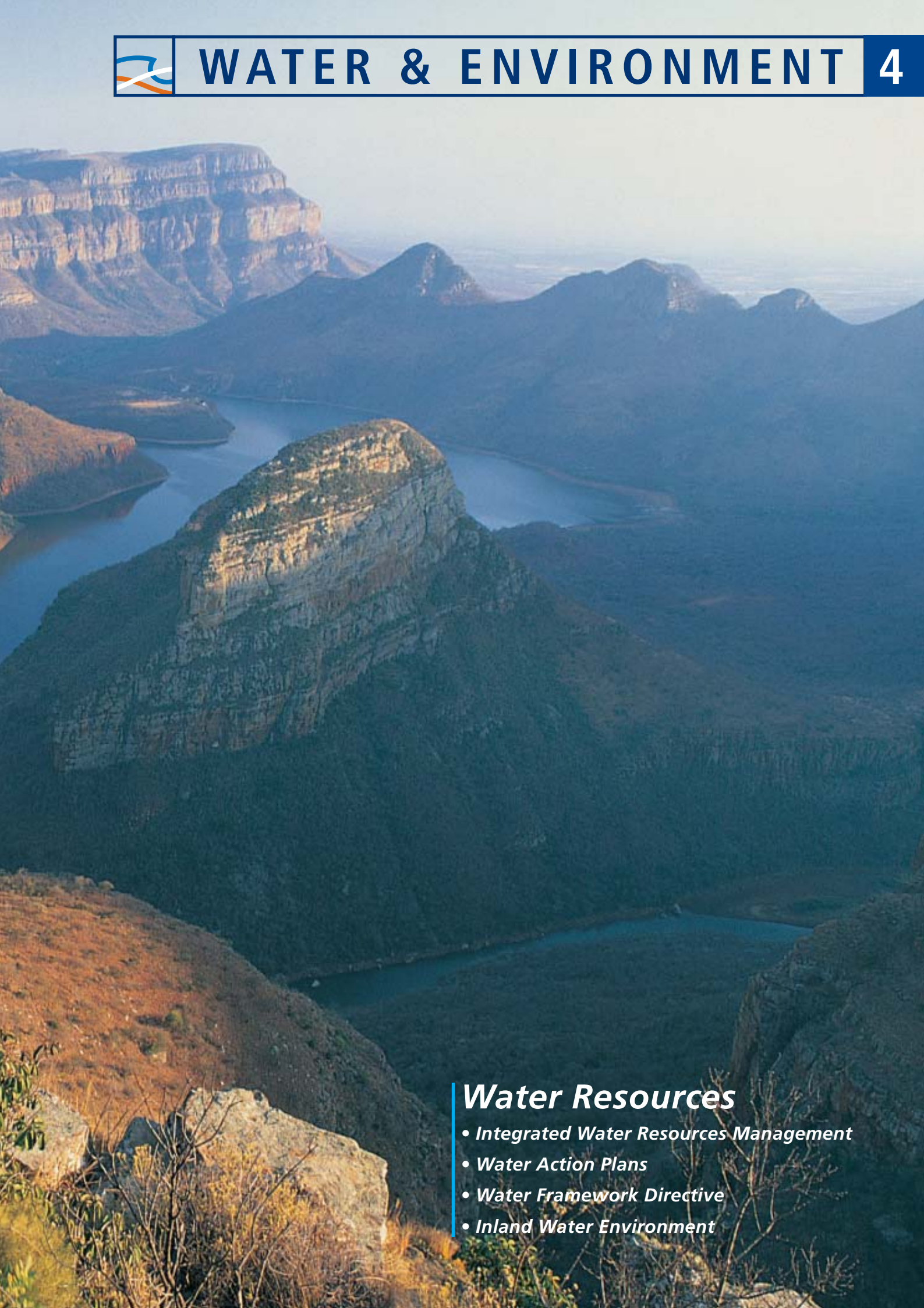

Water Resources

- *Integrated Water Resources Management*
- *Water Action Plans*
- *Water Framework Directive*
- *Inland Water Environment*

Contents

Blyde River Canyon, South Africa.

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- *Getty Images: cover*
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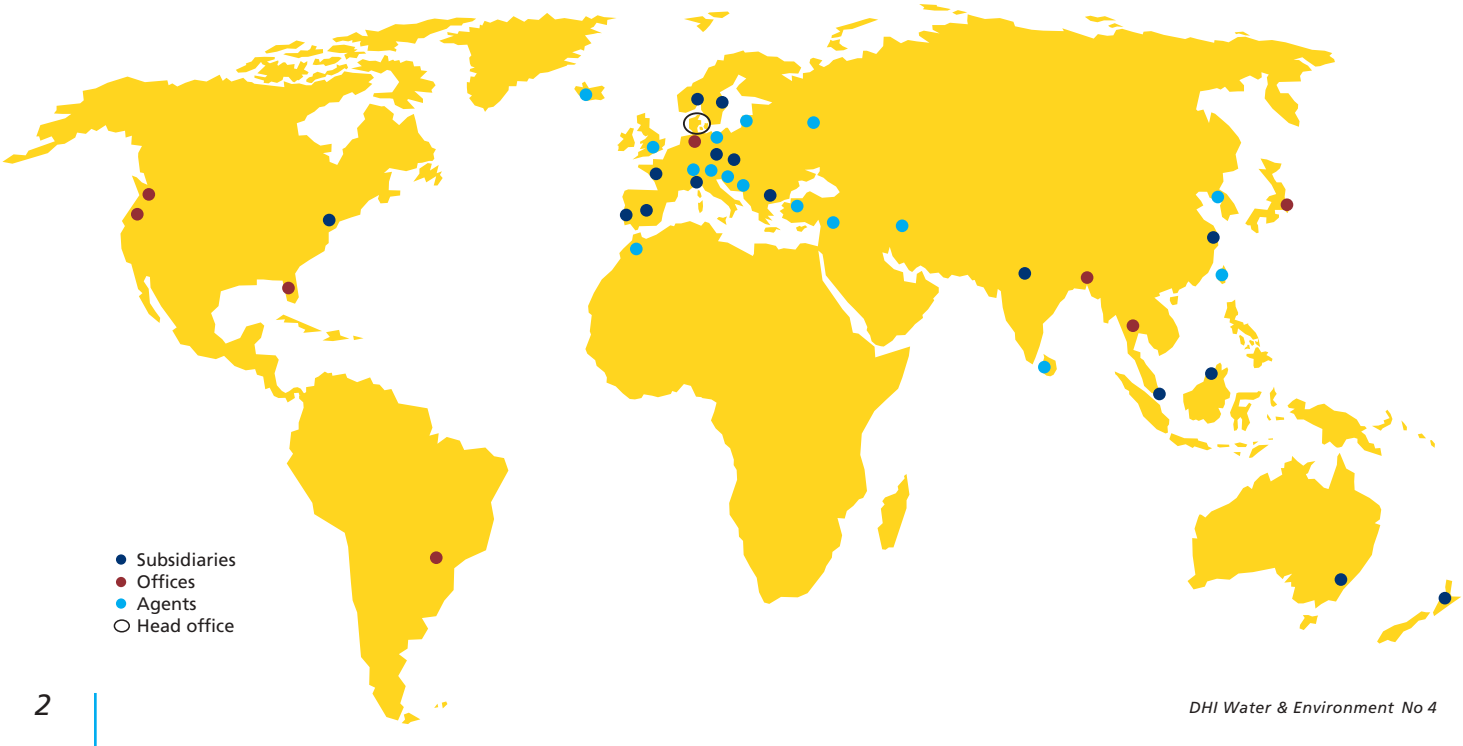
DHI Water & Environment

DHI Water & Environment is an independent, international consulting and research organisation.

The consulting services are based on the development and application of know-how and advanced technologies within coastal, river, ports and offshore engineering as well as ecology, water resources, hydrodynamics and other areas related to the water environment.

DHI offers a wide range of services and products, including consulting services, laboratory testing, physical hydraulic model testing and software tools.
Our staff numbers approximately 450, including 170 working in our 15 international offices.
DHI is authorised by the Ministry of Science, Technology and Innovation as a member of the GTS-Advanced Technology Group, a network of nine independent Danish research and technology organisations.



This issue of Water & Environment addresses one of the key sustainable development issues of our time: Water Resources. The world faces serious water challenges, both in terms of quantity and quality of freshwater. Only with improved management of this precious resource will mankind be able to sustain population and economic growth over the coming decades.

Recent international events have spelled this out very clearly: the UN Millennium Declaration, adopted in 2000, calls for dramatic progress in the provision of water supply and sanitation to the billions of people without appropriate access to these services; the World Summit of Sustainable Development (WSSD) in Johannesburg in 2002 focused strongly on water, and calls for all countries to 'develop Integrated Water Resources Management and Water Efficiency Plans by 2005'; the European Union has adopted the Water Framework Directive for its soon 25 countries to manage their water resources sustainably; and the Commission of Sustainable Development (CSD) has decided to focus on water, sanitation and human settlements in 2004-2005. Water has never in history been higher on the global political agenda than right now!

DHI Water & Environment is a key player in raising awareness about and developing approaches and technologies to deal with this challenge. We tell about this in the following pages: about Integrated Water Resources Management and the European Water Framework Directive as important ways to address the challenge, while keeping focus on the critical link between freshwater management and its interaction with the coastal environment.

As a leading water institute, the provision of services to public and private stakeholders in the technologies and management approaches to water resources is one of our top priorities.

A number of international organisations have turned to DHI to assist them in pursuing this important agenda: the United Nations Environment Programme (UNEP), the Global Water Partnership (GWP) and the World Health Organisation (WHO).

As Collaborating Centre for UNEP, under the name UCC-Water, we assist UNEP in the implementation of its water policy, with primary focus on the link between freshwater and coastal zone management as well as the environmental aspects of IWRM.

As Technical Advisory Centre for GWP DHI has since the inception been technically responsible for the development of the IWRM ToolBox of GWP.

As Collaborating Centre for WHO on Water and Health we combine our expertise in water resources and environmental health and chemicals management to assist WHO in developing and disseminating approaches to address water related health issues.

Recently DHI contributed to creating Danish Water Forum, DWF, as a partnership of some 40 public and private Danish institutional members with an interest in international water issues. We now host the Secretariat of DWF to provide knowledge management on international water resources issues to our partners.

We hope that you will enjoy reading about these challenges and our efforts to help you and others in addressing them.

Torkil Jønch-Clausen
Development Director

Integrated Water Resources Management

Rice production consumes a large part of the water resources available in the world.

The concept

Integrated Water Resources Management, IWRM, promotes the coordinated development of water, land and related resources in order to improve economic and social welfare without compromising the sustainability of vital ecosystems (GWP March 2000). It addresses water governance broadly and is an approach to build compromises between competing demands for water among societal sectors and stakeholders at all levels.

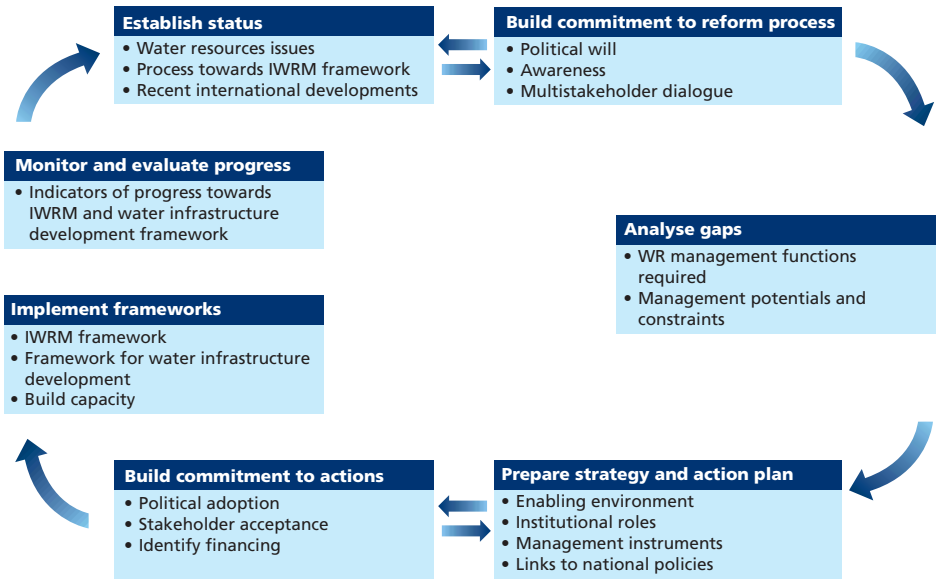
The recognition of the need to redress effects of weak water governance structures has convinced many countries that a new water management framework is needed.

This framework is in fact a question of getting 'three pillars' right:

- Moving towards an *enabling environment* of appropriate policies, strategies and legislation for sustainable water resources development and management
- Putting in place the *institutional framework* through which implementation of the policies, strategies and legislation take place
- Setting up the *management instruments* required by these institutions to do their job.

Global Water Partnership (GWP), a worldwide network promoting and assisting IWRM, is drawing on the expertise of DHI as an advisory centre. Since its establishment in 1996 GWP has been assisted by DHI in the development of the concepts of IWRM, the development of an IWRM ToolBox for exchange and sharing of knowledge and in the development of guidance documents for IWRM.

The generic process towards IWRM



IWRM and the Water Framework Directive

IWRM is an important instrument for developing countries to address poverty reduction and work towards the achievement of other goals related to hunger, health and environmental sustainability.

For more developed countries IWRM is a mechanism for sustainable development and management of their waters with primary focus on the ecological status. In most regions of the world, rich or poor, IWRM approaches are required to ensure reasonable and equitable water sharing between countries.

Ensuring that the environment gets its fair share of the water resources available will influence the future water use. Cleaner technologies are able to reduce the demand in various industrial sectors. Urban water demands can be reduced by means of new technologies. Other sources of supply can be used for less demanding purposes, eg for irrigation.

The integrated management of water resources at river basin level is a new concept in many of the EU member states. An area of concern is the increasing groundwater abstraction that has lowered the groundwater in several

The Water Framework Directive

In the European Union the adoption of the Water Framework Directive (WFD) reflects the emphasis put on environment and sustainable water use in this part of the world. The principles of IWRM are inherent parts of WFD.

WFD promotes an integrated management approach and defines the river basin as the relevant management unit. It sets the objective of *good ecological status* for all waters in Europe before 2015.

regions, resulting in drying-up of rivers, streams and wetlands. In other regions with limited groundwater reserves, the surface water resources are also scarce and water shortage will be the result if actions are not taken.

Taking these perspectives into consideration, the requirement of WFD to ensure a proper share of the water resources for the environment becomes an even greater challenge. Implementation of WFD is ongoing in the expanding European Union and DHI is involved in numerous activities and projects supporting the implementation of WFD.

Water Action Plans

Although in some cases well endowed with water, many countries need an increased capacity to manage and protect the water resources in a sustainable manner.

Integrated water resources management is a necessity to cope with large annual fluctuations in river flows in Burkina Faso.

A road map towards IWRM

The preparation of Water Action Plans marks the beginning of the road towards IWRM. Water Action Plans are often prompted by macro-economic considerations and a need to avoid negative health impacts and loss of productivity due to water quality degradation. Soil degradation and loss of productive lands, floods and droughts are also examples of issues urgently requiring rational management of water.

A Water Action Plan is a milestone in the IWRM process and takes stock of the progress, summarises agreed improvements in the IWRM framework and sets out actions designed to achieve these improvements.

The Plan of Implementation from the World Summit on Sustainable Development, Johannesburg 2002, is to start water resources reforms by 'developing Integrated Water Resources Management and Water Efficiency Plans by 2005'. These plans are in most aspects identical to Water Action Plans. DHI assisted in the development of the Water Action Plans for Uganda and Burkina Faso, as well as similar Water Action Plans in Nicaragua and for Sre Pok, Vietnam.

Uganda Water Action Plan

An IWRM process was started in Uganda in 1993, at a time when civil strife had caused the break-down of all water monitoring and information systems, when institutional capacity was low, when water policy and legislation were rudimentary and, consequently, when water resources management was seriously constrained.

The first milestone in the IWRM process, guided by DHI, was the development of the Water Action Plan – the first of its kind following the international principles agreed upon at the UN Conference on Environment and Development in Rio 1992.

The action plan outlined a framework for water resources management based on the identification of the key water resources issues set against the background of gaps and constraints in the enabling environment, the institutional roles and the management instruments.

The action plan
- assisted the development of the water resources policy and the legislative framework
- defined short term and long term roles and responsibilities of the involved institutions
- assessed their needs for capacities, capabilities and management instruments.

Cross-sectoral aspects were dealt with in a committee with representatives from a number of relevant ministries, from districts, from water service providers and from private sectors. A number of actions were programmed, all aiming at supporting the overall policies and strategies. Among these were the *Strengthening of the Water Resources Monitoring and Assessment Services in Uganda, Water Sector Capacity Building, Water Resources Management* and *The Water Sector Reform Studies* linking water resources management to reform requirements for water services delivery.

Over the past ten years the IWRM framework has been built up to a degree where Uganda has asserted its role in the Nile Basin. A consistent policy and legislation provide guidance and rules for priorities of water use, allocation and wastewater discharge and stakeholder participation and decentralisation provide local level involvement.

The identified programme activities of the Water Action Plan 1994 provided the road map for this development, which has contributed to empowerment, both at local, regional and international levels.

Burkina Faso Water Action Plan

Confronted with serious water resources problems constraining development, Burkina Faso decided to prepare an action plan setting out the future framework for integrated water resources management and identifying the specific actions and means for their implementation.

The elaboration of an action plan for IWRM reflects Burkina Faso's determination to address its severe water resources management issues and its will to take part in the global commitments made at the conferences in Dublin and Rio de Janeiro.

The overall objective of the action plan is to contribute to the implementation of IWRM adapted to the national context and the national policies. At the same time it reflects the principles of sustainable and ecologically viable rational water resources management.

The underlying strategies of the planning process were to:

- implement an integrated approach rather than a sectoral approach
- support the disengagement of the Government from water production and services and management of irrigation schemes
- propose an institutional and human resource plan for the public administration of water resources
- develop an efficient and stable management framework at appropriate ministerial levels and propose a restructuring process.

The key steps of the planning included: assessing the status, adapting the legal framework to IWRM principles, identifying key water resources management issues and developing an action plan.

A permanent secretariat was established to implement the decisions of the management committee of the action plan. Its responsibility is to define operational strategies for implementation, to elaborate annual activity programmes and to mobilise and manage financial resources necessary to implement the action plan.

IWRM and WFD tools

▲ *The Water Framework Directive requires water managers to restore and protect the water environment - and to document the effect of their actions.*

Need for tools

Integrated Water Resources Management at a global scale and the implementation of the Water Framework Directive in Europe comprise challenging tasks that require substantial resources and time. Efficient tools are needed to support the process. These tools have to be adapted to the tasks ahead. In addition, these tools should encapsulate the knowledge and experience obtained by the professionals involved, reflecting state-of-the-art technology.

IWRM ToolBox

The Global Water Partnership is drawing on the expertise of DHI as an advisory centre. DHI has assisted in the technical development of an IWRM ToolBox for exchange and sharing of knowledge on Integrated Water Resources Management.

The ToolBox addresses:
- policies and legislation
- institutional roles
- management instruments

and builds on the vast experience in water resources management by professionals around the world. The ToolBox enables the user to search for general guidance within IWRM and to find case story examples of how specific issues have been addressed. Many of the items are just as relevant to European authorities as to water resource managers outside Europe.

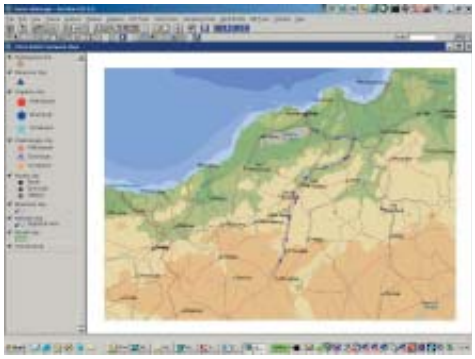
MIKE INFO Land and Water

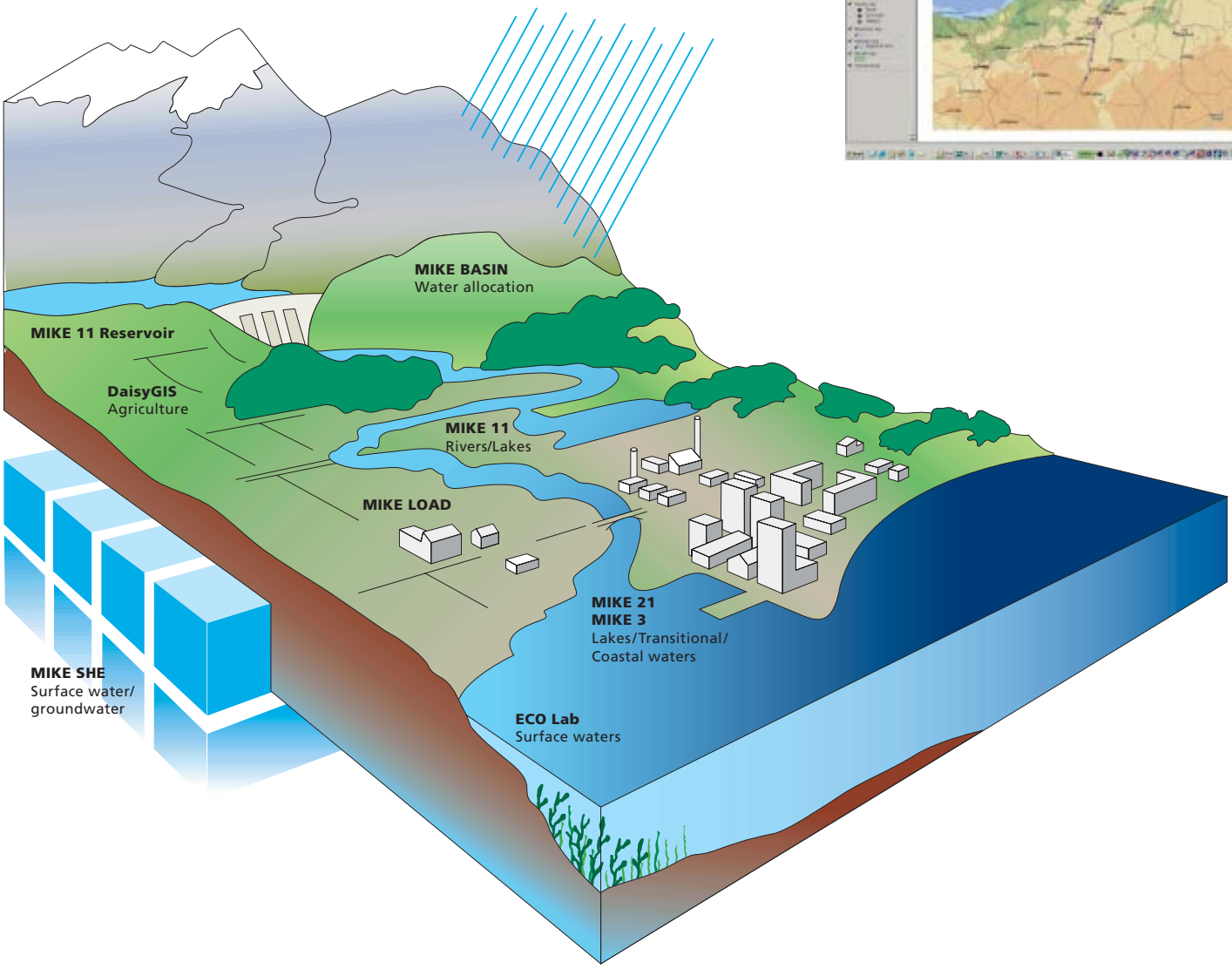
DHI has developed a series of GIS tools allowing the user to manage spatial and temporal data for tasks involving the comprehensive analysis of land and water systems.

These tools provide overview of all types of spatial data and, at the same time, support the implementation of the Water Framework Directive.

The various GIS tools can be used as stand-alone tools or in connection with DHI's modelling tool MIKE BASIN.

MIKE BASIN is a powerful planning and management tool at the river basin level.





MIKE BASIN is a GIS-based decision support system developed to help planners and managers get a complete overview of the water resources available and the use on a basin level. It is simple to use, but yet powerful and enables the user to ask the important 'what-if' questions in a planning context. Changes in water use and water consumption can be compared to future water allocation strategies to obtain an optimal, balanced and sustainable water use locally, regionally and on a wider basin scale.

Special features

- Watershed delineation tools
- Groundwater/river source links
- River routing
- Water supply and irrigation allocation
- Multipurpose reservoir operation
- Hydropower generation
- Low flow controls
- Priority-based allocation principles
- Optimisation of water allocation

New features added

- Optimisation procedures for reservoir operation and water allocation
- Interactive use of MIKE BASIN using the internet
- Linkage to macro-economic assessments
- Soil erosion and sediment transport

MIKE SHE is a comprehensive system for modelling all major processes occurring in the land phase of the hydrological cycle. MIKE SHE is applicable to spatial scales ranging from a single soil profile to large regions, including several river catchments for the analysis, planning and management of a wide range of water resources and environmental problems related to surface water and groundwater.

New developments of grid-based, large scale hydrological modelling have been prompted by increasing access to meteorological modelling, radar and satellite remote sensing as well as by the need for distributed modelling.

Operational large scale hydrological modelling requires a trade-off between model complexity and accuracy and the need for efficient calculations to reduce the computation time. DHI's approach is to further develop the state-of-the-art grid-based hydrological modelling tool, MIKE SHE. That will include simple conceptual process descriptions and the existing physics-based model structures to be used in IWRM studies on a large scale. In practice, simpler simulation options for surface flows, river flows and subsurface flows have been implemented.

IWRM and the Coastal Environment

Integrated Coastal Area and River Basin Management is needed when important links between river systems and coastal systems are not accounted for in the traditional management frameworks. Such links may comprise:

Links and interactions in the aquatic ecosystems, eg

- **Changes in upstream river regimes, affecting the salinity and tidal conditions in estuaries and lagoons**
- **Increased pollution and sediment discharges into sensitive coastal ecosystems**
- **Saltwater intrusion and tidal flooding in near shore river systems**
- **Backwater effects due to changes in coastal morphology**

Constraints to linked management

- **River basin authorities having limited concern for adverse impacts in downstream coastal waters, like estuaries, lagoons, etc**
- **Coastal planning authorities without mechanisms to control important impacts from upstream river systems**
- **Fisheries management authorities with limited mandate to control pollution impacts**
- **Administrative and sectoral fragmentation of planning processes**

Links between river basin and coast

The IWRM and ICZM concepts (Integrated Water Resources Management and Integrated Coastal Zone Management) are increasingly appearing high on the international agenda. This position is based on the declarations from the UN Conference on Development and Environment in Rio de Janeiro and Agenda 21 in 1992.

A parallel development of principles for the management of freshwater and coastal waters has taken place and the IWRM and ICZM concepts show many similarities. However, freshwater and coastal waters are still generally managed in different institutional environments paying too little attention to important impacts from upstream activities on the downstream coastal areas.

A new international initiative has been taken by UCC-Water, the UNEP Collaborating Centre on Water and Environment at DHI, and by GPA, the UNEP Global Programme for Action. Thus, a new partnership initiative on linking IWRM and ICZM was launched by UCC-Water and GPA at the World Summit on Sustainable Development in Johannesburg, August 2002.

The objective of the partnership (FreshCo) is to provide management options for solving problems originating from the interrelation between human activities in the river basins and those in the coastal zone. The partnership identifies good practises and experiences at policy/legal, institutional and technical levels through pilot projects and contributions from the partners and stakeholders.

Moreover, it disseminates the results to relevant decision makers and stakeholders through channels such as international meetings, regional workshops and the Internet, the latter in collaboration with the IWRM ToolBox of the Global Water Partnership. Some 20 initial partners, including UN agencies, intergovernmental institutions, governments, NGOs and international water institutes, have joined the initiative.

More information on: www.ucc-water.org

Songkhla Lake

The Songkhla Lake Basin is a highly unique and valuable economic and ecological region in southern Thailand comprising lakes, wetlands and the coastal region.

An Integrated Environmental Management Project (IEMP) has been implemented as an ongoing interactive strategic process dealing with environmental and development issues in an integrated and participatory manner. It constitutes an important planning tool for ensuring sustainable development.

The IEMP for Songkhla, which was carried out by DHI for the Government of Thailand and supported by DANCED, included development analysis, environmental analysis and affordability analysis. Development policies and strategies were formulated by balancing development benefits against economic and environmental costs. On this basis environmental objectives and strategies were developed.

Cambodia

The coastal zone of Cambodia is in a state of rapid development. Apart from the country's main deepsea port, Sihanoukville, the coastline is characterised by mangroves and sandy beaches. The infrastructure is imperfect and the natural resources are threatened in different ways.

Typical livelihoods are fisheries, traditional small scale as well as modern large scale, shrimp farming and several subsistence occupations related to mangrove areas (seaweed farming and charcoal manufacturing). Tourism is another important possible livelihood activity, not yet exploited to its full potential.

The environment (and thus also the basis for fisheries) is threatened by overexploitation and degradation of mangroves, enhanced by migration from inland to coastal areas. Therefore, it is prudent to identify alternative livelihoods for the poorest part of the coastal population.

With support from Danida DHI assisted the Government of Cambodia in the implementation of ICZM for the entire coastal area of the country. The project covers administrative and legislative strengthening within multidisciplinary management of water and natural resources and direct poverty alleviation by implementation of alternative livelihoods on a pilot scale.

The work was carried out with active participation by national sector agencies, provincial authorities and NGOs.

Senegal River

A pilot study on Integrated Coastal Zone and River Basin Management was carried out for the Senegal River. The environmental problems were characterised and prioritised. Issues included modification of streamflow, landscape degradation, reduced biodiversity, soil degradation, pollution of water and public health problems.

The first phase of the project identified weaknesses in public involvement. In addition, mediation mechanisms and institutional linkages and recommendations for improvements were elaborated. A second phase will include testing of proposed management options. The pilot study was assisted by UCC-Water at DHI.

▲ *Degradation of the coastal environment may also affect the fisheries and the livelihoods of the coastal population.*

Inland Water Environment

Pressure on the environment

IWRM is not only a question of having sufficient water of acceptable quality for the various categories of users. Water resources should sustain the environment in a broader sense, maintaining the ecological balance and safeguarding the natural resources.

Environmental flows

The growing demand for water has put a tremendous pressure on the global freshwater resources, be it surface water or groundwater. Most regions suffer from water stress to some extent; the losers are often the aquatic and terrestial habitats, which are dependent on the same water resources as human beings.

Environmental flow is a term reflecting the establishment of special flow reserves to protect the natural environment from the effects of overexploitation of water resources. There is as yet no standard method to do this! Every catchment has its own individual features which should be taken into account. Vital habitats are being destroyed every day due to overexploitation of water resources and water managers must take the principles of environmental flow into consideration.

DHI has carried out a wide range of projects in which environmental flow has been one of the key issues.

Wetlands

Wetlands are recognised as precious elements in the preservation of natural resources and aquatic ecosystems. They sustain not only their own inherent ecosystems, but also act as breeding and resting grounds for migrating fauna and as spreading corridors. In recent years, their role as natural filters reducing nutrient pollution has increasingly been recognised.

However, no water - no wetland! Wetlands are lost at an increasing rate due to upstream water use and diversion as well as drainage and siltation. In maintaining and restoring wetlands it is important to consider the water and sediment balances and their interaction with habitat development, biodiversity and nature conservation, and nutrient retention.

DHI offers broad and integrated services as well as models for the optimisation of wetland management including all above-mentioned aspects.

For the Chinese goverment DHI has been involved in an ADB-funded project establishing the 'Carrying Capacity of Water Resources', an example of application of the environmental flow approach.

Over the years DHI has been involved in numerous research programmes and studies of wetlands worldwide.

Okavango

The Okavango Delta is a unique 6,000 km^2 flooded swamp in the interior of Botswana. The existence of the delta (having no outflow to the sea) depends on the inflow from the upstream tributaries in Namibia and Angola.

In order to establish a prediction model to answer 'what-if' questions regarding the water and sediment balance, an integrated surface water and groundwater model based on DHI's MIKE SHE and MIKE 11 models is being used to quantify the expected effects in the Okavango Delta from:

- climatic changes
- changes in groundwater exploitation around the delta
- dredging of new channels
- cutting of reed
- upstream developments such as irrigation, water supply and hydropower.

The Okavango model will support the development of the Okavango Delta Management Plan and is financed by the Government of Botswana and various donors, including Danida.

In parallel, an EU-funded project, TWINBAS, supports the integration of the activities into an international research network covering river basins in Sweden, the UK, Kazakhstan and Chile.

Everglades

The water resources in South Florida are under heavy stress due to the rapidly increasing population. There is a growing awareness of the need to protect the unique aquatic ecosystems in the Everglades.

To achieve the goals set out for the protection and restoration of the Everglades, the South Florida Water Management District early realised that an integrated water management strategy was needed. The MIKE SHE system was selected as the most suitable decision support tool due to its integrated surface water/groundwater description.

DHI has been awarded a number of integrated water resources management projects in South Florida, which has further emphasised DHI's position as a world leader in development and application of integrated modelling systems.

Sundarbans

The largest remaining mangrove areas in the world are the Ganges Delta, West Bengal in India, and the Brahmaputra Delta, South West Bangladesh. A comprehensive modelling system covering the intricate river and floodplain network was set up in the 90s in a collaboration between DHI and the Institute for Water Modelling in Bangladesh. Over the years, the model system has been used in various projects describing environmental parameters affecting the ecosystem such as salinity, suspended solids, flooding patterns and morphology.

WFD Projects

DHI assisted the Lithuanian government with the implementation of the Water Framework Directive.

Denmark

Denmark is at the leading edge when it comes to analysing the implications of the WFD and application of fertilisers. The European pilot basin of Odense River and the major Skjern River catchment were studied in detail. The run-off of nutrients from primarily agricultural areas into the river and coastal environment was monitored and assessed using integrated surface and groundwater models.

The projects prepared under the third Danish Water Environment Plan constitute an important element of the implementation of WFD. DHI carried out detailed mathematical modelling assessments.

Estonia

DHI assisted the Government of Estonia in the EU approximation process, establishing a river basin management plan for the Matsalu Subriver Basin District in accordance with WFD and the Estonian Guidelines.

DHI was responsible for the implementation of the project and transfer of GIS tools to the Estonian Ministry of Environment and to the river basin authorities. The information and modelling systems were used to:

- define the reference situation
- assess the likelihood of meeting the water quality objectives for various anthropogenic stresses
- define monitoring plans
- prioritise investment schemes
- assess programme of measures and hence
- assist preparation of river basin action plans.

Lithuania

is one of the few countries in Europe using groundwater resources exclusively for water supply, and its protection has top priority.

By providing tools for groundwater and surface water assessment in the country, DHI assisted the Lithuanian authorities implementing WFD.

The tools comprise an integrated package of GIS technology, databases and groundwater and surface water models based on the MIKE technology, eg MIKE BASIN, MIKE 11, Daisy and MIKE SHE.

Greece

In Greece DHI was involved in the development of water resources management systems and tools for the water districts of the western, Central and Eastern Macedonia and Thrace.

The projects implemented a comprehensive water resources management system assisting the Government in the general planning and management of the water resources in accordance with WFD.

Piemonte

The Piemonte region covers an area of more than 25,000 km^2. DHI supports the development of water resources management tools used for the implementation of WFD through its local company Intecno-DHI. Several water resources models have been applied as support for the planning. The tools are used to investigate various schemes for reorganisation and/or rationalisation of the water use in the region with focus on the overall water management and water budget.

DHI provides the tools for water management to authorities in Central and Eastern Greece, allowing them to comply with the Water Framework Directive.

The system covers the largest and most populated part of the Greek territory and contains:

- a comprehensive GIS-based water information system
- analysis tools creating overview and knowledge from these data
- an integrated surface and groundwater modelling system with high flexibility in relation to degree of details and input data demand
- a management model, including economic features for planning and optimising the region's water exploitation and allocation

Czech Republic

In the Czech Republic DHI Hydroinform has developed methods for identifying heavily modified water bodies. Moreover, DHI Hydroinform prepared

recommendations for establishing reference conditions at basin and subbasin levels in accordance with the WFD guidelines. Tools based on information available from the River Basin Authorities were prepared.

The designation of the conditions was based on observed morphological changes, changes in water flow and water use. The project, funded by the Flemish Government, represents the practical application of WFD in the Czech Republic.

DHI Software
SHORT NEWS

New developments in DHI's flood modelling technology

Since the first release of MIKE 11 in 1987, DHI has been a leader in river flow modelling technology. Experience from numerous large flood modelling projects, eg in Bangladesh, has been turned into practical tools for flood modellers around the world. The latest developments involve linking of the traditional 1D modelling techniques with 2D (and later 3D) techniques into even more powerful engineering tools.

New MIKE FLOOD features

MIKE FLOOD allows a choice between a 1D and a 2D model representation of a river with flood plains and estuaries. The user can mix the two types of representation freely using a more detailed 2D representation when needed, while maintaining the less computationally intensive 1D representation for other areas. This makes MIKE FLOOD a very cost-effective tool for flood studies involving a combination of open channels, flood plains and estuaries.

New capabilities are continuously being added to MIKE FLOOD. In the latest releases, more options have been included for the linkage between 1D and 2D model areas and a more comprehensive library of hydraulic structures is available.

MIKE URBAN FLOOD

Flooding in urban areas typically includes flows in a subsurface drainage system and flows in the streets and adjacent areas. Traditionally, the drainage system has been modelled using a 1D pipe flow model, while the street flows have been approximated either as surface storage or as a second 1D open channel layer.

With MIKE URBAN FLOOD it is now possible to combine the 1D drainage system model with a 2D overland flow providing a much more detailed and correct representation of the interaction between the two parts of the system.

The integrated solution

Work is progressing on the fully integrated flow modelling tool set, which includes tools for pipe flow, river flow and overland flow. The comprehensive solution will make use of the MOUSE, MIKE 11 and MIKE 21 numerical engines. A pilot application has been carried out for a study area in Hong Kong. Development is progressing on the user interface, which will make extensive use of GIS components.

It is expected that the integrated tool set will be released for general use in 2005.

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