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The Iraqi Marshlands are the largest wetland ecosystem in the Middle East and Western Eurasia. By the time the former regime collapsed in 2003, the Marshlands had almost been destroyed. UNEP's Iraqi Marshlands project is contributing to their sustainable management and restoration through the identification and implementation of suitable mitigation options, particularly for drinking water, sanitation systems, and Marshlands water quality management. Implemented by the International Environmental Technology Centre (IETC), the Marshlands project includes stakeholder training, coordination with Iraqi authorities and other stakeholders, communication and dialogue through the Arabic-English Marshlands Information Network (MIN), and pilot projects to introduce Environmentally Sound Technologies (ESTs) to the Marshlands communities.

DTI/0722/PA

UNITED NATIONS ENVIRONMENT PROGRAMME

Back to Life

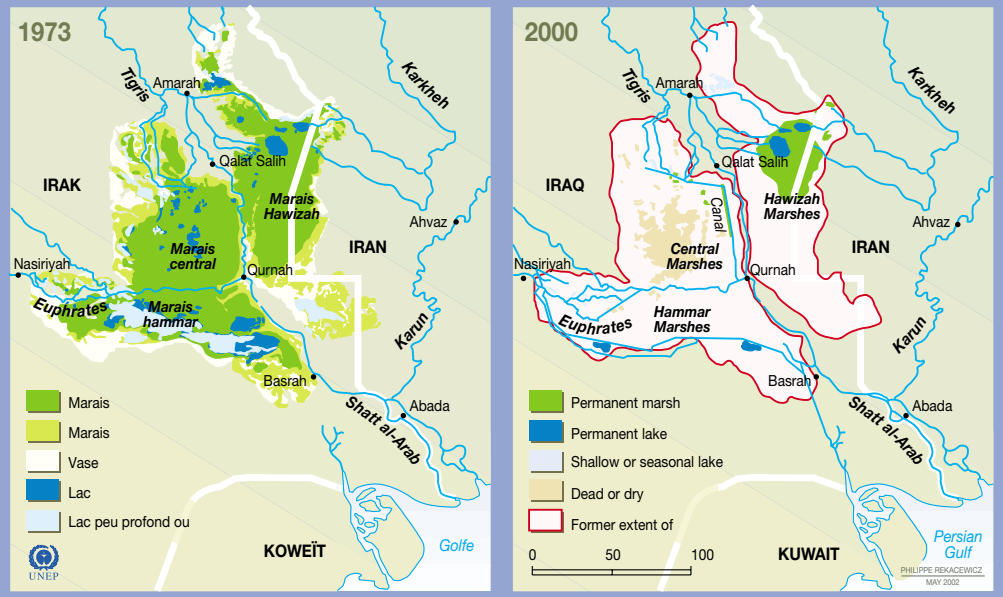
Environmental Management of the Iraqi Marshlands

The Iraqi Marshlands are one of the world's largest wetland ecosystems. By the time the former Iraqi regime collapsed in 2003, these Marshlands - with their rich biodiversity and unique cultural heritage - had been almost completely destroyed.

Extensive ecological damage to this area, with the accompanying displacement of much of the indigenous population, was identified by the United Nations Environment Programme (UNEP) and the United Nations/World Bank Needs Assessment Initiative for the Reconstruction of Iraq as one of the country's major environmental and humanitarian disasters.

In 2001, UNEP alerted the international community to the destruction of the Marshlands when it released satellite images showing that 90 percent of the Marshlands had already been lost. Experts feared that the Marshlands ecosystems would be completely lost within three to five years unless urgent action was taken. UNEP has continued to be the leading agency reporting on the condition of the Marshlands.

As the former regime ended, people began to open floodgates and break down embankments that had been built to drain the Marshlands. Re-flooding has since



Note: These two maps are sourced from satellite images and maps originally created by GRID-Geneva.

Source: The Mesopotamian Marshlands: Demise of an Ecosystem, United Nations Environment Programme (UNEP), Division of Early Warning and Assessment (DEWA), 2001.

occurred in some, but not all, areas. Satellite images and analysis by UNEP show that approximately 30 percent of the total Marshlands area has been re-flooded.

Water quality problems include contamination by pesticides, by untreated industrial discharge, and by sewage originating upstream. Pollution and the salinity levels of both water and soil are in part influenced by the flow of water, or lack thereof, through the Marshlands.

A 2003 UN inter-agency assessment and a public health survey conducted by the U.S. Agency for International Development (USAID) indicated that safe drinking water had become the inhabitants' most critical need. While some people could buy tanker water, many others had no choice but to drink untreated, unfiltered marsh water. UNEP's dialogues with the local communities and government officials have also confirmed that the provision of drinking water is the number one priority for the local population.

To protect human health and livelihoods and to preserve the area's ecosystems and biodiversity, the Iraqi authorities included water quality and Marshlands management on the priority list for reconstruction under the United Nations Development Group (UNDG) Iraq Trust Fund and made direct appeals to donor governments for assistance.

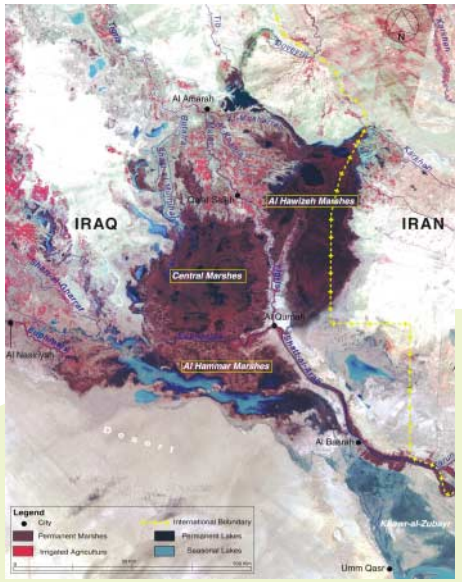
UNEP's project to help Iraq restore and sustainably manage the Marshlands

"Support for Environmental Management of the Iraqi Marshlands," the UNEP Marshlands project, is helping Iraq restore the environment and provide clean water and sanitation systems for up to 100,000 people living in or near the Marshlands. As the marshes are re-flooded and the displaced population returns, the number of inhabitants could potentially reach half a million.

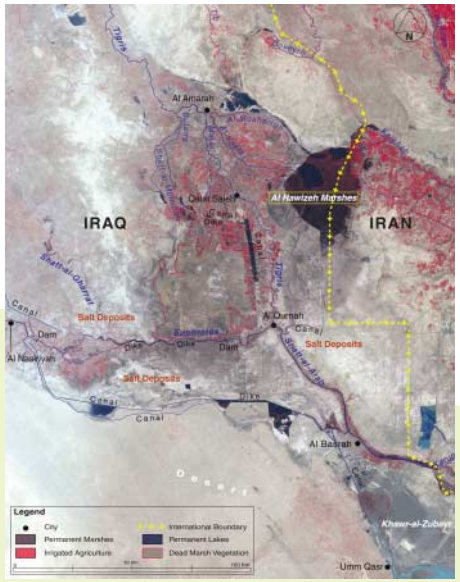
The UNEP project was approved in July 2004 by the UNDG Iraq Trust Fund Steering Committee. UNEP was also requested to play a coordinating role with respect to Marshlands management activities undertaken by various UN and bilateral agencies as well as Iraqi institutions.

By the summer of 2005, the project's start-up phase had been completed. This phase included support for strategy development and coordination efforts within and outside Iraq for Marshlands management, the provision of drinking water and sanitation, water quality management, and specialized training.

During this phase, UNEP launched six pilot projects to provide safe drinking water, sanitation systems, and water quality management in pilot communities, by using Environmentally Sound Technologies (ESTs). Selection of appropriate ESTs is based on in-depth field assessments, water quality monitoring, and consultations with local communities. In addition, the Marshland



Landsat image:
MSS Bands 4, 2 and 1, taken on MAY 1976.



Landsat image:
ETM Bands 4, 3 and 2, taken on MAY 2000.

Source: USGS/EROS Data Center
GEC-3: Global Environment Outlook-3, UNEP (URL: http://www.unep.org/geo/geo3/english/)

Information Network (MIN) was implemented in Arabic and English.

The UNEP Marshlands project is being implemented by the International Environmental Technology Centre (IETC), located in Japan, through the framework of UNDG Iraq Trust Fund with US$ 11 million funding from the Government of Japan. IETC promotes and implements ESTs, including management systems, for disaster prevention, production and consumption, and water and sanitation. It has supported pilot projects for EST applications since its inception in 1994. IETC is part of UNEP's Division of Technology, Industry and Economics (DTIE).

Implementation of the UNEP Marshlands project

Implementation of the Marshlands project began in August 2004. The project has five activity components: support for strategy development and coordination; data collection and baseline analysis; capacity building; pilot project implementation; and awareness raising and follow-up.

Implementing the Marshlands project has entailed:

- Pilot implementation to provide safe drinking water, sanitation, and water quality management practices that utilize ESTs in six Marshlands communities.
- Capacity building through training that uses a "train the trainer" approach.
- Development of the MIN and the setting up of server infrastructure within Iraq, with websites created by Iraqi partner institutions in both English and Arabic.
- Collection and analysis of baseline data, including water quality data and remote sensing analysis with field verification.
- Continuous information exchange with Iraqi stakeholders, including interactions with an Iraqi national coordinator, relevant ministry representatives, and community leaders.

Project benefits

The UNEP project has the following benefits:

- It is contributing to and supporting efforts by the Iraqi Government to restore and sustainably manage the Marshlands, by identifying suitable mitigation options, particularly for drinking water, sanitation systems, and Marshlands water quality management.
- It is giving inhabitants better access to drinking water and sanitation systems, as well as improving the state of ecosystems and biodiversity, beginning in pilot project communities.
- It is providing input for a long-term management plan to benefit people and ecosystems in Southern Iraq. The input will include experiences with suitable management options, recognition of local communities as stakeholders, and assessment of policy and institutional needs. The project will also provide analyzed data, gathered through water quality testing, satellite image analysis, and remote sensing.
- It is improving the capacity and knowledge of Iraqi decision-makers, technical experts, and community members regarding various elements of Marshlands management. These elements include policy and institutional aspects, technical knowledge, community engagement, and analytical methods.
- It is creating employment opportunities at the professional and community level related to assessment, pilot applications, awareness raising, and monitoring.
- It is introducing and implementing ESTs, utilizing Iraqi expertise.
- It is creating greater commitment to – and the capacity to address – water, sanitation/wastewater, and Marshlands management issues.
- It is improving dialogue and access to information and management tools, above all through the MIN.
- It is making a contribution to overall rebuilding efforts in Southern Iraq, and to long-term peace and security in the country.

The main beneficiaries of the project include Marshlands communities, Iraqi policy-makers and technical experts, and environmental management stakeholders at the national, regional, and international levels.

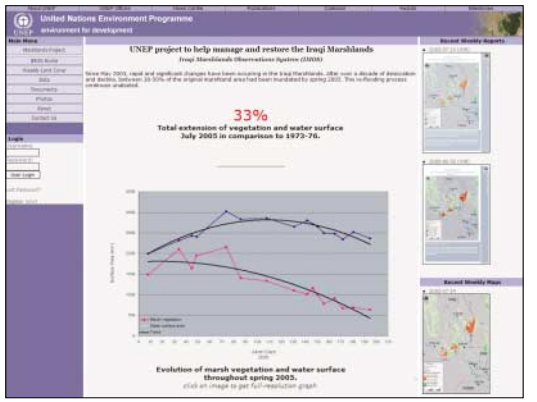
Marshlands management efforts and assistance to the inhabitants are being integrated into a wider regional development framework for the reconstruction of Southern Iraq, through which some 2.5 million people will eventually stand to benefit.

The Marshlands Information Network (MIN)

The MIN is solving the problem of limited availability of environmental and social information concerning the Marshlands by providing a forum for information and data sharing. Stakeholders to benefit from the MIN include officials in the Ministry of Environment, Ministry of Water Resources, and Ministry Municipalities and Public Works, academics, and other experts, as well as representatives from the southern governorates, and individual communities. All the institutions involved in Marshlands restoration and management have access to this cost-effective, Internet-based tool through an Arabic version of the Environmentally Sound Technology Information System (ESTIS), the innovative, multi-language e-service developed by IETC in 2003. One server in Amman and five in Iraq are supporting the MIN in the region.

For more information on the MIN, go to: http://www.estis.net/communities/min_eng/.

Iraqi Marshlands Observation System (IMOS)



The objective of the Iraqi Marshlands Observation System (IMOS) is to monitor the extent and distribution of re-flooding developments and the associated changes in vegetation cover. Systematic assessment of on-going changes is essential to achieving a better understanding of the dynamics and ultimately the level of success of the wetland recovery process. In practical terms, the IMOS is meant to serve as a pragmatic decision-making support tool to assist stakeholders to modify and adapt restoration plans in a timely manner based on valid scientific information.

For more information on the IMOS, go to: http://gridca.grid.unep.ch/xoops/html/

Training courses

The training courses organized by IETC have responded to needs identified by relevant Iraqi institutions for Marshlands management. Each course has been designed to enhance Iraqi participants' knowledge of developments in particular areas such as environmental policy and institutional aspects, technical capability, and data and IT management. These courses have supported practical capacity building, with linkages to pilot project implementation, policy analysis and development, and data management.

Participants have included nominated officials from the Ministry of Environment, Ministry of Water Resources, and Ministry of Municipalities and Public Works, together with representatives from the southern governorates, Marshlands communities, and academic institutions. As of July 2005, 241 Iraqi trainees have participated in the training courses.

The training courses have consisted of lectures in English and Arabic, demonstrations, and group exercises. Participants have actively taken part in discussions and course activities. Most courses have also included site visits. For example, during the course on Phytotechnology for Wetland Management, a field trip was organized to Egypt's Lake Manzala, one of the largest artificially constructed wetlands in the Middle East. In Japan, a visit was made to the water treatment plant in Maibara City in Shiga Prefecture where participants learned about the reverse osmosis technology. The Iraqi trainees also learned about household-level sanitation EST options implemented in Japan during a visit to Toyono Town in the Osaka Prefecture.

The MIN was demonstrated during several courses. Participants in these courses learned how to use the MIN for information sharing.

Inspecting a Japanese household purifier in Toyono Town, Osaka, December 2004

Materials provided to training course participants are in Arabic or English. When the training material kits corresponding to these courses are finalized, they will be available in both languages – in hard copy versions and downloadable from the MIN.

The attention given to gender balance is demonstrated in the proportion of female participants, as shown in the table below.

Content of the training courses

The training courses have corresponded to different elements of the UNEP Marshlands project. Some courses have emphasized policy-making and management; others have mainly provided technical training. Several courses have combined these two aspects.

Courses mainly concerned with policy-making and management

"Water Quality Management" gave participants needed policy and institutional information on how

to manage water quality, including standard-setting, monitoring, enforcement and management plan development.

“Integrated Water Resource Management (IWRM): Policy and Integration” improved the capacity of national experts, government officials and local authorities to work with IWRM concepts, principles and applications.

“Community-Level Initiatives” addressed how to raise public awareness of Marshlands environmental issues and how to engage and support communities. Community leaders and officials involved in community outreach received this training.

“Wetland Management” examined policy and management topics including institutional, legal, conservation, socio-economic, and economic elements. The course also addressed basin management and community participation.

Courses mainly concerned with providing technical training

“Phytotechnology for Wetland Management” furnished participants with practical technical information in preparation for the pilot implementation of ESTs in Marshlands communities. Phytotechnology, the use of vegetation for environmental improvement and management, is an EST that is increasingly employed to improve water quality

“Sustainable Sanitation” provided practical technical information prior to pilot implementation of ESTs. In addition to lectures, site visits gave participants the opportunity to learn about options for sanitation and wastewater treatment, and related management practices. The visits included large-scale, community-scale, and household-level treatment facilities, as well as an industrial reuse facility.

“Application of Remote Sensing and GIS for Marshlands Assessment and Monitoring” taught participants how to provide timely information on restoration activities using remotely sensed satellite imagery. The benefits of this approach to monitoring, assessing and empirically quantifying changes on a near real-time basis include cost-effectiveness, a global perspective, and repeatable and systematic survey methods.

“Marshlands Information Network (MIN)” taught participants – including information managers, IT officers, technical editors and engineers – to use the ESTIS system developed by IETC (available in Arabic and English). Each organization represented created its own website, which can now be used for information sharing through the MIN.

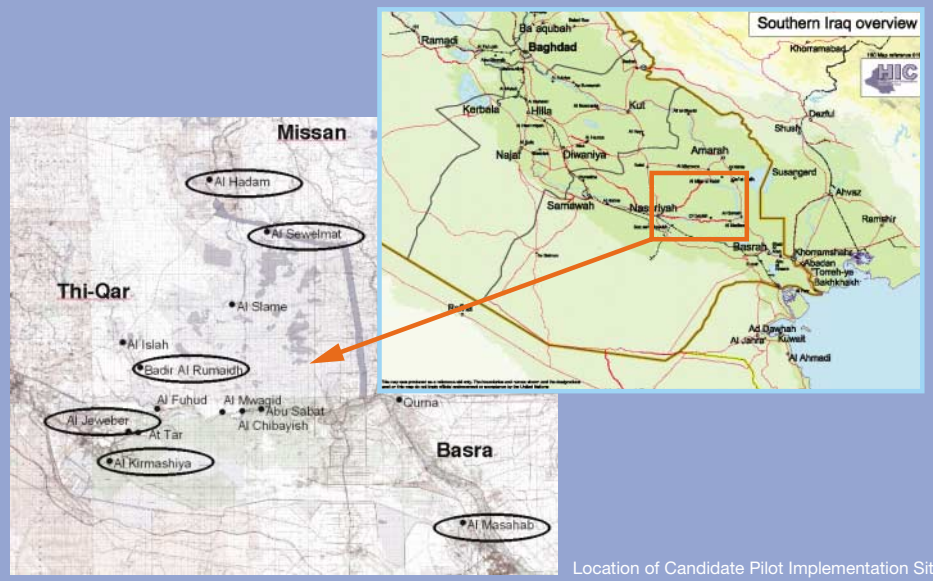
“Environmentally Sound Technologies (ESTs) for Drinking Water Provision” provided an introduction to the application of ESTs for safe drinking water. This course responded to the need to equip Iraqi engineers, public officials, and other stakeholders with adequate knowledge and tools to implement appropriate ESTs. Reverse osmosis is an example of an EST that can be used for drinking water provisions.

The training course on “EST Assessment” will take place in the fall of 2005.

The ten training courses associated with the project were designed using the model "train-the-trainers.” This approach was selected to enable the course participants to train their colleagues in Iraq as secondary training. UNEP will provide support for secondary training, which will take place on the ground in Iraq using training materials produced by UNEP.

Marshlands Project Training Courses, 2004-2005

Date	Course	Location	No. of Iraqi participants	Proportion of female participants	Parter organizations taking part
6-16 Dec. 2004	Phytotechnology for Wetland Management	Cairo, Egypt	27	26%	Cairo University
6-17 Dec. 2004	Water Quality Management	Shiga, Japan	28	36%	International Lake Environment Committee (ILEC); WHO-Iraq; UNEP GEMS-Water, Shiga Prefecture
6-17 Dec. 2004	Sustainable Sanitation	Osaka, Japan	27	33%	Global Environment Centre Foundation (GEC); Osaka City and Prefecture; Japan International Cooperation Agency Osaka International Center (JICA OSIC)
6-10 Feb. 2005	Application of Remote Sensing and GIS for Marshlands Assessment and Monitoring	Amman, Jordan	21	10%	International Institute for Geo-Information Science and Earth Observation (ITC); UNEP Post-Conflict Assessment Unit (PCAU)
27-31 Mar. 2005	Marshlands Information Network (MIN)	Amman, Jordan	31	26%	
4-9 Apr. 2005	Integrated Water Resource Management (IWRM): Policy and Integration	Amman, Jordan	30	23%	American University of Beirut (AUB); UN Economic and Social Commission for Western Asia (UN-ESCWA)
16-27 May 2005	ESTs for Drinking Water Provision	Osaka and Shiga, Japan	30	17%	GEC; Osaka City; Maibara City; JICA OSIC
11-16 Jun. 2005	Community Level Initiatives	Alexandria, Egypt	18	5%	UNEP Regional Office for West Asia (UNEP/ROWA); Centre for Environment and Development for the Arab Region and Europe (CEDARE)
19-26 Jun. 2005	Wetland Management	Cairo, Egypt	29	14%	Cairo University; Secretariat of the Ramsar Convention on Wetlands; Wetlands International; International Agricultural Centre



Location of Candidate Pilot Implementation Sites

Targeting pilot project implementation

ESTs are being implemented to determine how well they perform in bringing safe drinking water, sanitation, and water quality management options to local people and communities. Two technical meetings and a technical workshop were held in Amman, Jordan, to target the implementation of six EST pilot projects in the Marshlands communities.

The technical meetings both took place in February 2005. Participants included representatives from Iraqi ministries, the Marsh Arab Forum (MAF), and the Iraq Foundation. Representatives from several UN agencies were also present.

At the technical meeting on "Pilot Project Implementation," consensus on six EST pilot sites was reached. The sites selected – Al-Kirmashiya, Badir Al-Rumaidh, Al-Masahab, Al-Jeweber, Al-Hadam and Al-Sewelmat – were considered suitable from both technical and social perspectives. They are located in the three southern governorates of Thi-Qar, Basrah, and Missan.

Site selection was based on multi-ministerial and multi-institutional consensus, Iraqi proposals, and other contributions, including input from local communities. These communities expressed their support with respect to facilitation of field assessment, construction, and operation and maintenance.

The technical meeting on "Data Collection and Analysis" focused on field sampling for water quality monitoring, analysis of samples, and data sharing and coordination. The three ministries present agreed to cooperate on monitoring and analysis. Based on discussions held during the meeting, UNEP signed a Memorandum of Understanding with the Ministry of Environment for water quality monitoring. The Minister of Environment is responsible for coordinating the inter-ministerial team for this purpose.

The technical workshop on "Phytotechnology Applications for Pilot Sites," which took place in Amman in May, complemented the earlier training course on "Phytotechnology for Wetland Management in Cairo." It provided knowledge about the design of artificially constructed wetlands for wastewater treatment and the rehabilitation of natural wetlands.

Technical Meetings and Technical Workshop, 2005

Date	Name	Location	No. of Iraqi participants	Proportion of female participants	Partner organizations taking part
21-22 Feb. 2005	Technical Meeting on Data Collection and Analysis	Amman, Jordan	18	22%	FAO, UNESCO, UNHCR, UNICEF, WHO; Italian Ministry for Environment and Territory
23-24 Feb. 2005	Technical Meeting on Pilot Project Implementation	Amman, Jordan	18	22%	FAO, UNESCO, UNHCR, UNICEF, WHO; Italian Ministry for Environment and Territory
23-27 May 2005	Technical Workshop on Phytotechnology Applications for Pilot Sites	Amman, Jordan	11	18%	University of Copenhagen

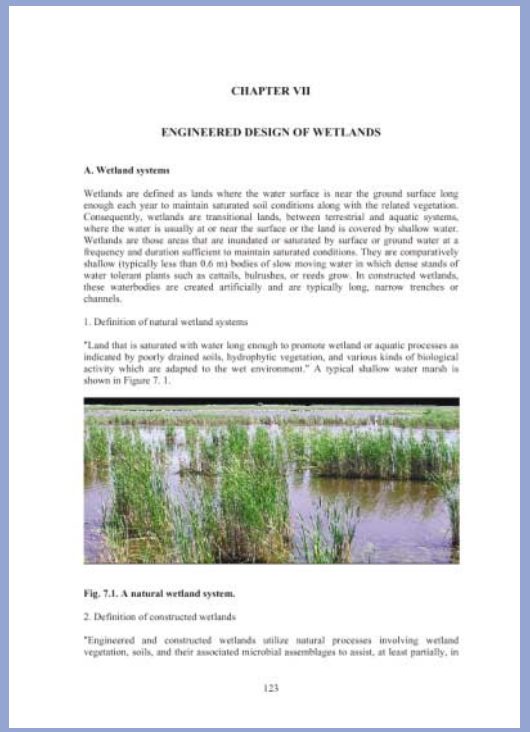
Publications and other forms of communication

The training kits corresponding to the subjects of the ten training courses will be made available in both English and Arabic.
The complete Report of the UNEP Roundtable on Iraqi Marshland Management (21 – 22 September 2004) has been made available.
A newsletter concerning the UNEP Marshlands project is published regularly in Japanese.

Access to the Marshlands Information Network (MIN) is freely available to all stakeholders.
The UNEP Marshlands project website (http://marshlands.unep.or.jp) is in three languages: Arabic, Japanese and English.
Summaries of training programmes and meetings in English and Japanese are available for downloading from the project website.
Maps and regular updates on reflooding conditions are available on the project website.

Appropriate media outreach has been done at different stages of the project development and implementation.

A high profile public symposium has been organized in Tokyo in August 2005.



CHAPTER VII

ENGINEERED DESIGN OF WETLANDS

A. Wetland systems

Wetlands are defined as lands where the water surface is near the ground surface long enough each year to maintain saturated soil conditions along with the related vegetation. Consequently, wetlands are transitional lands, between terrestrial and aquatic systems, where the water is usually at or near the surface or the land is covered by shallow water. Wetlands are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to maintain saturated conditions. They are comparatively shallow (typically less than 0.6 m) bodies of slow moving water in which dense stands of water tolerant plants such as cattails, bulrushes, or reeds grow. In constructed wetlands, these waterbodies are created artificially and are typically long, narrow trenches or channels.

1. Definition of natural wetland systems

"Land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation, and various kinds of biological activity which are adapted to the wet environment." A typical shallow water marsh is shown in Figure 7. 1.

Fig. 7.1. A natural wetland system.

2. Definition of constructed wetlands

"Engineered and constructed wetlands utilize natural processes involving wetland vegetation, soils, and their associated microbial assemblages to assist, at least partially, in

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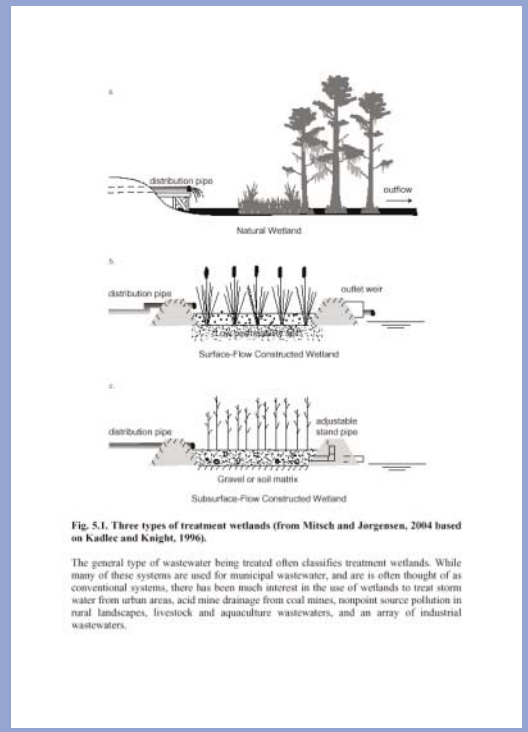


Fig. 5.1. Three types of treatment wetlands (from Mitsch and Jorgensen, 2004 based on Kadlec and Knight, 1996).

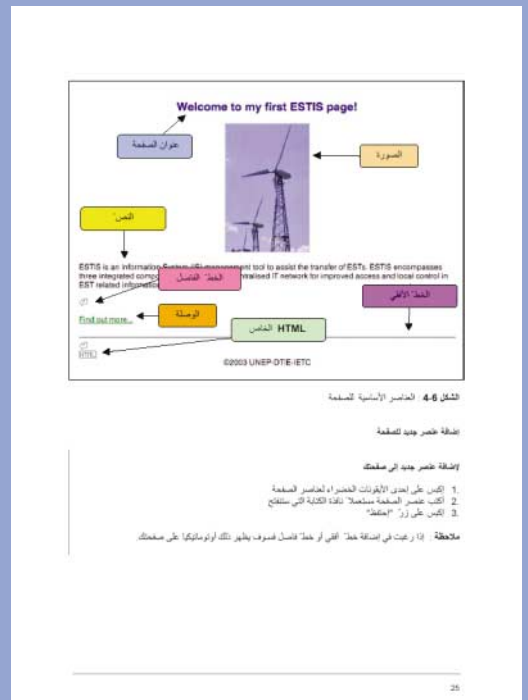
The general type of wastewater being treated often classifies treatment wetlands. While many of these systems are used for municipal wastewater, and are is often thought of as conventional systems, there has been much interest in the use of wetlands to treat storm water from urban areas, acid mine drainage from coal mines, nonpoint source pollution in rural landscapes, livestock and aquaculture wastewaters, and an array of industrial wastewaters.

Training Kit in English and Arabic

3- تغيير موضوع موقعك

1-3 مواضيعنا

الشكل 3-1 اختيار موضوع مواقعك



الشكل 4-6 : العناصر الأساسية للصفحة

International coordination

The sustainable management of the Iraqi Marshlands is considered as one of the priority issues for the reconstruction of Iraq, particularly from ecological, water resource, and socio-economic perspectives. Recognizing the complexity of Marshlands management, the Iraqi authorities and various donor governments have been engaged in dialogue and coordination on this issue since 2003. UNEP has played an increasingly active role in promoting such coordination, which has also been requested by the UNDG Iraq Trust Fund Steering Committee.

Roundtable in Amman, September 2004

One of the coordination activities, organized by UNEP, was a Roundtable on Iraqi Marshland Management in Amman, in September 2004. The Roundtable provided the opportunity to discuss the status of Marshlands initiatives being supported by the UN, bilateral organizations, non-governmental organizations, and others. Participants included representatives from Iraqi authorities at the national, governorate and local levels, UN agencies from relevant clusters within the UNDG Iraq Trust Fund mechanism, bilateral organizations, and other stakeholders. Discussions served as input to establish practical cooperation.

UNEP has also strengthened its involvement in donor coordination, which has provided a platform for sharing up-to-date information on various initiatives supported by donors and fostered cooperation. Donor coordination meetings have taken place in Geneva (November 2003), Rome (March 2004), and Venice (October 2004). A fourth donor coordination meeting has been organized in Tokyo (August 2005).

Reflecting a need identified during the Amman Roundtable, project coordination was one of the main topics addressed at the Venice meeting. Participants agreed on a coordination mechanism for managing the Marshlands. The mechanism adopted clarifies the coordination and policy-formulation process. The structure of the agreed mechanism reflects the thematic division of responsibilities within the Iraqi government, along with activity elements. This structure will provide information on current and planned activities, supporting institutions, and areas where further work is needed.

The participants also endorsed the performance of a liaison role by UNEP as well as its contribution as a key partner, especially in the case of tasks concerned with the ecological aspects of Marshlands management.

UNEP is coordinating the activities of donor countries, which currently include Canada, Italy, Japan, the United Kingdom, and the United States, as well as those of the World Bank, other UN agencies, and the various types of organizations involved in the restoration and management of the Marshlands. UNEP's role includes coordinating these activities with the work of relevant Iraqi ministries and other Iraqi bodies.

Examples of individual country projects include:

Canada: Provision of Canadian expertise through the International Development Agency (CIDA), in partnership with the University of Waterloo (http://www.acdi-cida.gc.ca), focusing on biodiversity and wetland management initiatives.

Italy: Support for the Free Iraq Foundation's New Eden project, with other contributions to the project by the Iraqi Ministries of Environment, Water Resources, and Municipalities and Public Works. Also contributing to the New Eden project are UNEP, the Canadian International Development Agency (CIDA), Birdlife International and other groups (http://www.edenagain.org).

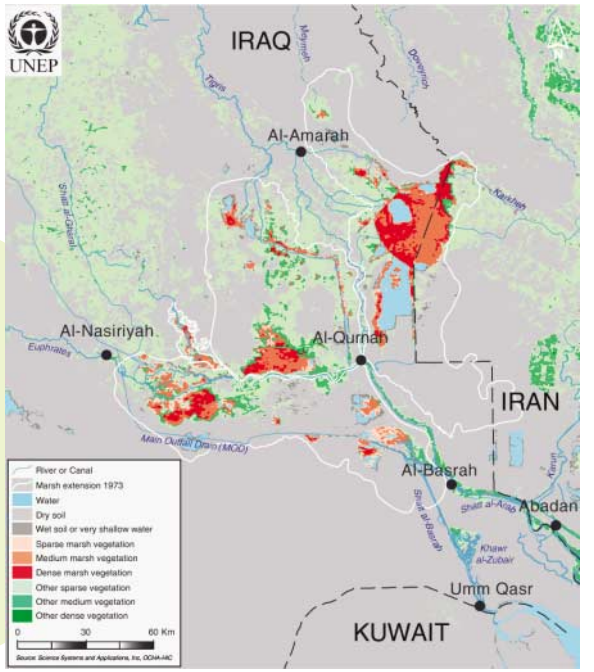
Japan: Contributions to the UNEP Marshlands Project, with funding of US$ 11 million through the UNDG Iraq Trust Fund. UNEP/DTIE/IETC has implemented the project "Support for Environmental Management of the Iraqi Marshlands." (http://marshlands.unep.or.jp/)

United Kingdom: Participation in the Marshland Restoration and Management Program, in partnership with Iraqi bodies such as the Ministry of Environment, the Ministry of Water Resources, the University of Basrah College of Agriculture, the AMAR (Assisting Marsh Arabs and Refugees) Charitable Trust and the Iraq Foundation, together with the Governments of Canada, Italy and Australia.

United States: The Iraq Marshlands Restoration Program (USAID); interagency efforts led with the USAID and the US State Department's Bureau for Oceans and International Environmental and Scientific Affairs (OES) (http://www.usaid.gov/iraq/accomplishments/marsh.html).

33%
Total extension of wetland vegetation and water surface area in June 2005 in comparison with pre-drainage marshland extent in 1973-76

Latest image of 30 June 2005 from Iraqi Marshlands Observation System (IMOS)



About the UNEP Division of Technology, Industry and Economics

The UNEP Division of Technology, Industry and Economics (DTIE) helps governments,local authorities and decision-makers in business and industry to develop and implement policies and practices focusing on sustainable development.

The Division works to promote:

> sustainable consumption and production,
> the efficient use of renewable energy,
> adequate management of chemicals,
> the integration of environmental costs in development policies.

The Office of the Director, located in Paris, coordinates activities through:

> **The International Environmental Technology Centre** - IETC (Osaka, Shiga), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.
> **Production and Consumption** (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
> **Chemicals** (Geneva), which catalyzes global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.
> **Energy** (Paris), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.
> **OzonAction** (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.
> **Economics and Trade** (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies.

UNEP DTIE activities focus on raising awareness, improving the transfer of knowledge and information, fostering technological cooperation and partnerships, and implementing international conventions and agreements.

For more information, see **www.unep.fr**