ME8/AIDCO/2001/0515/59768
Zer0-M
Sustainable Concepts Towards a Zer0 Outflow Municipality

Final Report

Covering period 01.09.2003 – 28.02.2009

Report Preparation Date: 28. October 2009
Contract Start Date: 1 September 2003 Duration: 66 months

Project Applicant: AEE – Institute for Sustainable Technologies

Partners:

1 Associazione Ambiente e Lavoro Toscana – O.N.L.U.S. (ALT)
2 This partner quit the project on his own wish
3 Tübitak-Marmara Research Center (MRC-ESERI)
4 Water Research & Pollution Control Department, National Research Centre, Dokki, Cairo, Egypt (NRC)
5 Centre de Recherche et des Technologies des Eaux Laboratoire Traitement et Recyclage des Eaux Usées (CERTE) *before: Institut National de Recherche Scientifique et Technique, Laboratoire Eau et Environnement (LEE)*
6 Institut Agronomique et Vétérinaire Hassan II, Wastewater Treatment and Reuse Unit (IAV - WTRU)
7 Department of Geography and Regional Research, University of Vienna (IGR)
8 TU Berlin, Zentraleinrichtung Kooperation and Fakultät III, Fachgebiet Verfahrenstechnik (TUB)
9 Universität Hannover, Zentrale Einrichtung für Weiterbildung (weiterBILDUNG)
10 Fachvereinigung Betriebs- und Regenwassernutzung e.V. (fbr)

MEDAWater Programme

Project funded by the European Union under the MEDA WATER PROGRAMME initiative

Table of contents

- Rainwater harvesting
- Greywater recycling
- Constructed wetlands
- Membrane reactors
- Wastewater ponds
- Anaerobic treatment
- Sludge disposal and reuse
- Planning tools
- Water regulations
- Pilot plants
- Journals Sustainable Water Management
- Train the trainer seminar

8. DVD 2
Film "Waste not Waste", BBC World Earth Report (English)

9. DVD 3
Film "La Récupération des Eaux Pluviales en Tunisie" (French)

Tables

Figures

Name:	AEE Institute for Sustainable Technologies (AEE INTEC)		
Address:	Feldgasse 19, 8200 Gleisdorf, Austria		
Phone Number:	+43 3112 5886-0	Fax Number:	+43 3112 5886-51
E-mail:	m.regelsberger@aee.at		
Project websites & other access points:			www.zer0-m.org

{ TC "Abbreviations and Acronyms" \l 2 }Abbreviations and Acronyms

Organisations

ACSA	Association culturelle et sportive de l'Agriculture
ADIRA	**A**utonomous **D**esalination system concepts for seawater and brackish water **I**n **R**ural **A**reas with renewable energies – Potential, Technologies, Field Experience, Socio-technical and Socio-economic impacts, a MEDA Water partner project
AEE INTEC	AEE Institute for Sustainable Technologies
AFT	Agence Foncière de Tourisme
AGIRE	Appui à la Gestion Intégrée des Ressources en Eau
AIDCO	EuropeAid Co-operation Office
ALT	Associazione Ambiente e Lavoro Toscana – O.N.L.U.S.
ANPE	Agence National de Protection de l'Environnement, Ministère de l'Environnement et du Développement Durable
BBC	British Broadcasting Corporation
BMBF	Bundesministerium für Bildung und Forschung (German Federal Ministry for Education and Research)
CEMAGREF	French reference research institute for sustainable water and land use management, www.cemagref.fr
CENTA	Centro de Nuevas Tecnologias del Agua, Sevilla, Spain
CERTE	Centre de Recherches et des Technologies des Eaux, previously INRST
CITET	International Centre for Environmental Technologies
COST	European Cooperation in Science and Technology
CRDA	Commissariat Régional au Développement Agricole
Delegation	Delegation of the European Commission to the Hashemite Kingdom of Jordan
DGGREE	Direction Générale du Génie Rurale et de l'Exploitation de l'Eau (Department of Rural Engineering and Water Use)
DGR	Départment du Génie Rural
DGRE	Direction Générale des Ressources en Eau
EC	European Commission
EcosanRes	The ecosanitation group of the Swedish Environment Institute, Stockholm
EcoSan-Club	An Austrian umbrella organisation for ecosanitation
EMPOWERS	Euro-Med Participatory Water Resources Scenarios, a MEDA Water project
EMWATER	Efficient Management of Wastewater, its Treatment and Reuse in the Mediterranean Countries, a MEDA Water project
EMWIS	Euro-Mediterranean Information System on know-how in the Water sector
EU	European Union
fbr	Fachvereinigung Betriebs- und Regenwassernutzung e.V.
firmm	**f**oundation for **i**nformation and **r**esearch on **m**arine **m**ammals
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
IAV	Institut Agronomique et Vétérinaire Hassan II, Rabat
IGR	Department of Geography and Regional Research, University of Vienna
INAT	Institut National Agronomique de Tunis
INRST	Institut National de Recherche Scientifique et Technique, Tunisia, now CERTE
ISIIMM	Institutional and Social innovations inIrrigation Mediterranean Management, a MEDA Water partner project
IUCN	International Union for Conservation of Nature
LEE	Laboratoire Eau et Environnement, a department of INRST, now LTREU
LTREU	Laboratoire Traitement et Recyclage des Eaux usées, previously LEE
MEDAWARE	Development of tools and guidelines for the promotion of the sustainable urban wastewater treatment and reuse in the agricultural production in the Mediterranean countries, a MEDA Water project

MEDROPLAN	Mediterranean Drought Preparedness and Mitigation Planning
MEDWA	Stakeholder Participatory Sustainable Water Management at Farm Level, a MEDA Water project
MPWWR	Ministry of Public Works and Water Resources
MRC	Tübitak-Marmara Research Center, Gebze
NRC	National Research Center, Cairo
ONAS	Office National de l'Assainissement, Tunisia
ONEP	Office National de l'Eau Potable, Morocco
PAGER	Rural Population Grouped Provision of Potable Water Program
RMSU	Regional Monitoring and Support Unit
SPICOSA	Science and Policy Integration for Coastal System Assessment, a project in the 6^{th} Framework Programme
SONEDE	Société Nationale d'Exploitation et de Distribution des Eaux
SuSanA	Sustainable Sanitation Alliance
TVE	Television Trust for the Environment
wb	Zentraleinrichtung für Weiterbildung, University of Hanover
WHO	World Health Organisation
WTRU	Wastewater Treatment and Reuse Unit at IAV
Zer0-M	Sustainable Concepts towards a Zero Outflow Municipality

Other abbreviations

AS	Anionic Surfactants
BOD_5	Biochemical Oxygen Demand at 20°C and in 5 days
BW	Black Water, i.e. wastewater from the toilet
COD	Chemical Oxygen Demand
CS	Cationic Surfactants
CW	Constructed Wetland
DSS	Decision Support System
E.Coli	*Escherichia Coli*
ECOSAN	ecological sanitation, i.e. sustainable sanitation
FC	Faecal Coliforms
FS	Faecal Streptococci
FWS	Freewater System (constructed wetland)
GPS	Global Positioning System
GW	Grey Water, i.e. domestic wastewater except from the toilet
HRT	Hydraulic Retention Time
IWRM	Integrated Water Resources Management
LCA	Life Cycle Analysis
MBR	Membrane Bioreactor
MCA	Multi-Criteria Analysis
MCP	MEDA Country Partners
MDG	Millennium Development Goals
MEDA	"**ME**sures **D'A**ccompagnement": measures accompanying the reform of economic and social structures in the Mediterranean partners
MPC	MEDA Partner Countries
NGO	Non-Governmental Organisation
NH_4^+	Ammonia
NO_2^-	Nitrite
NO_3^-	Nitrate
NTU	Nephelometric Turbidity Units
pH	-log(concentration of H^+)
PM	Person month
PO_4^{3-}	Orthophosphate
RBC	Rotating Biological Contactor
SBR	Sequencing Batch Reactor

SM-SBR	Submerged Membrane – Sequencing Batch Reactor, i.e. a submerged membrane bioreactor operated as a sequencing batch reactor
SS	Suspended Solids
SSHF	Subsurface Horizontal Flow (constructed wetland)
SSVF	Subsurface Vertical Flow (constructed wetland)
SWM	Sustainable Water Management
TC	Total Coliforms
TDC	Training and Demonstration Centre
TKN	Total Kjeldahl Nitrogen
TMP	TransMembrane Pressure
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TS	Total Streptococci
TSUAR	Two Stage Upstream Aerobic Reactor
TtT	Train the Trainer
UASB	Upstream Anaerobic Sludge Blanket reactor
UC	Uniformity Coefficient
UDDT	Urine Diversion Dehydration Toilet
VER	Volumetric Exchange Ratio
VF	Vertical Filter
VSS	Volatile Suspended Solids
WSD	Water Saver Devices
WSP	Waste Stabilisation Ponds
WW	Wastewater

SI units
Figures are written according to continental standard: 1.000,00 is one thousand

1 Background Information

Introduction

Water scarcity is a central problem in countries around the Mediterranean Sea due to the warm and dry climate and a growing need for water caused by population growth and increasing per capita domestic water demand but also industrial and, more than anything else, agricultural water demand.

Although the situation in every beneficiary country of Zer0-M is different, all of them face growing water scarcity, exacerbated by trends of climatic change. Turkey and Morocco could transfer water from mountainous regions but Egypt depends for more than 90% on the water reservoir of the Nile and Tunisia can only rely on its precipitation during the winter months.

Increasing water demand causes problems to offer water of sufficient quality and quantity. Improvident exploitation of water resources can cause environmental and economical damage. But increased water consumption also means more wastewater and a need for sanitation, or, in absence of effective wastewater treatment, pollution of receiving bodies and health hazards for the population.

A quick overview of the water and sanitation "status" in each MEDA partner country (MCP) is needed to understand the concept of Zer0-M.

Egypt

Egypt is facing increasing water needs, demanded by a rapidly growing population, by increased urbanisation, by higher standards of living and by an agricultural policy which emphasises expanded production in order to feed the growing population. 85% of the water is consumed by agriculture. The per capita water amount available is expected to drop from the 1990 value of 922 m^3 per year to about 340 m^3 per year in 2025. And, if the present management practices and cropping patterns prevail, this could mean that up to 60 per cent of the presently farmed land will have no irrigation water available by 2025 and fall dry.

The Egypt Ministry of Public Works and Water Resources (MPWWR) is responsible for national water resources and is the only body to authorise use of water from the Nile, canals, drains, and groundwater sources. The ministry also has control over works built to discharge water into canals, drains, and the Nile. The MPWWR is authorised to assess penalties if its orders are not obeyed. In addition to the MPWWR, a number of other ministries are also involved in water management and use, including agriculture and land reclamation, health, tourism, power, transportation, industry, and housing and reconstruction. Two ministries, agriculture and land reclamation, and health, hold special responsibilities in their management role of water.

Almost all the Egyptian population lives in the area under cultivation along the Nile Valley and the Delta. The urban areas are equipped with high rate wastewater treatment systems (activated sludge). Cairo is discharging over 5 million m^3/day of sewage that is treated in 6 activated sludge treatment plants. While Alexandria city discharges 3 million m^3/day. The use of this effluent for irrigation purposes would reclaim 40,000 hectares of land. However, the use of such effluent in traditional flood, spray or trickle irrigation will present severe public health risks and cultivation difficulties.

In rural areas, sanitation problems are growing seriously due to the increase in population density and the increase in water consumption as a result of improved level of water distribution service. The disposal of raw sewage without adequate or any treatment into drainage systems returning to the Nile is considered a source of pollution threatening the population. As a result, wastewater projects covering five different treatment technologies were implemented in both delta regions. In one of these projects that consists of two anaerobic ponds followed by an aerated lagoon and three maturation ponds, it has been concluded that the aerated lagoon and wastewater stabilisation ponds (WSPs) proved their applicability as cost-effective methods for wastewater treatment in rural Egypt. Whereas the activated sludge systems have high investment needs as well as operational and maintenance costs.

Morocco

Morocco is relatively well supplied with water compared to other MEDA countries, with an annual rainfall estimated at some 150 billion m^3. However, significant variations in time and space have to be noted. There is a declining gradient from north to south and from west to east. Certain regions receive 600 to 700 mm per year, others less than 100 mm. Droughts have increased greatly: Nine droughts have been recorded since the early 1980s, whereas during the first half of the century there was on average only one drought every ten years.

In Morocco regional governments have the responsibility of water and sanitation since the 1976 decentralisation law. The Rural Population Grouped Provision of Potable Water Program (PAGER) has the objective of providing the 12,6 million of the rural population access to potable water until 2010.

For the past few decades in Morocco, the installation of sewerage networks has not kept pace with urban and industrial development. Only 70% of the population have sewerage connections in large cities and 45% in small and mid-sized towns. By the year 2015, the sewerage networks in place or programmed for construction will collect approximately 750 million m^3 per year of wastewater, for which treatment will be required to preserve fresh water resources and to protect public health. The number of treatment plants in Morocco, which are currently operating, is less than twenty.

Sanitation in small communities is generally poor; the population relies on individual facilities, mainly cesspools (68% in centres of rural districts and only 32% in villages). Also, the level of sanitation facilities varies widely ranging from none, in small villages, to the situation where an insufficient sewerage network is in use. Some centres are equipped with wastewater treatment plants consisting of primary but rarely secondary treatment units. However, most of these facilities are either poorly run or no longer in service. Small cities generate 25,6 million m^3 per year of wastewater (40 million m^3 by 2010) that is mostly reused for irrigation or disposed of without treatment.

Tunisia

In Tunisia the annual total volume of exploitable water resources amounts to 3 billion m^3, consisting of 90% surface water. Around 25% of water resources are consumed for potable water. In southern Tunisia, the demand exceeds water resources available in the region.

According to the Ministry of the Environment and Land Use Management the amount of treated wastewater in Tunisia is 136 million m^3 per year, of which 27 % are reused for irrigation. 61 treatment plants are operating. In the areas that are served by ONAS – the national authority responsible for the planning, construction and operation of sewer systems in the country – 81 % of the population in urban areas are connected to the sanitation network. In rural areas about 70 % of the population have access to safe public water, 18 % thereof by private house connections. In cities 73 % have public water with 92 % thereof by private house connection. In rural areas, where sanitation relies on more traditional methods such as septic tanks and field disposal, access to improved sanitation is around 64% (http://waterwiki.net/index.php/Tunisia).

Turkey

Turkey has more freshwater per capita than other MEDA countries. With water supplies of 3000 m^3 per person per year it is categorised as a water rich country. The total rainfall is about 240 billion m^3/year. However, beside significant seasonal variations, precipitation differs largely between regions and over the years. Thus some regions in Turkey must be characterised as suffering from water scarcity.

In Turkey several governmental and non-governmental organizations are involved in development and conservation of water resources and pollution control activities. The institutional framework exhibits in general three levels, i.e. decision-making, executive and end users. The key organisations in water and sewage works are: General Directorate of State Hydraulic Works, General Directorate of Bank of Provinces, General Directorate of Rural Services and General Directorate of Electric Power Resources Survey and Development. In addition to that General Directorates for Water Sewage Works are in charge of water supply, wastewater collection and treatment as well as the regulatory activities in metropolitan areas as part of the municipalities.

According to recent statistics 56% of the population in urban areas are connected to a sewerage system whereas for the rest the systems are under construction or projected. The related figures for the population living in rural areas are lower. Around 40% of the population was served by septic tanks (1994). The situation has been progressively improved over time. Attempts are being made to serve the total population with sewerage systems and treatment facilities. Most of the big cities have biological wastewater treatment facilities. Some of the treatment plants constructed in areas having a high priority because of environmental issues such as Marmara Sea, Bosphorus, etc., have tertiary treatment units to remove nutrients. In addition to that in tourist areas the effluents of biological treatment plants are discharged to the sea by means of sea outfalls. In general the tourist residential areas and the cities situated around the Mediterranean Sea have biological treatment systems.

The Directorate for Water and Sewerage Works of Istanbul estimated the wastewater flow rate generated from residential areas at 130-180 l/(capita*day) and 200-230 l/(capita*day) for the years 1990 and 2040 respectively. However, the wastewater flow rate discharged from hotels and summer resorts is around 650 l/(capita*day) according to the Ministry of Tourism (1995).

Contribution of the Zer0-M approach to improve water and wastewater management

Until now the countries of the region try to cope with the problem of growing water scarcity by introducing and increasing the efficiency of water management systems developed in areas rich in water. They introduce these systems at enormous cost, which they often cannot bear themselves, at least not in order to reach full service coverage. They do so often abandoning ancient practices specifically developed in the area. Zer0-M wanted to explore the revival and modernisation of local water management traditions, e.g. rainwater harvesting, and possibilities for new approaches to water management specifically designed for the climate of the Mediterranean region and affordable for all.

The Turin Declaration and Action Plan proposed Areas of Action and horizontal themes to ensure sustainability of future water supply. Most of all, Action 1, integrated management of local drinking water supply and sanitation and Action 5, use of non conventional water sources, were the goal of Zer0-M activities. The activities involved all horizontal themes as awareness raising of the population, exchange of know how, technologies and experience between EC and MPC partners and capacity building in the MPC.

Zer0-M stands for "Sustainable Concepts towards a Zero Outflow Municipality". The project aimed at introducing a new approach to water. It focused especially on household centred water and wastewater management. ZERO-M key ideas were:

- to integrate water supply, treatment and reuse of wastewater or its components
- to shift wastewater from a disposal problem to an asset and
- to introduce the new, innovative approach to beneficiaries and stakeholders

It was expected that the integration of water supply and wastewater treatment, the reuse of resources and the choice of appropriate, decentralised systems would dramatically cut costs, increase efficiency of resource use and reduce the level of skills for implementation, operation and maintenance. Thus, sanitation would become accessible for low income areas. The project focused on peri-urban and rural areas or isolated locations as is often the case for tourism facilities.

Requirements on quality and quantity of water supply can be high (tourism!) as well as requirements on a healthy environment (pollution control).

Larger water consumers (municipalities) are served by water distribution networks, which permit high water consumption. This causes high wastewater flows, which, for a small part, are treated in centralised conventional treatment plants. The remaining wastewater flow is released into the environment without treatment but is nevertheless often used for irrigation purposes given the lack of alternatives.

A lack of know how and training on "low technology" treatment and especially pathogen barrier systems leads to an insufficient protection from pathogens and, therefore, health hazards if untreated wastewater is used for irrigation. The rural, peri-urban and dispersed habitat as well as isolated tourism facilities that are targeted by Zer0-M do frequently not yet have satisfying sanitation due to the high cost of sewerage and wastewater treatment systems.

Here the knowledge and training capability on simple investments, substantially reducing the cost, into water saving devices, grey water separation and reuse, urine separation as well as "low technology" treatment systems like constructed wetlands (CW) with easy maintenance and high cost effectiveness were improved by project activities. Nutrients and partially water were to be reused in agriculture.
Thus vertical issue 4, irrigation water management, is in this special way also included in the Zer0-M activities.

To summarise Zer0-M, it was about introducing a new approach to water and resources in wastewater, i.e. nutrients and organic matter, in order to sharply reduce their consumption and shift from a disposal problem to the management of assets in order to make sanitation affordable for all.

2 Project synopsis

Zer0-M is a project financed by the MEDA Water programme of the European Union (EU). It started in September 2003 and lasted until August 2008, with the implementation of the pilots in Morocco and Tunisia extended until December 2008 and February 2009 respectively.
Ten partners from eight countries were engaged to develop and implement concepts and technologies to achieve optimised close-loop usage of all water flows in small municipalities or settlements. It is a key issue of Local Water Management and concerns a wide range of stakeholders, authorities and beneficiaries.

The total amount spent in Zer0-M is **5.685.500,00** Euro.

The partner countries were: Egypt, Morocco, Tunisia and Turkey. Participating European countries were: Austria, Italy and Germany.

The project is defined as follows. A detailed logical framework is attached as annex 1. Resources used are detailed in chapter 0.

Overall objectives	Contribution to the reduction of water abstraction
	Contribution to guaranteeing the quality of water bodies receiving treated wastewater
	Contribution to the restoration of the biogeochemical cycle
	Contribution to the alleviation of health and social problems caused by insecurity of water supply and wastewater disposal
Project purpose	Enable in each of the MPC a centre of excellence to implement and disseminate Sustainable Water Management
Expected results	1. More exchange about water and wastewater management in partner countries 2. Knowledge about water and wastewater management in partner countries improved 3. SWM implementations available 4. Concepts and design tools for integrated sustainable water and wastewater management available 5. Awareness of sustainable water and wastewater management raised

Activities

1.1	Installation of a long-term living internet network on Zero-M concepts
1.2	Starting the publication of semestrial journal
1.3	Legislation up-date
1.4	First conference
1.5	Second conference
1.6	Third conference
2.1	Preparation of training material
2.2	Legislation up-date
2.3	Training the trainers intensive course
2.4	Training excursions to EU countries
2.5	Training courses and thematic Workshops organised by MPC training centres
3.1	Demonstration plants realisation
3.2	Real scale plants realisation
4.1	Preparation of tools for spatial representations
4.2	Preparation of a software tool for economic assessment of Zero-M measures
4.3	Multi-criteria analysis of Zero-M components in MPC environment (environment/health/social aspects)
4.4	Case study analysis
5.1	Video production

3 Achievement of objectives

3.1. Achievement of project results

The project could provide the following results, deemed to contribute to promote the project objectives.

Result 1: More exchange about water and wastewater management in partner countries

A website with information about sustainable water management is available and well used by a large community. Certain documents have been hit or downloaded up to 3000 times. Eight journal issues were published and between 5000 and 7000 copies of each distributed to water experts and decision makers in all partner countries and to all MEDA Water projects, the Delegation and the RMSU. Three conferences took place and proceedings were published on the webpage, in hardcopy and two issues of Desalination. Presentations in other conferences, not least those organised by the RMSU, were made by Zer0-M partners.

The partners developed very good research capabilities and infrastructure and gained experience through its operation. Thus each partner has now the means and concrete knowledge to promote a range of SWM techniques (reference is made to chapter 3.2 for a list of activities by country, emerging from Zer0-M). All partners have developed and are seeking further projects about SWM. Approximately 90 publications about the project topic are available, making the issue of SWM a major part of the scientific production of the project partners during the project period and certainly beyond with the data yet to come and the resulting papers.

In Egypt the TDC became the major training and demonstration location for the Pilot Training courses that aim for increasing the public awareness and exhibits the different technologies for SWM. Presently the training courses are running periodically 4 times per year. Meanwhile, there are different researches going on depending mainly on the TDC as experimental site. These researches are carried out by two post Doctors. One is dealing with Membrane Technology and the other with Constructed wetlands. Besides, the TDC is used for several Masters and Ph.D. theses. Moreover, it is the only site in Egypt that can show practical examples of technologies exhibiting both simple and advanced technologies and is visited by many experts.

In Morocco, the TDC was constructed by the WTRU, which is one of the main components of the department of Water Environment and Infrastructures (DEEI). This anchorage point in an academic entity helped adding the Zer0-M approach as a new topic for students preparing their last year personal research work. Also, the basic curriculum taught in the second year of rural engineering specialisation has been modified introducing 20 hours of practical work to be done on the TDC components. Each year starting 2009, around 25 students of the second year of rural engineering will do such practical work as part of their basic training program.

In Tunisia Ahmed Ghrabi has introduced a chapter about local water management, i.e. segregation of wastewater (yellow, grey, black, dry faeces disposal) into his lecture “Wastewater Treatment” for sanitary engineering students at the INAT. Makram Anane, the CERTE specialist on GIS/DSS, is going to include a chapter of 4 hours about the DSS in his 30 hours course on natural resources management given at the “Ecole Supérieure d’Agriculture de Mograne”.

In Turkey many interest groups from Ministries, Municipalities, University lecturers, students and NGOs visited the TDC during the project implementation not only for the purpose of trainings carried out in the project but also by means of our invitation to promote the concept or their special interests. The TDC is still being visited by interested groups and technical visits to the TDC are usually planned when a meeting or seminar is held on water related issues. In addition, although the MRC does not provide education in the same manner as universities, further collaboration with the Istanbul Technical University for urine treatment and reuse, which also will be a thesis of a MSc. student, is in progress. By this way, the TDC and infrastructure established in Zer0-M, will be further contributing to the research activities.

Result 2: Knowledge about water and wastewater management in partner countries improved

In total 685 participants, water experts from authorities and consultants, students, journalists… were trained in and made aware of sustainable water management (see training report) through trainings, meetings, discussions about and practical work at pilot systems.

Especially the trainees from the water administrations became aware of the approach, continued to develop and concretise it further and were subsequently coming back to the project partners for assistance and advice about how to implement the approach in various instances. Thus activities beyond the work of Zer0-M have emerged from these contacts and first policy changes can be observed, not only through Zer0-M, but with Zer0-M providing solutions for how to implement the policy changes (see chapter 3.2).

Besides the water experts attending trainings, Zer0-M also gave opportunity for long term training to students and post-graduates working at theses at the MCPs'. In Morocco, the TDC was constructed by the WTRU, which is one of the main components of the department of Water Environment and Infrastructures (DEEI). All other partners received students who participated at the monitoring of the TDC and thus got a thorough knowledge about the approach and the technical options (see annexed table 42 for a complete list).

In total, six engineers were trained on this approach. Four among them are working in important consulting companies, where they have had already many opportunities to suggest solutions inspired by the Zer0-M approach.

One excursion to Italy and Germany showed applications of sustainable water systems in these countries to a selected group of decision makers from the MPCs. This was the first encounter of the participants with concrete examples of modern rainwater harvesting or greywater systems and dry sanitation. Thus the excursion enhanced the understanding of the participants from the national water administrations for the project approach and paved the way in further discussions and negotiations.

Result 3: SWM implementations available

Training and Demonstration Centres (TDCs) are available in Egypt, Morocco, Tunisia and Turkey. These centres comprise a variety of examples of concrete sustainable water management systems in a small scale, treating flows of several hundred litres to several m3 per day and used for research and demonstration purposes (for a detailed description of the TDCs see annex 3).

With the TDCs first examples of various sustainable water management techniques were successfully demonstrated in the MPCs, e.g. segregation of greywater, treatment and re-use for domestic purposes, particular constructed wetlands or modern dry sanitation devices. These examples had never been implemented in the countries before and thus had a corresponding impact during visits and trainings. On the other hand the implementations at the TDCs helped gain first experiences with the technical options involved and served as trials for larger pilot installations.

In all countries many engineers from consulting companies are regularly visiting the TDC especially to take advantage of life observation of the technical options adapted for recently introduced technologies.

Most requests are linked to greywater segregation, treatment and recycling, constructed wetlands for small communities in various variants (horizontal, vertical flow). In Morocco there is also interest to get offshoots from the *Phragmites australis*, the reed species used in the TDC.

In three locations in Egypt, Morocco and Tunisia pilot systems[1] are implemented, demonstrating some sustainable water management technologies at real scale (for a detailed description of the pilot systems see annex 3).

Result 4: Concepts and design tools for integrated sustainable water and wastewater management available

A planning tool for sustainable water systems is available and readily usable upon registration on the internet, taking advantage of developments of the internet itself, e.g. Google Earth providing maps of increasing quality of many locations in MEDA countries. This tool comprises a GIS for spatial visualisation of geographical and infrastructure elements, economic and environmental modelling for the assessment of the performance of water systems. A multi-criteria analysis tool allows to compare variants of water systems according to preset or self-defined criteria. For interested persons without computer access a simplified paper version of the tool is available (see annex 6.4). A report with four case studies using this tool was prepared (see annex 6.3).

The DSS was subsequently used on a master thesis in Austria, which aimed at determining the optimal water system for a municipality with small centres and dispersed habitat. The thesis was also used to calibrate some functions and to check the models of the DSS. It is presently used (time of preparation of this report) to work on the project of the MRC aiming at the protection of a lake in Izmit from diffuse pollution (see chapter 3.2, Turkey). These examples will help to further feed the DSS with data, especially about cost, speeding future uses.

Result 5: Awareness of sustainable water and wastewater management raised

Openings of conferences, steering committee meetings, inaugurations of training centres and pilot plants were attended by high level decision makers of the partner countries.

For dissemination and awareness raising purposes addressed mainly to the general public and other non expert persons, e.g. decision makers, three videos are available:

[1] With the Zer0-M approach the term pilot system is preferred to pilot plant. While there is often one (or several) wastewater treatment plant comprised in such a system, it normally consists of a comprehensive set of measures, including water saving, substituting potable water with water from other sources and reuse of the effluent of treatment plants.

- The Innovative Turn, with examples of sustainable water management in Germany, (in Arabic, English, French, German and Turkish)
- Flush and Forget, explaining the approach recommended and developed by Zer0-M and showing a variety of appropriate water techniques, (in English and Arabic).
- "La récupération des eaux pluviales en Tunisie", concerning the particular rainwater harvesting tradition in Tunisia (in French).

Flush and Forget is an extended version of the video "Waste Not Waste", a BBC World Earth Report by TVE. This Earth Report was aired in January 2008 as the first of a series of films about sanitation in the International Year of Sanitation 2008 and was repeated in January 2009. Waste Not Waste also received the prize in the *A* category - journalistic programmes and films of the 14th International Environmental Film Festival ENVIROFILM 2008 in Banská Bystrica, Slovakia.

BBC World is available to 280 million households in 125 countries. Actual viewers are estimated at 70 million by BBC World. Copies are distributed to other broadcasters in Africa and South Asia by TVE. It has been presented at the 5th World Water Forum in Istanbul.

The video "The Innovative Turn" shows to a broad public that industrialised countries, too, are seeking more sustainable solutions for water management, that it is possible to introduce even controversial techniques under certain conditions and that there is a wide variety of different sustainable systems available. "Flush and Forget" translates this into the Mediterranean context with many practical examples. The reach of the Earth report far exceeds what could be expected during design of the project.

One DVD comprises the two videos "The Innovative Turn" and "Flush and Forget" plus supporting technical documentation including all Zer0-M journals and training material. Ten thousand copies of this DVD are distributed through the same channels than the Zer0-M Journal. They were also shared with the Sustainable Sanitation Alliance, which means they reach out to more than 100 organisations world wide working in the field of sustainable sanitation with their affiliate and partner organisations.

3.2. Achievement of project purpose

Project Purpose

Enable in each of the MPC a centre of excellence to implement and disseminate SWM

The four MEDA partners are centres of excellence in their countries in the field of water research, being either a technical research institution or a university, and, since Zer0-M, in sustainable water management. They have each developed training material in their languages, have a fully equipped and operating Training and Demonstration Centre (TDC) showcasing the technical options listed below. They have gained experience with the design and operation of the technical options of sustainable water management and with trainings on the related issues.

The project has worked on a few concepts considered as key elements of sustainable water management, and the four MEDA partners CERTE, IAV, MRC and NRC are fully familiar with technical options, i.e.

- Water saving: Water saver appliances, waterless urinals, fixing fixtures
- Segregation of grey and black water, on site treatment of greywater with natural and intensive techniques and reuse for domestic, landscaping or irrigation purposes

- Simple, low cost treatment of wastewater or components, e.g. grey and black water as well as primary sludge, especially with constructed wetlands, which are cheap and easy to operate,
- Irrigation with treated wastewater
- Urine segregation and separate collection
- Dry sanitation, including composting of faecal matter and use of urine
- Rainwater harvesting and use for various domestic purposes

In each country the pilot installations intended by the project are available and further implementations are under preparation in cooperation with relevant water authorities. These authorities have been confronted with and informed about SWM, its approach and technical options, through conferences, the journal, trainings and physical implementations. Especially the physical implementations and the discussions around permits. Thus the project had the **impact** as follows below.

Egypt

The representative of the Egyptian partner in Zer0-M, Prof. Hussein Abdel-Shafy has given several interviews for the Egyptian television, could show the TDC on screen and explain sustainable water management. This proves the high attention the project received to its approach to water management.

Many local organisations sent their representatives to attend the training courses as well as to the TDC site to learn about the project activities. This was achieved through the promotion of the Egyptian partner. These organisations were water/wastewater municipalities, research centres, universities, graduate students, engineers, private sector companies and NGOs, partners of other MEDA Water projects, etc. Demonstration of the constructed wetlands pilot plant, MBR and SBR were among the technologies that were under their focus for implementation. The partner also carried out two international workshops in June 2007 and October 2007 that were funded by other organisations where the project concepts were presented by the project team. Representatives from organisations participating at these workshops comprised:

- Agricultural bodies
- Drinking-water sector
- Environmental protection entities
- Industrial wastewater treatment and processing
- Ministry of Agriculture
- Ministry of Irrigation and Water Resources
- Ministry of Public Health
- Ministry of Industry
- Municipal wastewater treatment and reuse units
- Public health stakeholders
- State Ministry of Environmental Affairs
- Summer and coastal area resorts
- Urban Cities, Remote areas, Tourism areas

In addition, Abou-Rawash wastewater treatment plant (Giza) constructed a large artificial wetland. The purpose is to treat the extra by-pass municipal wastewater. Meanwhile, the Water & Wastewater Authorities of Cairo are presently convinced by the Egyptian partner to implement the membrane technology for the treatment of municipal wastewater.

The Egyptian partner established a joint project with European and MENA countries that was dealing with membrane technologies.

Graduate students and one post—doctor studies were carried out through the project activities that dealt with the project concept, namely simple and advanced technologies to close the loop of water and safe reuse of water.

AEE INTEC and SEKEM[2] are presently negotiating an involvement of the water department of AEE INTEC in the establishment of the Heliopolis University by the SEKEM group in order to take into consideration sustainable water management techniques during erection of the infrastructure and later in the research and teaching of the University.

Morocco

According to a recent royal directive golf courses in Morocco must not use fresh water anymore but treated wastewater as much as possible. Recycling of wastewater must be given the utmost attention. Since then the REDAL, a subsidiary of Véolia, France, managing water supply and wastewater of Rabat, Salé, Temara and Skhirat, which is presently building an ocean outlet, has recently launched a tender for the design of a reuse scheme for 100% of the town's wastewater. The watchword is reuse.

The Ministry of Interior, which also supervises has water and wastewater management by the councils of municipalities and rural communities by providing technical and financial support is very interested in a larger application of the Zer0-M approach. On 19 January 2009 a meeting with the Director of water and sanitation, Mr. Mohamed Dinia, and the head of the wastewater division, Mr. Abdelmajid Benoumrhar and the head of the GTZ project AGIRE, Mrs. Christine Werner was held. Potential sites for pilot system for a whole settlement were discussed. The first step will be a study of the possible water systems according to the Zer0-M approach. This could be a cooperation of the Ministry of Interior, the GTZ project AGIRE and Zer0-m partners.

Throughout its operation Zer0-M invited ONEP to cooperate in developing interesting zero emission water schemes for municipalities together. These never went beyond a friendly declaration of interest. With the new royal directive this may change as ONEP now is looking for appropriate reuse technologies. Thus a meeting between ONEP, Zer0-M and AGIRE took place with the aim of bringing ONEP to cooperate inside the Zer0-M approach.

The hammam example of greywater treatment and solar heating of water has raised a lot of interest and the Moroccan Zer0-M partner is invited to work with further such hammams. A project set-up, possibly in cooperation with partners from Tunisia, is still under development.

The partnership with Prof. Bouchaib El Hamouri, IAV Hassan II in Rabat, Morocco, made it possible to compose a new project team of German and Moroccan partners. This team successfully submitted a proposal for a project about urban agriculture in Casablanca within the context of a research program by the German Ministry for Education and Research (BMBF) on the sustainable development of Megacities of tomorrow. Urban development has to be considered in a broader, integrated management context to count on the different levels of development, to determine their interaction and to balance them properly. Particularly, the use of water by the different users, like the agricultural, domestic, and energy sector, as well as industry and environment are of high relevance.

[2] The name SEKEM is the transliteration of a hieroglyph, meaning "vitality". The SEKEM Initiative aims to meet today's challenge of sustainable human development by contributing towards a comprehensive advancement of the individual, the community and the environment. Cooperation in economic, social and cultural endeavours is cultivated through dedication to the pursuit of science, art and religion. www.sekem.com

There is increasing competition between these different sectors for the scarce global fresh water resources and for the available energy resources.

The question of how urban agriculture can be an integrated factor for the development of Casablanca includes issues of biodiversity conservation in multifunctional landscapes through the implementation of eco-agriculture principles as well as the sustainable water management approach and needs further investigation. Likewise, the resource consumption of water and the greenhouse gas emissions by the industrial sectors are to be reduced in a sustainable way in the future. Experiences gained in Zer0-M are important for the knowledge transfer and capacity building. The water reuse and renewable energy scheme for the hammam Attaisir in El Attaouia implemented in Zer0-M serves as an example for pilot projects in the new urban agriculture project.

Tunisia

CERTE has been invited by SONEDE to participate in workshops organised for public education, training and research institutions. The objective of these workshops is to raise the awareness of planners and managers of these institutions for new water management systems able to save and reuse water. The approach of Zer0-M is mentioned as an economically viable and resource effective example.

The government has made rainwater harvesting a priority issue of research and will entrust it to CERTE in the frame of a general agreement, which will be signed between the supervisory ministry (Ministry of research) and CERTE.

Further development of the Zer0-M approach could arise soon following the activities below carried on by CERTE as a result of Zer0-M:

- Discussion with the Ministry for Agriculture and Hydraulic Resources about implementation of a rainwater harvesting system for the office building of the General Directorate of Water and Soil Conservation, which should supply the toilets with water for flushing. The toilets have already water saving push buttons.
- Discussion with decision makers at the Ministry of Defence about a pilot system for local water management following the examples of the TDC, the school at Chorfech and the wastewater treatment plant there. This discussion has reached an advanced stage. The next step is to identify a site for the pilot system and the funding.
- Discussion with ONAS for the implementation of greywater systems at hammams in Tunis. ONAS intends to use the treated greywater as service water mainly for sewer cleaning with their jetter trucks. A project proposal is presently under preparation.
- Contacts with the Tourism Land Agency (Agence Foncière de Tourisme – AFT) for a study at one hotel in order to implement the Zer0-M approach following the example of the TDC and the examples visited during the 2005 excursion to Germany and Italy organised by Zer0-M. One of the representatives of AFT, Mr. Zouhair Jallouli, participated to this excursion.
- Participation of CERTE as representative of Zer0-M to the events listed below, exhibiting demonstration equipment, posters and the journal on Sustainable Water Management:
  - The show “Green Africa” in November 2007, presenting the project to the Prime Minister, the Minister of Education and the Minister of the Environment and Sustainable Development;
  - exhibition at the national research sitting in Tunisia November 2007
  - National research fair “Fiftieth Anniversary of the Tunisian University”

- Presentation of the TDC at a scientific event “Desert and Technology”, GEOSS African Water Cycle Symposium (January 2009)
- Invitation of the Tunisian Zer0-M team by CITET to two conferences and podium discussions targeting consultants and aiming at the introduction of cleaner production
- Invitation of high decision makers of Tunisian Authorities (Prime Ministry, Ministry of Research, Ministry of Agriculture, SONEDE, ONAS, research and higher education institutions, etc.) for the inauguration of the TDC,
- Presentation of the TDC, the primary school at Chorfech in the video “Waste not Waste” made by TVE for the BBC World Earth Report and broadcast in January 2008 and 2009, with two repetitions each.
- the Chamber of Architects in Tunisia has prepared a Video-learning (V-learning) tool together with Zer0-M and based on Zer0-M experience, which it is going to use for further education of architects in Tunisia, and possibly in North Africa (the Tunisian Secrétaire Général is also responsible for further training in the three North African Chambers of Architects and representative for further training of Africa in the Union Internationale des Architects).

Turkey

During the project implementation many interest groups (Ministries, Municipalities, University academics and students, NGOs, partners of other MEDA Water projects etc.) were informed about sustainable water management by means of meetings, trainings, excursions. They became aware of how these technologies can be applied according to Turkey’s needs. Some organisations were very interested with the topic such as

- Municipality of Istanbul + General Directorate Water and Sewerage,
- Ministry of Environment and Forestry,
- Local Offices of the Ministry of Environment and Forestry (Istanbul, Kocaeli…),
- Governorships of cities (Isparta,… etc.).
- Municipality of Kocaeli
- Municipality of Izmir
- Municipality of Fethiye.

It is stated that these organisations will apply these concepts in their territories.

A national project called “Urban Wastewater Management along Coastal Areas of Turkey: Re-identification of Hot Spots & Sensitive Areas, Determination of Assimilation Capacities by Monitoring and Modelling and Development of Sustainable Urban Wastewater Investment Plans” was started in 2008. Coordinated by TUBITAK MRC and constituted of a large national consortium, the project has a big budget and is supported by the Ministry of Environment and Forestry. In this project the experience gained from Zer0-M is going to be used in order to plan and implement the sustainable wastewater investments.

Istanbul Water and Sewerage Administration is planning some initiatives to implement a regulation for shopping malls. It is intended to apply efficient use of water in the newly built shopping malls by using water saving devices and after application of proper treatment, reuse of wastewater in landscaping. This is not an official regulation yet but at least a very good awareness and attempt to apply sustainable water management.

Since Zer0-M the MRC is involved in one FP7 project proposal called PREPARED where it will be responsible for implementation of the SWM approach for a selected residential site in Istanbul together with the municipality of Istanbul as the work package leader.

The technological advances experimented and the relevant experience gained within Zer0-m are also being used for the integrated coastal zone management project (SPI-

COSA, www.spicosa.eu, FP 6 integrated project) where the MRC is responsible for the development of technical options to be employed for coastal zones including sustainable water management.

Another large scale national project deals with the protection of a lake in Izmit (Turkey) from land based sources of pollution, mainly none-point sources in the form of road, urban and rural area run-off. In this case, the SWM methods that we have gained experience with through Zer0-m are also implemented at large scale.

In addition to that, through collaboration and dissemination activities of Zer0-m, the level of relationship with the universities and institutions significantly increased at national and international state. Among these, further collaboration with the Istanbul Technical University, for urine treatment and reuse, and with IRIDRA (Italy), concerning natural treatment systems for our ongoing projects, are worth to mention.

Hence, it should be noted that the level of the technical knowledge, existing capacity and the awareness to SWM concept that the MRC had, at the start of Zer0-M in 2003 has increased significantly through collaboration with the partners as well as the synergy created. This experience also has been shared successfully with the important stake-holders of the country. As a result, it is believed that especially for the issue of conservation of natural resources, development of innovative water resources, as well as mitigation of climate change impacts, significant achievements and contribution were made.

In two well-known local TV channels, TRT-2 (governmental) and CNN-Türk (private) interviews about the activities of Zer0-M and sustainable water management given by the project personnel were shown.

Information about the activities of TÜBITAK MRC in relation to sustainable water management was published in a Popular Scientific Magazine called “BILIM Teknik”. This leads to more awareness of TUBITAK MRC among the public.

3.3. Contribution to overall objectives

Contribution to

- **the reduction of water abstraction,**
- **guaranteeing the quality of water bodies receiving treated wastewater,**
- **the restoration of the biogeochemical cycle,**
- **the alleviation of health and social problems caused by insecurity of water supply and wastewater disposal**

Five years of work are a short time to introduce change, especially in a domain so strongly governed by traditions and taboos as sanitation. The partner countries, however, have made some way towards the project objective, not least due to the fact that the project was part of a larger program, with many activities pointing towards the same goal.

The following activities, mostly initiated by Zer0-M but carried on independently show that the new approach was introduced and raised a certain amount of interest.

Presently there are the following actions already going on:

- The video "Waste not Waste" is further promoted and broadcast by TVE after its broadcasting in January 2008 by BBC World as the first of a series of films about the International Year of Sanitation. It was repeated in January 2009 and was shown at the World Water Forum 2009 in Istanbul.

- EMPOWERS and its participatory approach to water planning were adopted by the IUCN office for Central and Western Asia and North Africa in Amman. Partners of Zer0-M and IUCN are presently working at combining the Sustainable Water Management Approach and the Participatory Planning Approach to build one efficient tool for the promotion of sustainable water management in the IUCN programme for water of the region.
- AEE INTEC and IRIDRA[3] have become partners in the Sustainable Sanitation Alliance and use their experience in capacity building and technical aspects to participate in the preparation of information material on the issues of sustainable water management and the MDGs within the Sustainable Sanitation Alliance[4].
- The partnership of Zer0-M, together with new partners, has submitted a COST proposal to form a trans-sectoral network promoting sustainable water management which is based on the lessons from Zer0-M.

The following actions are explored:
- Formation of a network of Training and Demonstration Centres, comprising those of Zer0-M project and of other MEDA water projects but also other existing centres.
- Preparing of further projects to
  a. Introduce greywater treatment and reuse and solar systems for hammams in Morocco and Tunisia (guidelines, regulations, pilots).
  b. Introduce greywater treatment and reuse in urban housing in Tunisia
  c. Introduce sustainable water systems together with Heliopolis University, created by SEKEM at Heliopolis, Egypt.
  d. Introduce the concept of Zer0-M to public institutions using much water and not connected to the sewerage systems (military bases and penitentiary institutions)

3.4. Contribution of the ZER0-M project to the objectives of the Turin Action Plan

With respect to the Turin declaration, the vertical issues of the MEDA Water programme Zer0-M contributed as follows.

I Integrated management of local drinking water supply, sanitation and sewage;
Wastewater, or partial flows of it can easily become a source of water, provided the proper treatment and, therefore, water supply and sanitation have to be planned and managed as an integrated unity.

II Local water resources and water demand management (quantity and quality) within catchment areas and islands;
There are systems available combining simple techniques, which can be managed at the very local level of a building or a neighbourhood, and allow to recycle water, provided the households participate and agree to small modifications of their sanitary plumbing and habits. The techniques can be readily applied

III Prevention and mitigation of the negative effects of drought and equitable management of water scarcity;
Greywater, wastewater and rainwater are perfectly suitable or can be treated to be suitable for various domestic or other urban water needs.

3 IRIDRA sarl is subcontractor of ALT for technical design and work supervision http://www.iridra.com
4 http://www.susana.org

IV Irrigation water management;
Wastewater or the blackwater fraction and urine contain valuable nutrients. It was a particular concern in Zer0-M to make these nutrients available to agriculture, to protect the aquatic environment from eutrophication on one side and to prevent depletion of natural resources, e.g. phosphorus reserves, on the other. Zer0-M showed techniques which allow to easily make nutrients available to agriculture.

V Use of non-conventional water resources;
In every MPC best practice examples of SWM systems, which make use of alternative water sources, have been implemented and are used for demonstration.

With respect to the horizontal issues of the MEDA Water programme Zer0-M contributed as follows.

A. Strengthening institutional capacities and training;
4 MEDA partners were enabled to disseminate sustainable water management (SWM) approaches and to train water experts on SWM.

B. Exchange of information and know-how;
Several tools, a website, a journal, meetings, conferences, personal contacts allowed exchange of information about SWM.

C. Transfer of know-how and technology;
The SWM approach and technologies already applied in several European countries were transferred and adapted to the situation in Mediterranean countries.

D. Awareness raising, mobilisation and promotion of commitment of the population.
Awareness raising tools (flyers, videos) and events raised awareness and interest for the SWM approach.

4 Implementation of activities

The introduction of SWM is a paradigm shift[5]. A paradigm shift typically involves various phases, which cannot be leapfrogged. Arthur Schopenhauer put it that way: “All truth passes through three stages. First, it is ridiculed. Second, it is violently opposed. Third, it is accepted as being self-evident.” The new paradigm is cycle oriented and sparing management of all substance flows in human economy, at the image of nature.

Change Management

A major issue was change management. Even though included in the project design, it could not be sufficiently addressed, not least because finite projects do not give enough room for the related considerations.

This was especially apparent with the physical implementations. Identifying potential pilot sites, explaining what the systems were meant to be and achieve, obtaining the necessary permits for their implementations were so many obstacles, each bearing a potential of complete failure. Thus the time allocated to the activities was too short and had to be extended, even beyond the original end of the project.

[5] Thomas Kuhn, The Structure of Scientific Revolutions

4.0. Project coordination

4.0.1. Meetings

A first kick-off meeting was held in September 2003. Nine further steering committee meetings were held, one every six months (see table 1) from March 2004 to April 2008. The steering committee was composed of one representative per partner organisation of the project consortium. The steering committee meetings were accompanied by technical meetings. Each partner assigned those members to the meetings who had important contributions to technical issues of the project implementation.

Table 1: Steering Committee, or Project Meetings in Zer0-M

Activity	Start	End	Location
Kick-off meeting	11/09/03	13/09/03	Austria (IGR,Vienna)
Project Meeting 1	19/03/04	22/03/04	Egypt (NRC,Cairo)
Project Meeting 2	08/09/04	12/09/04	Germany (wB,Hanover)
Project Meeting 3	16/03/05	20/03/05	Turkey (MRC, Istanbul)
Project Meeting 4	14/09/05	18/09/05	Italy (ALT, Florence)
Project Meeting 5	16/03/06	19/03/06	Morocco (IAV,Rabat)
Project Meeting 6	13/09/06	17/09/06	Germany (TUB,Berlin)
Project Meeting 7	25/03/07	29/03/07	Tunisia (CERTE,Tunis)
Project Meeting 8	15/09/07	18/09/07	Italy (ALT,Catania)
Project Meeting 9	23/04/08	26/04/08	Austria (AEE INTEC, Gleisdorf)

These meetings were used to up-date all the partners about the progress of each member of the consortium and to plan and co-ordinate the work ahead. At the same time the meetings were a welcome opportunity to work on issues, which needed the contribution of several partners. The meetings were also a forum to discuss and refine the Zer0-M approach in order to enable the participating institutions and partners to better understand and reinforce their roles in their own countries.

4.0.2. Reporting

The progress reports listed in
all financial reports were audited by the independent audit firm deloitte & touche gmbh. the change of auditing firm from ernst & young, wirtschaftsprüfungs- und steuerberatungsgesellschaft m.b.h. to deloitte & touche gmbh was notified to the delegation.

additionally, monthly reports were submitted from august 2007 to july 2008 concerning progress of physical implementations of the project. weekly progress reports of the implementation of the pilot systems at chorfech in tunisia were submitted during november and december 2008, from the beginning until the completion of the works at the treatment plant.
table 2 were submitted.

All financial reports were audited by the independent audit firm Deloitte & Touche GmbH. The change of auditing firm from Ernst & Young, Wirtschaftsprüfungs- und Steuerberatungsgesellschaft m.b.H. to Deloitte & Touche GmbH was notified to the Delegation.

Additionally, monthly reports were submitted from August 2007 to July 2008 concerning progress of physical implementations of the project. Weekly progress reports of the implementation of the pilot systems at Chorfech in Tunisia were submitted during November and December 2008, from the beginning until the completion of the works at the treatment plant.

Table 2: Reporting

Period	Technical report	Financial report
01/09/03 to 31/08/04	20/01/05	20/01/05
01/09/04 to 31/08/05	28/02/06	28/02/06
01/09/05 to 31/08/06	08/05/07	08/05/07
01/09/06 to 28/02/07	10/09/07	
01/03/07 to 31/08/07	07/11/07	03/04/07
01/09/07 to 29/02/08	26/07/08	
01/09/03 to 28/02/09	25/03/09*)	31/05/09

*) first version of report

4.0.3. Transfer of Project Results to EMWIS

All project results printed or available on data supports (DVD) were spread among partner projects, EMWIS/SEMIDE, among others. Otherwise, the project results are presented on the project website, which EMWIS/SEMIDE is linking to.

4.0.4. Contract Amendments, Extension in Time

The project introduced four requests for Amendments, which were all accepted by the Delegation. Three of them, 2 to 4, were mainly about extensions in time, as discussed above.

- Amendment 1, comprising the termination of partner Kalithea and modification of budget item 5.6. which was not processed any more by the head office in Brussels and ultimately reintroduced with Amendment 2.
- Amendment 2, extension of one year until 31 August 2008 and related budget modification: signed 05 July 2007 and 20 August 2007 by Delegation and AEE INTEC respectively.
- Amendment 3, extension of pilot activities in Tunisia and Morocco and coordination by AEE INTEC until 31 December 2008 approved by the Delegation on 24 June 2008 and signed by AEE INTEC 18 June 2008
- Amendment 4, extending pilot activities in Tunisia until end of February 2009, signed on 19 November 2008 and 25 November 2008 by Delegation and AEE INTEC respectively.

Problems specific to the execution of the project which essentially lead to a need for extension in time and to the requested Amendments are listed in table 3.

Table 3: Problems specific to the execution of the project

Causes and Description	***Corrective actions***
Kalithea: The Greek partner, Kalithea, failed to fulfil their tasks and asked to leave the Consortium at the end of the first project year.	After intensive talks with the delegation from Kalithea at the 1st project meeting a letter of contract breach according to article 7.4 Defaults and Remedies was filed. At the same time a particular effort by the management and other project partners was made to support Kalithea. At the 2nd project meeting the steering committee decided to follow the application of Kalithea to leave the project and reallocated Kalithea project tasks and budget.
Procurement: Problems were anticipated with respect to the procurement procedure after the first MEDA meeting in Brussels 2004. The procurement procedure as explained at the meeting was rather inflexible whereas the TDCs should have been a prototype sort of installations allowing to try different techniques, to modify and improve them throughout the project and according to new findings	The attempt was made to assemble a list of all needed items for one year that should be procured. The TDCs were consequently planned more static than initially intended, with one design implemented at the beginning and no subsequent changes throughout the project. It was tried to include needs for future trial runs in the initial design and procurement in order to have the equipment available when needed.
Procurement procedure: The most important cause for delays in year two was the difficulty to carry out procurement procedures according to the understanding of the EU AidCo office in Brussels for the various implementations of the project. Basically the request was to have yearly general tenders for all supplies, regardless of the type and final destination.	The situation could not be unblocked until the responsibility for the program was moved to the Delegation. After March 2005, when the Delegation of the European Union to Jordan took over the coordination of the MEDA Water Program the situation was eased somehow and the approach became very cooperative. Nevertheless, remaining conflicts between national and EU rules for procurement took a long time to be solved.

Causes and Description	***Corrective actions***
Delay: The project had accumulated delays due to different reasons: • Procurement • Administrative issues with construction permits of TDCs and pilot plants • Identification of pilot sites and planning process with owners	Some of the activities could not be completed in the planned time A request for contract amendment for an extension in time of 1 year was discussed with the RMSU and the Delegation and subsequently approved. Thus the project was extended from August 2007 to August 2008.
Construction permit: The construction for the pilot treatment plant at Chorfech in Tunisia was delayed by concerns of the authorities	After examining of the possibilities to still build the treatment plant together with the Delegation and the RMSU the project applied for first another 4 months and than additional 2 months of extension to erect the plant. The plant was finally completed and commissioned in February 2009 (see list of amendments below) .

4.1. Result 1, More Exchange About Water and wastewater Management in Partner Countries

Activity 1.1. Installation of a Long-Term Living Internet Network on Zero-M Concepts

The realisation of the project website started immediately after the kick-off meeting, at the beginning with the conceptualisation of the contents and the structure itself. Specific descriptions of the activities of all Results and the general contents were reviewed and edited. Two domains, zer0-m.org and zero-m.org, were registered. A restricted area was set up which is accessible only by the Zer0-m partners, in which two different levels are available: 1) Forum for internal discussion 2) exchange files FTP directory.

Table 4: Maximum hits and downloads at the homepage.

Item	Downloads (texts) Hits (pictures)
Download area	
1st issue of Zer0-M Journal	2840
Brochure about water saving in Turkish	2765
Italian guidelines for constructed wetlands	2300
Photo album	
Morocco, TDC at the IAV	3000
SEKEM pilot plant	2400
Constructed wetlands	2350
Dry toilets, allegedly a non-goer, still	1557

In order to simplify the communications between the partners a mailing list has been implemented and instructions to facilitate the website usage for all partners were provided.

In August 2004 a Public Forum for the discussion of the main topics inherent to Sustainable Water Management has been set up on the website and a photo gallery was installed. The Public Forum however had practically no acceptance and was abandoned at the end of 2007. Other features, like the files download or the photo album showed much better frequency (see table below).

The forum for experts was finally closed down after spam attacks. Zer0-M partners joined existing networks to participate in and contribute to professional discussions:

- Med-reunet of the Agbar foundation until its closure
- Ecosanres mailing list
- Sustainable Sanitation Alliance
- Wikipedia, where articles about sustainable water management, sanitation are co-edited
- Facebook groups about CWs, ecological sanitation,
- Wiserearth

These networks were used to announce broadcasting or other particular events in Zer0-M. At the same time the webpage was used to publish and report about, in almost real time, interesting project activities. Thus the erection of the constructed wetland at Chorfech 24 was followed by a large community of interested water experts almost worldwide, with interesting feedback to the project.

It had to be acknowledged that fora are rather inactive, while mailing lists so far can work quite well, if properly managed. It was more reasonable for the project partners to join existing networks about the topics addressed by Zer0-M than to maintain an inactive forum. The mailing lists and networks were used among others to announce major Zer0-M events and achievements, advertise information available on the webpage etc.

The Zer0-M webpage (www.zer0-m.org) will be maintained for three years beyond the project end. A reassessment of its usefulness will be made than in order to decide whether it should be further remain accessible.

Activity 1.2 Starting the Publication of Semestrial Journal

Information on hard copy is still considered an important dissemination tool, despite the availability of the Internet. A 6-monthly journal allowed Zer0-M to publish information about sustainable water knowledge and to induce exchange among those working on the topic. The journal was used by Zer0-M partners to spread information about their work, but also to make the MEDA Water programme and other initiatives on SWM known in the region. Thus one issue was dedicated to the projects of the MEDA Water programme, with each project publishing its most relevant issues.

Hard copies of the journal were distributed to the trainees of the course, the water ministries, universities, research centres, municipalities, and the partner projects. During the several TV interviews by the Egyptian partner, the journal was always mentioned and shown by the TV camera.

The idea of co-ordinating the journal with the other MEDA projects and publishing it more often, even though well received by the project representatives at the MEDA meeting in Brussels in June 2004, had no follow up as it was not possible, out of one project, to integrate others into this activity. Therefore the layout of a Zer0-M journal was created and 8 issues of the journal published throughout the project. Until the end it remained the only journal on SWM. Between 5000 and 7500 copies of each issue were distributed in all partner countries, to all the MEDA Water projects, the Delegation and the RMSU. The project partners forwarded the journal to water professionals and authorities in their respective country. The later issues were also spread to other countries, e.g. Pakistan and India on the demand of partners of the Sustainable Sanitation Alliance.

Figure 1: Conference in Tunis, March 2007

Activity 1.3 Legislation Up-date

A comprehensive overview of existing legislation about wastewater segregation, reuse of wastewater and reuse of excreta was prepared for all MEDA partner and European countries. Especially for Mediterranean countries the work of MEDAWARE could be relied upon. This paper is available for download on the Zer0-M website and included on the Zero-M DVD, annexed to this report as DVD 1, (file "Legislation_Overview_Wastewater_Reuse.pdf" in folder "Water regulations").

Activities 1.4, 1.5 and 1.6: First, Second, and Third Conference

Three conferences were organised, in Istanbul, Marrakech and Tunis in 2005, 2006 and 2007 (see figure 1) respectively. Each conference attracted between 100 and 150 participants. The conference in Marrakech was organised in cooperation with MEDAWARE. This decision was taken in order to avoid two competing events within a short time period at the same location. The cooperation allowed to attract a broader public and to exchange scientific and technical information between the two projects and their respective contacts in the MEDA countries.

The abstracts of the conferences are available for download from the Zer0-M webpage and on DVD 1. The proceedings of the last conference have been downloaded 600 times, with an audience of 150 persons at the conference. Thus the outreach through the webpage could be further increased. the Proceedings were printed for each conference and two issues of Desalination were published with a selection of 25 papers of the second and the third conference.

The approach of Zer0-M is still very new, especially in Mediterranean countries. Thus it is understandable that little research was bearing on the particular approach. Therefore many of the talks given at the conferences were about rather conventional issues. However the conferences organised by Zer0-M allowed to present the approach and the work by Zer0-M. They also allowed to place the approach in a larger context with at least some presentations about new water techniques from participants outside the project. Thus the information could be brought to local and international researchers and water experts from authorities in an open and engaging atmosphere with lively discussions and exchanges.

All conferences were attended by important representatives of the countries authorities, a fact which gave the message a certain weight and allowed us to deliver it at a high level. Talks were made by researchers from the region, MEDA Water partner projects and Zer0-M members. Attendees were mainly researchers, water administration members and students from the country of the conference itself and from neighbouring countries.

Thus in Istanbul in 2005 we had the opportunity to discuss demand side management as compared to the gigantic new water works planned by the town with the director of the Istanbul Water and Sewerage Administration. It did not appear from the discussion that the water administration had ever considered to work in this direction. Two years later there were ads all over Istanbul encouraging water saving.

In Morocco in 2006 certainly the cooperation with MEDAWARE and its related water community emphasised the better known and more easily accepted concept of wastewater reuse as compared to the sustainable water management approach. However in Morocco Zer0-M could already point to first experiences with greywater segregation and reuse for domestic purposes at the TDC of the IAV. There were also a number of presentations from other countries about similar or even more advanced experiences, e.g. Cyprus. The discussion lead to the conclusion there should be more exchange around the Mediterranean as the countries are facing similar challenges and the exchange not least among authorities, e.g. between Cyprus and Morocco could speed the advancement of appropriate technologies. For administrations to meet beyond their national borders however there would have to be some sort of formalised framework. In order for the exchange to be fruitful it would have to give sufficient freedom to the participants on the other hand. Conferences, workshops or excursions were identified as suitable settings.

The conference in Tunisia was the last in the Zer0-M series. It was opened by his Excellency the state secretary for higher education, Mohamed Ridha Ben Mosbah, with a comprehensive talk about the pressing need for new solutions to cope with the threatening water crisis. In Tunisia Zer0-M had already substantial own results to present and also attracted some very interesting contributions e.g. from France, Spain (e.g. the experience of Saragossa about water saving), The Netherlands and Germany. Discussions during this conference underlined the importance of a tight cooperation of the municipal water sector with agriculture, especially for the optimisation of nutrients management. During this last conference in Zer0-m lessons were extracted from the different sessions and collected as conclusions and recommendations of the assembly after a public reading to the plenary at the closing session. These recommendations are attached as annex 2.

The conferences in Morocco and Tunisia were used to produce an issue of Desalination with 25 papers each, this reaching out to a large community of water experts working on non-conventional water resources.

The exchange of knowledge and spreading of the work by Zer0-M was not limited to the conferences organised by Zer0-M but fostered through participation of Zer0-M members at other conferences on the subject, especially those organised by partner projects in the MEDA programme and the RMSU but also to international conferences specific for the topic. For a detailed list of talks at conferences and publications by Zer0-M members see table 44.

In total the project members published some 90 papers, posters, news items, etc throughout the project period on issues related to and directly developed in Zer0-M.

4.2. Result 2, Knowledge About Water and Wastewater Management in Partner Countries Improved

Activity 2.1 Preparation of Training Material

The project first established a detailed list of topics relevant for SWM trainings and a roster of expertise within the project to identify those partners best to assign the various topics. These partners then prepared a comprehensive training documentation in English under the supervision of weiterBildung (wB) of the University of Hanover who organised a training of trainers at Hanover, Germany, where the authors of the various chapters presented there information to a select group of partner members. The documentation was subsequently translated into Arabic, Turkish and French. It is available for free download from the Zer0-M website and on DVD 1.

Activity 2.2 Legislation Up-date

The legislation update was incorporated into the training material. It is available for free download from the Zer0-M website and on DVD 1.

Activity 2.3 Training the Trainers Intensive Course

wB organised a training of trainers at Hanover, Germany where the authors of the various chapters presented there information to a select group of partner members.

Activity 2.4 Training Excursions to EU Countries

An excursion to selected SWM sites in Italy and Germany was organised in July 2005. A list of participants is given in table 5.

Table 5: Participants to the excursion

Partner	Name of participant	Affiliation
	TUNISIA	
CERTE	Ahmed Ghrabi	Zer0-M partner, CERTE
CERTE	Habib Hadj Ali	Dept. of wastewater in rural area, ONAS
CERTE	Mabrouk Nedhif	Director, department of hygienic and environmental protection, Health Ministry
CERTE	Zouheir Jallouli	Head of Division of fluid and Energy, National land (bank) Agency, Tourism Ministry

Partner	Name of participant	Affiliation
	TURKEY	
MRC	Kemal Gunes	Zer0-M partner, MRC
MRC	Guselvim Sener	Ministry of forestry and environment
MRC	Isa Parlak	Governor of Isparta
	EGYPT	
NRC	Hussein Abdel-Shafy	Zer0-M partner, NRC
NRC	Soliman H Abdel-Rahman	Oceanography & Fishery Institute (Alexandria)
	MOROCCO	
WTRU	Abdelmajid Benoumrhar	Director of Water and Sanitation, Ministry of Interior
WTRU	Amer Chakouk	Director of sanitation (ONEP)

One invited person, the mayor of El Attaouia, unfortunately could not join the excursion. He did not get his visa in due time because he did not comply with the European immigration rules, e.g. he did not have a bank account.

A descriptions of the objects visited in Italy and Germany are attached as annexes 6.2 and 6.3.

Activity 2.5 Training Courses and Thematic Workshops Organised by MPC Training Centres

The trainings in sustainable water management were designed to partly rely on the physical implementations at the so called Training and Demonstration Centres (TDCs) to be implemented at a location suitable for each MEDA partner. Especially in Tunisia and Egypt, less in Turkey, these implementations were delayed for different reasons, as discussed in chapter 4.0, Project coordination. This caused the trainings to be delayed, too. The TDCs were a key part of the trainings, allowing to physically demonstrate the new techniques.

Therefore, an extension of one year was asked for. Due to the extension of one year the effect of the delays on the trainings could be neutralised giving the project enough time to carry out the trainings with the TDCs already in operation.

Once the TDCs were implemented in the countries, the partners started the training with the assistance of other project partners. At almost each training, members of other partners, Mediterranean and European were present, each providing their particular expertise.

The project carried out 36 training courses in the MPCs, 15 in Egypt, 7 in Morocco, 7 in Tunisia and 7 in Turkey. A summary of the training reports and a comprehensive documentation of each training is available on the Zer0-M website and as annex 6.1 to this report. Many of the trainees in Egypt were from the neighbour Arab countries who gained valuable information through the pilot course. As a result a large project of constructed wetland is planned to be implemented in Saudi Arabia (Jedda) for the treatment and reuse of municipal wastewater. It is worth mentioning that the training courses continue up till now on a regular basis in Egypt.

Besides the trainings more than 40 students and post-docs prepared a thesis within Zer0-M, working at different topics of SWM (Annex, Table 42).

Figure 2: Organisation of a training sessions (Non-governmental organisations and decision makers), by CERTE, Tunisia

4.3. Result 3, SWM Implementations Available

Activity 3.1 Realisation of Training and Demonstration Centres - TDCs

The TDCs were a major element in the strategy of Zer0-M to introduce sustainable water systems in MEDA countries. Besides dissemination through information and trainings it was considered paramount to build a variety of systems at one single place for demonstration and practical training. The TDCs were an important element of the project for several reasons

- the need to carry out research and adapt known systems to local conditions
- the possibility to develop new components
- physical demonstration of what the project was working at in each country, to politicians, water experts, students and the public in general
- use for trainings.

Table 6: List of TDC implementations in chronological order of their completion

Location	Description	Contractor	Recipient	Date of completion	Remarks
NRC	TDC NRC	RSD	NRC	15/08/08	Extension
NRC	TDC NRC	RSD	NRC	15/08/08	
CERTE	TDC CERTE	SENEL	CERTE	03/08	
NRC	TDC NRC, constructed wetlands	Misr Trading	NRC	12/07	
MRC	TDC MRC	YURT INSAAT	MRC	14/12/06	
IAV Hassan II	TDC IAV	Implemented by IAV	IAV	02/04/06	

Each MEDA Partner implemented such a TDC either on their own premises or at a convenient other location (in Tunisia, where a student home at the INAT in Tunis was chosen).

The TDC characteristics are summarised in the table below. All TDCs are operating. The TDCs in Morocco, Tunisia and Turkey have new projects running and funding for their further operation is secured.

Table 7: Components of the 4 TDCs

MPC	Selected application site	Saving devices / Segregation of WW components	Application of WW treatment alternatives	Wastewater reuse alternatives	Rainwater harvesting	Capacity
CERTE, Tunisia	Student residence hall with 4 floors and 210 students at INAT	WSD, segregation of Grey/black waste streams	Septic tank, MBR, SBR+UV, CW	Toilet flushing, landscaping irrigation	Showering, sand filtration	2-3 m³/d used, more available if needed
IAV, Morocco	Fitness facilities of the "Association Culturelle et Sportive de l'Agriculture" or "ACSA" existing site used and complemented: IAV compound	WSD, segregation of Grey/black waste streams	AD, SBR, MBR, CW, TSUAR, HRAP, different CWs, CW with solids composting	Landscaping, toilet flushing Landscaping	Toilet flushing	100 p.e., 8 m³/d 1500 p.e.
MRC, Turkey	14+14 apartments in 2 houses at MRC	WSD, segregation of Grey/black waste streams, urine collection	CW, SBR, MBR, TSUAR, RBC, UV, natural UV	Flushing, Landscaping, Irrigation	Filtration	4-5 m³/
NRC, Egypt	Apartment house opposite to the NRC-compound	WSD, segregation of Grey/black waste streams, urine collection	Septic tank, UASB, CW, SBR+UV, MBR, RBC, sludge composting CW	Flushing, Landscaping		20 – 40 p.e, 2 – 4 m³/d

AD	anaerobic digester– Biological wastewater treatment unit
HRAP	high rate algal pond
CW	constructed wetland – low cost wastewater treatment system
MBR	Membrane Bio-Reactor – Biological wastewater treatment unit
p.e.	population equivalent
RBC	Rotating Biological Contactor
SBR	Sequential Batch Reactor - Biological wastewater treatment unit
TSUAR	Two-Step Upflow Anaerobic Reactor
UV	ultra violet type disinfection unit
WSD	Water Saving Devices

The TDCs were the first opportunity to implement the Zer0-M approach to water in the MPCs. Consequently they were helpful in the trainings organised by the MCP. Thus every training also comprised a visit at the TDC including analyses of samples taken by the group and presentation of the results of the various treatment and recycling systems. Such hands-on experience helped introduce trainees to the new techniques, components of the systems the project was promoting.

The TDCs were also used for promotion of the presented water systems besides the trainings. During the project, e.g. at inauguration event but continuing afterwards, visitors were coming to learn about the different systems. The Egyptian TDC was filmed and broadcast by Egyptian Television. The Tunisian and the Moroccan TDC were filmed and broadcast in “Waste not Waste” on BBC World. All four are presented in the video “Flush and Forget”.

The systems implemented were also used for research purposes. The supplied first data about greywater and blackwater in Mediterranean countries for quite different situations, from households to a sports club. The experience gained with a natural greywater treatment in Morocco was used and up-scaled for the larger systems at El Attaouia. The implementations at the student residence in Tunisia now serve as a basis for the design of efficient water systems of all buildings of the Ministry of Education in Tunisia.

Below a more detailed description of what was implemented at each site is following. As these implementations had a reduced scale, demonstration and pilot character and included research equipment for particular monitoring purposes beyond the normal operation of the systems, the cost are not representative for such systems under real conditions. No economic study is therefore undertaken.

In Tunisia a detailed acceptance study was carried out with the users. The result is published in F. Arnold, L. Bousselmi, Local waters treatment and reuse in a students' residence hall – a study on acceptance, Sustainable Water Management 2/2007 P 15 - 19.

Table 8: New reuse purposes and regulations

Reuse purpose	Guideline
Greywater for toilet flushing	Germany, USA, Australia, Italy
Greywater for other domestic uses	Germany
Greywater for trade uses	Basis must be the quality requirements of the trade
Greywater for irrigation	Based on wastewater guidelines for irrigation
Urine as fertiliser	WHO
Faeces as soil conditioner	WHO

Quality aspects of treated wastewater were taken into consideration for the treatment sequences in respect to the intended use. However some of the systems and resulting reuses are not yet covered by regulations at all or only in one or some countries. No regulations are available in the target countries for other than irrigation reuse purposes.

The aspects where regulations had to be borrowed from elsewhere or are inexistent are listed in table 8.

Activity 3.2. Realisation of Real Scale Pilot Systems

The pilot systems are described in detail in annex 4. For an extensive photograph documentation of the implementation and the final status of the pilot systems the reader is referred to the Zer0-M album accessible via the Zer0-M homepage.

The following pilot systems were implemented:

Egypt Wastewater treatment for reuse at SEKEM farm, an organic farm with attached food processing industry and facilities for employees. A first treatment system was implemented for the school, including a boarding house, a laundry and offices. A second system was erected for the highly contaminated wastewaters of the food processing unit, after segregation of waters which did not need treatment, e.g. used for cooling, from the wastewater stream.
Both systems are constructed wetlands and produce water for irrigation of trees for timber production.

The planning and design process was carried out in a partnership mainly of SEKEM, the NRC, AEE INTEC and IRIDRA. A participatory process was chosen, not least to ensure to make the beneficiary fully aware of and accept the Zer0-M approach. Before the second system was started there were discussions about several possibilities how to optimise the SEKEM water management, including a sludge collection and treatment system from villages, which would also have treated the sludge from the SEKEM treatment plant. This, however, was abandoned because for the sludge, co-composting with organic matter from the SEKEM farm was identified as a better option. Finally SEKEM agreed to separate the different flows of wastewater from the factory and to treat only those needing treatment. SEKEM proceeded to this separation prior to implementation of the treatment system, which was then built under the supervision of AEE INTEC.

The works at SEKEM were not tendered as they were carried out by SEKEM itself.

Table 9: Implementation programme of the pilot treatment plant at SEKEM

Event	Date
Phase 1, school	
Construction permit	Not relevant
Approval by Delegation	14/08/07
Start of works	24/06/07
End of works	15/09/07
Phase 2, factory wastewater	
Start of works	09/04/08
End of works	15/08/08

Morocco Two greywater systems were implemented at the rural centre of El Attaouia, one for an apartment house and one for a public bath, or hammam. Both systems are two stage constructed wetlands, the first a horizontal flow, the second a vertical flow wetland, similar to the one built and tested at the TDC. The apartment system produces water for the flushing of toilets in four apartments in the house concerned, while the hammam system provides the municipality of El Attaouia with irrigation water for landscaping.

Table 10: Implementation programme of the pilot treatment plant at El Attaouia

Event	Date
Hammam	
Construction permit	02 /07/07
Approval by Delegation	24/07/07
Tender of pilot plant	30/07/07
Opening of tender	04/09/07
Signature of Contract	10/09/07
Start of works	02/10/07
End of works	26/03/08
Apartments	
Construction permit	25/07/07
Approval by Delegation	24/07/07
Tender of pilot plant	08/08/07
Opening of tender	04/09/07
Signature of Contract	10/09/07
Start of works	16/10/07
End of works	06/07/08
Solar water heater	
Construction permit	Not relevant
Approval by Delegation	01/06/08
Tender for supplies of pilot plant	08/05/08
Opening of tender	16/05/08
Signature of supply Contract	30/05/08
Signature of Contract with hammam owners	17/06/08
Start of works	26/06/08
End of works	02/08/08

For the greywater systems the IAV signed an agreement with the municipality of El Attaouia, on the basis of which the municipality tendered and contracted the works and carried out the supervision with the assistance of the IAV.

The solar water heater was built upon an agreement between the IAV and the owners of the hammam. The design and the tender documents were prepared by AEE INTEC and the supervision of works was carried out by AEE INTEC in cooperation with IAV. An investigation in Morocco showed that no suitable solar collectors were on the market locally. Therefore the project was tendered in two lots, supply of solar collectors to the site and installation of the solar heating system with supply of heat storage tanks and ancillaries. Each lot could be submitted and were finally subcontracted separately.

Tunisia A comprehensive system for the village of Chorfech 24, with 350 inhabitants was planned and partially implemented. The existing sewerage network was connected, via pumping station, to a newly erected wastewater treatment plant consisting of a three stage constructed wetland preceded by an Imhoff tank.

Those houses, which could not be connected to the sewer network were offered individual systems. At the primary school a comprehensive system comprising water saver equipment, e.g. waterless urinals, rainwater harvesting for irrigation and toilet flushing and treatment of the wastewater for irrigation of the school yard, especially trees, was implemented.

At one of those private houses, which can't be connected to the sewer system the owner implemented a urine diversion dehydration toilet for production of urine fertiliser and composted faeces as soil conditioner.

For the village system Zer0-M concluded a report with ONAS for the execution and later operation of the treatment plant. On this basis Zer0-M tendered the works and ONAS carried out the supervision. However, due to the very tight time schedule and the particular design of the treatment plant, which was a first in Tunisia, IRIDRA was subcontracted to assist ONAS with the supervision of the works.

The progress of the works was reported weekly to the RMSU.

Table 11: Implementation programme of the pilot treatment plant at Chorfech 24:

Event	Date
Approval by RMSU, Delegation	18/04/08
Construction permit	30/07/08
Tender of pilot plant	08/09/08
Opening of tender	06/10/08
Signature with Contract	24/10/08
Start of works	03/11/08
End of works	02/02/09

A simple cost-benefit analysis was attempted to examine their economic viability (see annexes 4 A. to C.). Given that the benefits of such complex systems, with reuse of water for different purposes and reuse of nutrients are not always easy to assess these analyses must be seen with caution. When no other information was available the benefit was computed as the water cost saved and cost of wastewater treatment according to nationally valid tariffs. If these computations show a negative result this means that either the system is too expensive for the existing tariffs, or the tariffs are too low to cover the cost of any wastewater treatment and have to be revised. However, existing tariffs can be construed as the willingness or ability to pay of the population.

The following general assumptions were made for all analyses:

Lifespan of infrastructures	30 years
Lifespan of E&M equipment	10 years
Period under consideration	50 years
Social interest	5%

A problem, which was not properly assessed during the design of the project was the impossibility to find suitable consultants for the implementation of the Zer0-M pilot systems in the MPC. The reason was that the implementations partly had an experimental character. There was for example hardly any experience with greywater treatment in MEDA countries available. So the project Zer0-M realised during execution that it had to rely on its own engineering capabilities. However, due to the conditions of the call most partners were researchers, i.e. did not have a specific engineering background. This caused a shift of personnel cost from MEDA countries to European partners, especially AEE INTEC and the subcontractor IRIDRA, who are at least partly working as engineering consultants. The design of all items was always carried out in cooperation between several partners, not least the one directly concerned, so as to make maximum use of the available expertise, prior to and developed during the project. The various designs were then discussed in meetings and the performance data exchanged. Thus each partner knew all the implemented systems.

Table 12: List of pilot system implementations in chronological order of their completion

Location	Description	Contractor	Recipient	Date of completion	Cost (1000 EUR)
Chorfech 24	Wastewater collection and treatment of Chorfech	Rainbow, SGC	ONAS	28/02/09	241,4
Chorfech 24	Primary school	EROBAT	Ministry of education	17/02/09	44,7
El Attaouia	Solar water heater	MYFAK, SFTM	Hammam Attaisir	21/12/08	126,6
SEKEM	Pilot wastewater treatment, part 2	Implementation by SEKEM	SEKEM	20/08/08	61,6
El Attaouia	Pilot greywater for hammam	Societé A2L travaux publics	Municipality of El Attaouia	11/07	97,5
El Attaouia	Pilot greywater for apartment house	Societé A2L travaux publics	Municipality of El Attaouia	11/07	21,0
SEKEM	Pilot wastewater treatment, part 1	Implementation by SEKEM	SEKEM	17/09/07	18,3
	Grand Total Pilots				611,1

4.4. Result 4, Concepts and Design Tools for Integrated Sustainable Water and Wastewater Management Available

Activities 4.1 to 4.3: Decision support system

The DSS tool was developed in activities 4.1 “Preparation of Tools for Spatial Representations”, which is the mapping part of the DSS tool and 4.2 “Preparation of a Software Tool for Economic Assessment of Zero-M Measures” the numerical modelling part of the flows. This modelling tool incorporates the LCA approach computing the energy consumption of major materials and components.

The general term Decision Support System (DSS) describes a (computer) tool that supports people when making decisions, in a broader sense. The target of the DSS developed is to provide experts and technicians with a tool that helps them to develop and compare multiple SWM solutions for an existing problem from a broad technical perspective. This means that the tool has to be used during the preliminary design phase and it does not include detailed design, In order to be able to decide on a solution for concrete locations and their major problems regarding water and nutrient management, the DSS helps the user to consider and evaluate a range of different SWM technologies. The DSS will guide the user to consider different SWM options, integrate them in a design and/or planning activity and provide a logical procedure to compare project alternatives. This involves decision makers (representatives, population, traditional authorities, and water departments) in order to identify the most suitable solution and to show its relevant (economic, environmental, socio-cultural) impacts in a sustainability framework. Feasible solutions are developed by considering these technologies and combinations of them. The pro and contra of each solution is then assessed by means of clearly specified criteria (see table 13) in a multi-criteria analysis tool. Thus, the evaluation of the system helps to find the (possibly) best answer to the problems addressed.

A description and guide for the use of the Decision Support System was also developed. This guide can also used to design a sustainable water management system using various different SWM techniques, even if no computer is available.

The DSS is mainly intended to help design sustainable water supply and disposal systems from a broad technical perspective, roughly at a scale of about 1:25.000. Focused areas are small settlements in rural areas, isolated tourism facilities or peri-urban areas not connected to a centralized waste water collection and treatment system. This means the size of the case studies corresponds to the following:

- a single house
- scattered houses
- a compact settlement of houses (e.g. isolated geographically, by socio-economic or artificial boundaries for design purposes)

The users of the DSS will mainly be technical planners/designers of water and waste water systems (e.g. sanitary engineer or a team comprising the expertise of engineers, agronomists, socio-economists, environmental planners, biologists, etc.). Decision makers will contribute to the design providing the designer(s) with basic information concerning the decision. This is done by representing or directly involving their community. Basic information concerning the decision may be a judgment on the importance of criteria for decision making or cultural constraints, etc..

Table 13: Overview of criteria and indicators, implemented in the evaluation process of the Zer0-M Decision Support System

Environmental	**„Zer0-M-ity“**	**Local environmental impact**	**Non-local environmental impact**	
	Total water flow extracted per person	Abstraction pressure on sources	Global Warming potential	Eutrophicating compounds
	Degree of reuse and recycling of water	Quality-pressure on sinks (N, P, COD, Salinity)	Acidifying compounds	Energy resources employed
	Degree of Nutrients reuse (N, P)	Ecosystems (worsened or improved)	Ozone depleting gases	
	Energy employed (per person)	Landscape quality (worsened or improved)	Solid waste	
Economic	Present (discounted) value of total costs	Investment costs	Import costs	Operation and maintenance (O&M) costs per year
Socio-cultural	Local Mastering of technologies adopted	Socio-cultural acceptability of solution adopted	Satisfaction of users water demand	Nuisance (mosquitoes, smell)

One of the main objectives of the development of this tool was to guarantee as easy an approach as possible for the user. This was realized by focussing on two important implementation aspects. The DSS was realized as an internet-based application. This enables worldwide access to the system over the internet and thereby stimulates the cooperation between multiple partners by providing a centralized system, instead of multiple individual versions. Regarding the software used, the developer team concentrated strictly on using Open Source software components. Besides the fact that through this the Zer0-M DSS is available without software vendor costs or licences, it offers the possibility to adapt the programming code to the special needs of the Zer0-M project objectives.

With the development of the Decision Support System by the Zer0-M project a tool is made available, which especially focuses on the use for Sustainable Water Management. By using Open Source Software, the DSS is developed in an extendable and flexible way to be specifically adapted to the original task. Thus, it is giving the user the possibility to design and evaluate SWM alternatives in a powerful but easy way and helps to propagate the ideas and implementation of SWM. Each interested water expert can address a request to obtain access to the DSS and will be provided with access data by the University of Vienna at least during five years after the end of the operation. If there is a large interest this period can be extended. The webpage is accessed through the menu of the Zer0-M homepage under "Results/DSS". The source code of the DSS is also available and free and can be installed on any suitable hardware.

Activity 4.4. Case study analysis

The case study analysis in the Zer0-M project has two main objectives: one general and one specific. The general aim of the case study analysis is to check on real sites the feasibility of SWM solutions by confronting them to more conventional solutions. The specific objective was more related to the Zer0-M project itself: to test the DSS tool.

The idea behind the case study analysis was, therefore, to identify locations where real problems of water and wastewater management exist, to analyse feasible solutions for such locations – including as much as possible SWM – and find the best solutions, given the local conditions and a set of criteria to be developed by the project.

More than 4 candidate sites for the case studies have been developed at the beginning of the project, knowing that not on each of them it would be possible to develop the study. The final choice of the sites has been made considering the possibility that the case study could then lead to the realisation of a full scale intervention. This is the reason for instance, why two of the case studies have been located in Tunisia. In the beginning, in fact, the location of Jouggar had been selected and studied, but during the project the site of Chorfech then was chosen for the pilot implementation (activity 3.3) and then the case study analysis developed to select the best solution for the area.

The case study analysis was also an important testing phase for the DSS: several aspects of the system have been improved after the tests.

The following sites are detailed in the case study report attached (see annex 6.5 Case study report)

- Jouggar, Tunisia
- Cirali, Turkey
- Chorfech, Tunisia
- Hirtenfeld, Austria

Hirtenfeld in Austria, where a comprehensive set of data was available from the very beginning, was the calibration case for the DSS[6].

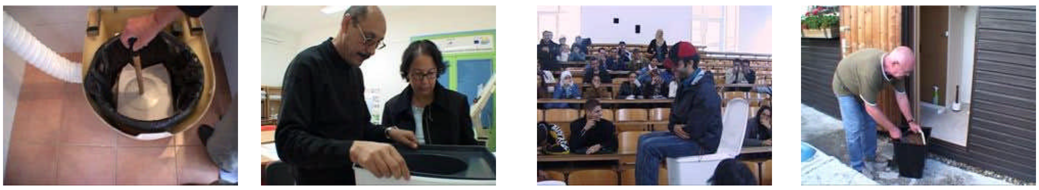
4.5. Result 5, Awareness of sustainable water and wastewater management raised

For dissemination purposes addressed mainly to the general public and other non expert persons, e.g. decision makers, three videos were produced by Zer0-M,

- The Innovative Turn, with examples of sustainable water management in Germany, (in Arabic, English, French, German and Turkish)
- “Flush and Forget”, explaining the approach recommended and developed by Zer0-M and showing a variety of appropriate water techniques, (in English and Arabic), respectively “Waste not Waste”.
- “La récupération des eaux pluviales en Tunisie”, concerning the particular rainwater harvesting tradition in Tunisia (in French).

“Waste Not Waste” was shot by Sapiens Productions on behalf of TVE for a BBC World Earth Report. This Earth Report was aired in January 2008 as the first of a series of films about sanitation in the International Year of Sanitation 2008 and was repeated in January 2009. Waste Not Waste also received the prize in the *A* category - journalistic programmes and films of the 14^{th} International Environmental Film Festival ENVIROFILM 2008 in Banská Bystrica, Slovakia.

Waste not Waste



Leeflang's 'no - smell' toilet | Ahmed and Latifa | A toilet demonstration in school causes some embarrassment | Helmut's toilet produces compost for his allotment

Figure 3: The making of “Waste not Waste”

BBC World is available to 280 million households in 125 countries. Actual viewers are estimated at 70 million by BBC. Copies are distributed to other broadcasters in Africa and South Asia.

“Flush and Forget” is an extended version of “Waste Not Waste”, demonstrating a wider variety of appropriate or Zer0-M water techniques.

The video “The Innovative Turn” shows to a broad public that industrialised countries, too, are seeking more sustainable solutions for water management, that it is possible to introduce even controversial techniques under certain conditions and that there is a wide variety of different sustainable systems available. “Flush and Forget” translates this into

[6] Ehrenfried Lepuschitz, <Nachhaltige Siedlungswasserwirtschaft im ländlichen Raum>, Master thesis, Universität für Bodenkultur, Wien, Austria

the Mediterranean context with many practical examples. The reach of the Earth report far exceeds what could be expected during design of the project.

One DVD was produced comprising the two videos “The Innovative Turn” and “Flush and Forget” plus supporting technical documentation including all Zer0-M journals and training material. Ten thousand copies of this DVD have been produced and are distributed through the same channels than the Zer0-M Journal. They are also shared with the Sustainable Sanitation Alliance, which means they reach out to more than 100 organisations world wide working in the field of sustainable sanitation with their affiliate and partner organisations.

Zer0-M also contributed to the video “Nor Any Drop to Drink” by EMPOWERS because the participatory approach to water management planning promoted by EMPOWERS was deemed instrumental to the spreading of SWM.

5 Project deliverables and resources used

Overview of used resources

The personnel effort is shown against the revised effort planned for the 3rd and 4th Contract Amendment. Some partners still exceed their planned effort, especially the MRC, which has spent more time on monitoring and operating the TDC than anticipated, and IGR, for programming work at the DSS. This, however, can be compensated from other partners personnel resources.

Table 14: Personnel effort until end of reporting period (person month), planned effort until the end of the project

Total to	Coordin.		Result 1		Result 2		Result 3		Result 4		Result 5		Total		Ratio
now	planned	used	planned	used	planned	used	planned	used	planned	used	planned	used	planned	used	%
AEE	107,5	124,7	18,0	19,5	3,6	3,1	20,8	24,2	18,7	18,7	13,5	9,7	182,1	199,9	110%
ALT	17,0	18,1	16,4	16,3	6,5	6,7	4,2	5,6	22,1	21,8	0,1	0,1	66,3	68,6	103%
Kalithea	1,5	1,5	2,0	2,0	0,0	0,0	0,0	0,0	0,5	0,5	0,0	0,0	4,0	4,0	100%
MRC	8,8	10,3	10,3	11,0	17,5	17,6	34,2	43,9	5,5	6,1	0,0	0,4	76,3	89,3	117%
NRC	80,6	82,5	15,0	15,2	20,9	26,5	160,6	151,8	0,5	0,5	2,5	0,3	280,1	276,8	99%
LEE	34,4	37,1	6,0	6,6	4,0	2,4	69,6	59,0	8,4	8,9	2,3	1,5	124,7	115,5	93%
WTRU	15,4	11,4	7,3	5,6	6,8	3,1	93,8	110,1	1,9	1,2	1,5	0,1	126,7	131,5	104%
IGR	8,0	11,0	1,6	1,6	24,2	24,3	0,6	0,6	70,4	70,9	0,0	0,0	104,8	108,4	103%
TUB	15,5	16,6	3,8	3,8	2,3	1,3	32,4	31,2	0,4	0,4	0,2	0,5	54,6	53,8	99%
wB	9,5	9,6	2,5	2,9	30,9	28,7	2,4	2,1	0,9	0,9	6,1	6,3	52,3	50,5	97%
fbr	8,1	8,7	2,7	3,1	6,8	8,0	5,7	4,6	0,0	0,0	12,1	11,7	35,4	36,1	102%
Total	306,3	331,5	85,6	87,6	123,5	121,7	424,3	433,1	129,3	129,9	38,3	30,6	1107	1134,4	102%

With the corrections of the 3rd and 4th Amendment the overall effort until the end (Table 14) is roughly according to what has been planned for the Amendment and the time extension. An important part of the effort at AEE INTEC went into Coordination. This however comprises the administrative management of the project as well as the thematic coordination and partly contribution to the different Results, as far as this was not clearly attributable to one of the Results.

A complete overview of the financial resources spent is given in the financial report. Detailed records of the monies spent for supplies, works and services are listed in the annex, table 46, table 47 and table 48. These tables however do only list contracts above 5000 Euro, while quite substantial amounts were spent especially on small purchases from local suppliers and on local services. These amounts, while considered in the tables below are not comprised in the annex.

The project planned to spend 546 thousand Euro on supplies (see table 15) according to Annex G of the project proposal. Actually 431 thousand Euro were spent. The planned supplies were mainly 2 cars, lab equipment and supplies for TDCs and pilot systems. One of the two cars, however, was not accepted by the Delegation, as the model purchased was not European. Thus the amount of supplies was reduced by this car and part of the corresponding amount shifted from cost item 3.1 to 4.1 “Vehicle cost”, as the Delegation accepted to cover the operation and maintenance cost. The biggest difference occurred at the NRC, where the original plan was to build a pilot system at a hotel in Hurghada, supposedly with small foot-print equipment. Finally the project opted for constructed wetlands at SEKEM, with a totally different cost characteristic. The supplies for the TDC also were less expensive than initially planned by the partner.

Table 15: Financial resources used for supplies, actual compared to planned expenditures

Partner	Actual	Planned	Difference
AEE INTEC	2.707,72	0,00	2.707,72
ALT	0,00	0,00	0,00
Kalithea, Rhodes	0,00	0,00	0,00
MRC	69.720,36	79.600,00	-9.879,64
NRC	99.735,21	236.200,00	-136.464,79
CERTE	86.938,40	50.640,00	36.298,40
IAV	165.990,95	137.200,00	28.790,95
IGR	0,00	35.000,00	-35.000,00
TUB	6.279,53	7.000,00	-720,47
wb	0,00	0,00	0,00
fbr	0,00	1.000,00	-1.000,00
Total	431.372,17	546.640,00	-115.267,83

The total amount planned for works contracts was 872 thousand Euro whereas the project actually spent 691 (see table 16). While there were minor increases for the MRC, the CERTE and the NRC, the IAV spent some 220 thousand Euro less than planned. The IAV actually had a pilot system in mind during the project proposal phase, a wastewater treatment plant for part of the town of Abidar. This however could finally not be implemented because the town did not, as initially intended, rehabilitate the sewer system. The systems implemented at El Attaouia better corresponded to the Zer0-M approach to SWM but were substantially cheaper.

The IGR had initially planned to purchase 4 GPS plus computer systems for GPS surveys. Due to the very heavy procurement procedures during the first one and a half years, which requested the projects to launch one general tender for supplies of one year for all partner countries and all types of items in common, these were not purchased at the beginning. Given developments of the internet and internal discussions it was then decided that maps obtained through the internet, combined with possible fast surveys on site were more appropriate for DSS purposes. Thus, this procurement with a total value of 35.000 Euro was abandoned.

Table 16: Financial resources used for works, actual compared to planned expenditures

Partner	Actual	Planned	Difference
AEE INTEC	0,00	0,00	0,00
ALT	0,00	0,00	0,00
Kalithea, Rhodes	0,00	0,00	0,00
MRC	63.804,86	46.000,00	17.804,86
NRC	119.213,85	115.900,00	3.313,85
CERTE	337.997,51	319.500,00	18.497,51
IAV	170.743,09	391.000,00	-220.256,91
IGR	0,00	0,00	0,00
TUB	0,00	0,00	0,00
wb	0,00	0,00	0,00
fbr	0,00	0,00	0,00
Total	691.759,31	872.400,00	-180.640,69

Table 17: Financial resources used for services, actual compared to planned expenditures

Partner	Actual	Planned	Difference
AEE INTEC	245.564,61	295.000,00	-49.435,39
ALT	0,00	0,00	0,00
Kalithea, Rhodes	0,00	20.565,00	-20.565,00
MRC	17.859,20	63.300,00	-45.440,80
NRC	165,76	55.330,00	-55.164,24
CERTE	81.791,96	5.000,00	76.791,96
IAV	15.333,71	2.000,00	13.333,71
IGR	0,00	0,00	0,00
TUB	0,00	5.400,00	-5.400,00
wb	0,00	7.900,00	-7.900,00
fbr	0,00	8.000,00	-8.000,00
Iridra	20.185,93	17.972,50	2.213,43
Ambiente Italia	19.385,12	15.925,00	3.460,12
Ecobilancio	9.766,20	13.650,00	-3.883,80
Total	410.052,49	510.042,50	-99.990,01

The financial resources for services (table 17) were overestimated by roughly 100 thousand Euro. Instead of planned 510 thousand Euro only 410 thousand were spent. Three MEDA partners had planned to make extensive use of external consultants, especially for the design and supervision of works. This was not possible for the lack of consultants

with appropriate SWM know-how, respectively willingness and possibility to work at such SWM techniques, new at least in the given context[7]. This part was rather covered by Zer0-M project partners contributing in terms of manpower. For the supervision of works at the Chorfech wastewater treatment plant in Tunisia the contract with IRIDRA, the subcontractor, who also did the design for the constructed wetland at Chorfech was extended until the end of February 2009. CERTE had initially planned to rely on own personnel for the organisation of the last and most important of the three Zer0-M conferences but due to the experience of the previous two conferences also decided to subcontract the organisational part. Thus in total CERTE spent over 76 thousand Euro more than the 5 thousand initially planned.
Kalithea was assigned the organisation of one conference. As Kalithea dropped out of the project on its own request the organisation of the conference was taken over by IAV. The conference budget was reallocated to IAV, Morocco. The amount spent was less than initially budgeted for the conference because of a cooperation with MEDAWARE, organisation of a joint event of the two MEDAWATER projects.

Deliverables

All deliverables and their time of completion, except for reports and meetings, are listed in table 18.

The progress and financial reports are listed in chapter 4.0.2, the meetings with their dates and locations in chapter 4.0.1. The details concerning the three conferences organised by Zer0-M can be found in annex 5, table 43. Extensive lists of theses prepared in Zer0-M, dissemination material, including publications at conferences, and technical reports can be found in table 42, table 44 and table 45 of the annex respectively.

The documentation of the trainings is attached as annex 6.1 and an acceptance study of the TDC in Tunisia, carried out with the students living in the residence hall, which served as water source and supply infrastructure for the TDC, as annex 6.2.

The physical implementations of Zer0-M are described in detail in the annex 3 (TDC) and annex 4, pilot plants. The four TDCs and the pilot plants are marked on Google Maps and can be localised through links at the Zer0-M webpage.

Table 18: Tabular overview of all deliverables (except reports and meetings)

Activity	Output	Planned delivery month	Actual delivery month	Leader	Comments
0	Project management				
	Kick-off meeting	1	1	IGR	11-13/09/03 in Vienna
0.1.1	Detailed design of annual action plan	12		AEE, TUB, kubus	prepared for each meeting and regularly up-dated
0.1.2	Design of detailed work program for each activity	9		WP leaders	prepared for each meeting and regularly up-dated

7 The issue at stake, which must not be underestimated, is the reluctance of people to engage in something perceived as new and uncommon. With the successful completion of Zer0-M and the existing examples this reluctance should be greatly reduced.

Acti-vity	Output	Planned de-livery month	Actual deliv-ery month	Leader	Comments
1	Know-how exchange				
1.1	Internet network installa-tion and management, homepage	12	12	ALT Kalithea	05/04 open discus-sion forum included ongoing
1.2	Papers from Zer0-M presentations at conferences	10		all	ongoing until end of project
1.2	Publication of a semestrial journal				ongoing biannually since 08/05, last is-sue No8 Month 64
1.3.1	Zero-M conference 1	19	19	MRC, all	03/05 in Istanbul
1.3.2	Zer0-M conference 2	31	34	IAV (WTRU), AEE	06/06 in Marrakech, previously Rhodes, now organized by WTRU combined with MEDAWARE project
1.4	Zer0-M conference 3	43	43	INRST (CERTE)	03/07 in Tunis
2	Know-how Transfer				
2.1	Training materials for train the trainer seminars	12	12	wB	09/04
2.2	Legislation update	7	56	TUB, AEE	IME update avail-able, not yet pub-lished
2.3	Train the trainer intensive course	11	13	wB, MPC	Carried out 09/04
2.4	Excursion to sites in EU countries	20	23	ALT, wB, fbr,	carried out 7/05
2.5.1	4 pilot courses in MPC	24		MCP, wB, ALT, fbr, TUB, AEE	MRC, CERTE, NRC accomplished 2005 07/05 IAV accomplished 06/06
2.5.2	trainings in MPC	56			ongoing until end of project
3	Zer0-M Realisation				
3.1	Identification of TDC in all MPC	3	5	All MPC	Completed
3.1	Detailed design of instal-lations for the TDC	11	24	All MPC	Completed
3.1	Demonstration plants realisation: Zero-M-installations at four TDCs	20	55	MPC, AEE, ALT, fbr, TUB	Completed in all countries
3.2	Operation and monitoring of TDC			MPC	ongoing process until end of project
3.3	pilot implementations	Year 3+4	year 6	NRC, IAV, CERTE, AEE, ALT, TUB	ongoing implementation completed during extension time
4	Case studies				
4.1.1	Target definition for case	3	3	AEE, IGR,	Completed

Acti-vity	Output	Planned de-livery month	Actual deliv-ery month	Leader	Comments
	studies (GIS, Modelling, LCA)			ALT	
4.1.2	Input data definition	6		AEE, IGR, ALT	Continuously until end of project
4.2.1.	DSS prototype tool	19	22	AEE, ALT, IGR	completed
4.2.2	Validated DSS tool	33		AEE, ALT, MPC, IGR	ongoing until end of project
4.3	4 case studies including GIS	48	59	IGR, AEE, ALT, MPC	completed
5					
5.1.	video production	5		fbr, AEE	participation in Empowers film, four more videos produced until end of project
5.2	Textbooks, flyers, data DVD	25	60	wB	ongoing until official end of project
5.2	Data DVD		60	AEE, fbr, wB, all	completed

The DSS is available on the Internet. The corresponding link can best be accessed via the Zer0-M webpage. It is described in chapter 4.4. A report about 4 case studies and a DSS paper tool are attached as annex 6.2 and 6.3.

The videos are attached to this report on a DVD as annex 1. Two additional DVDs contain videos, which were not explicitly intended at the beginning, but which were either a by-product to the production (“Waste not Waste”) or found particularly interesting and could be prepared from footage already available (“La Récupération des Eaux Pluviales en Tunisie”).

6 Lessons Learnt

6.1. Lessons learnt about the technologies targeted

The project experiences show the Zer0-M approach can make a difference in managing water resources and environment protection in Mediterranean countries. While water saving and segregation of wastewater flows can help save and reuse water, recovering nutrients and making them available to agriculture is equally important, both for environmental and economic reasons. Rainwater harvesting, a technique used for thousands of years around the Mediterranean sea, is rediscovered and adapted to modern expectations.

Zer0-M has shown that source separation of wastewater and its reuse for toilet flushing and irrigation are applicable to the MPCs. Given the most common architecture and the plumbing it can be implemented in new as well as in existing buildings. This has been proven at the TDCs of the MRC at Gebze, Turkey, of the NRC in Cairo and of the CERTE in Tunis.

In existing buildings, however, compromises have sometimes to be made. Thus at the MRC it was not feasible to connect the wastewater from the kitchens to the black water line. As a solution it was connected to the grey water line. This situation showed us that in some cases it might not be feasible or difficult to separate wastewater in existing buildings in an optimal way.

One other experience was that some of the compact household treatment devices are still not user friendly. During the operation of the TDC, it had been necessary to solve pumping and several failures with the help of a technician from the supplier. More research and development work is needed on these treatment devices.

Regarding the use of dry sanitation, people are still conservative. While one urine diversion dehydration toilet (UDDT) has been completed at the very end of the project in Tunisia and a video was made about introduction of UDD toilets, monitoring results have yet to be collected. Even though urine separating dehydrating toilets are a very effective and convenient technique to recover resources from excreta, i.e. nutrients, especially in water scarce areas, their wide introduction, or reintroduction actually, in Mediterranean countries will still need a lot of effort. Given the challenges in agriculture and environment protection ahead of us and the potential of UDDTs it will be worth making it.

Concerning the challenges related to nutrients the reader is referred to the United States Geological Survey[8] regarding phosphorus and to the International Nitrogen Initiative[9] regarding nitrogen and the problems created by the production and release of ever new quantities of nitrogen into the environment.

6.2. Lessons for the introduction of new sanitation technologies

When aiming at changing an approach to long living infrastructure, especially in fields so strongly ruled by traditions and taboos as sanitation, time is a key factor and must be thoroughly taken into consideration in the planning of the activity. This per se is not a particular lesson learned by Zer0-M but was taken into consideration during project planning. A few specific aspects however are worth mentioning here.

6.2.1. Need of time for the introduction of new water management concepts

The attempt to introduce new technologies and approaches as made by Zer0-M puts authorities in a difficult position as these technologies are not yet taken into consideration in national guidelines and regulations ruling permit procedures. Even though this did not come as a surprise but was actually comprised in the project design, the team should have allowed more time for the familiarisation of all stakeholders with the new concepts. This process took longer than initially planned and the project had problems to implement the intended TDCs and pilot systems in due time. Actually this was the main reason for the extensions in time, which had to be applied for. Even so the Tunisian pilot plant could only be completed at the very last moment.

[8] http://minerals.usgs.gov/minerals/pubs/commodity/phosphate_rock/phospmcs07.pdf
[9] http://www.initrogen.org/fileadmin/user_upload/2005_products/INI_Pre-Assessment_final.pdf

Possibly more emphasis on the change management strategy would have helped to speed the process. However, the project and the programme were about optimal use of water resources, not about introducing change management in the partner countries.

6.2.2. Lack of consultants with adequate engineering competence for Zer0-M

Due to the call for proposals the partners in Zer0-M were mainly research organisations. However, Zer0-m also planned to implement water infrastructure, i.e. the TDCs and pilot plants. The implementation of such infrastructure, however, needs engineering competence which is usually not available in research. The initial plan was to hire the needed competence for detailed design of the structures and the supervision of works on the local market as needed.

This plan turned out to be impracticable for several reasons, among which the most important was that the competence needed for the new water systems aimed for in Zer0-M was not available on the local market. The Egyptian partner NRC for example made a concrete attempt to have the detailed design of the TDC elements for grey and black water pre-treatment systems and constructed wetlands developed by a local engineer. However, the designs were not suitable for the tasks. Another reason was the difficulty most people, not least authorities and consultants, have to implement unusual sanitation systems, partly because of professional reservations, partly because of private apprehension. This is part of the paradigm change phenomenon.

Thus, design, applications for permits and supervision had to be shared between the MCPs and the European partners already familiar with the structures needed and convinced of their feasibility. These were, however mainly researchers and research institutions that had to adapt to formal processes of engineering work.

6.2.3. Trans-sectoral approach to water management

From the outset of the project one key element for resource oriented, sustainable water systems in the Mediterranean region was considered reuse of water in agriculture. During work it became clear that not only water but nutrients as well were an issue for reuse. The reuse of nutrients in agriculture however involves a series of challenges which cannot be solved by water engineers alone. Some of these challenges are

- Nutrients need of plants is not constant over time and depends on crop
- Wastewater is mostly produced in settlements while the nutrients are needed on agricultural land
- Reuse of wastewater and nutrients for crop production involves hygienic and toxicity problems

The economic examination of the pilot systems show that some are very viable while others have to be further optimised in order to become cheaper or more cost effective. Where larger volumes of water are to be treated and reused, economic viability is easier to achieve, which is no new finding. Cost effectiveness of small systems can be improved by development of better designs, or rather more standardised design and production, or possibly through better integration. Thus urban planning and architecture can adapt to the need of separate collection or grey and black water and treatment of grey water on site. It is supposed that this could allow cheaper structures, integrated into buildings or at positioned close to them and the reuse location of the water. While it can be expected that integrated optimisation will have this effect it will be necessary to carry out trans-sectoral projects comprising expertise in water engineering, agriculture, urban planning, architecture and possibly others, e.g. sociology.

The reuse of water can save important amounts of fresh water for other purposes. Especially in cases of drought, when it is generally admitted that domestic uses have the highest priority, at the expense of e.g. agriculture, the approach to assess domestic water needs differentiating between the various uses of water in a household, can lead to a reassessment of priorities and lead to the provision of recycled water of minor quality for certain domestic purposes, thus freeing high quality water for agriculture. A joint examination of the hydraulic potential thus mobilised by SWM and drought preparedness experts (e.g. MEDROPLAN) should optimise this approach.

While desalination still is an expensive technique to provide potable water, water for drinking is a high value good. Combining desalination (ADIRA) with the SWM approach to use different water qualities for different purposes and to reserve the highly treated, desalinated water for human consumption could be a strategy to introduce desalination as a viable technique in areas with a lack of fresh water.

The selective use of different water qualities is extremely interesting for authorities and utilities, especially in water stressed countries. The work of Zer0-M in this respect should be continued and decision makers in governments and water utilities be made aware and assisted to introduce such concepts in their planning. The EU could make this a policy, particularly in its funding of water projects in water stressed countries (see also chapter 7.1.2)

6.2.4. Legal barriers

There are different reuse regulations currently applied in different countries. These regulations should be harmonised in partnership with the EU, large importer of agricultural products from Mediterranean countries. The basis for this harmonisation could be the new WHO guidelines for the reuse of wastewater and excreta in agriculture. A basis for the domestic reuse of greywater could be the German guideline H201 published by the fbr.

Very often existing laws and regulations, based on scientific and technical knowledge of decades ago, are a significant factor hindering the development of a SWM approach. One interesting example comes from the results of the case study analysis done under WP4 in Chorfech. The multicriteria analysis – limited to the treatment system and possible reuse of effluent – selected clearly the most feasible solution in a plant able to treat the organic load leaving the nutrients in the effluent to be reused. However a different, more expensive, solution has been chosen in order to respect very strict effluent quality requirements, all but abandoning the possibility to reuse water in a way that could contribute to increase the availability of nutrients. A very important conclusion then is that the approach of strict and nationwide “quality standards” in the effluent, is often an obstacle to the diffusion of SWM. More flexibility in the legal requirements, even though carefully preventing pollution and sanitary risk, is one of the most important challenges to reach a more sustainable use of water.

6.3. **Development of a Joint Learning Process**

The projects of the MEDA Water Programme had only limited contact with each other at the beginning, as the start of the RMSU was delayed due to administrative procedures. Activities related to inter-linkages were not part of the initial design and budget of the project either. This left a substantial part of the potential of the programme unused: Learning from each other across projects, peer to peer support, generalisations of results of single projects to answers to the overall issues of the programme etc. as integrated parts of the project operations in the programme.

From the very onset a group of co-ordinators suggested a co-ordination of the programme and prepared a proposal for such a task at the first programme meeting in Brussels in May 2004 and later expanded it with a learning platform, a facility Germany has had good results with in research programs. Such a facility or tool could possibly be taken into consideration in a future regional programme.

The proposal was submitted first to AidCo and later to the Delegation and the EC took it into account insofar as the coordination part of the RMSU was somewhat emphasised during the related contract negotiations. With the start of the RMSU the situation improved. Thus the RMSU organised a number of very successful program events. However, the projects were sceptical of the fact that one organisation would be in charge of project monitoring and co-ordination activities (see also chapter 7.1.1 Coordination structure for inter-project exchange).

6.3.1. Objectives

The purpose of a shared learning process is to "create a learning community" for a programme funding several projects where all projects will benefit from the know-how, the experiences and the "lessons learned" of all partners, in order to

- allow to fully benefit from knowledge and experience of other projects and all partners, even while the programme is still under way,
- make sure that questions of interest in several projects have to be solved just once,
- through co-operation reach new perspectives that are hardly accessible for single projects.
- make programme results coherent.

These activities should be dealt with separately from a monitoring and reporting unit.

6.3.2. Installation of a learning community with broad participation

Creating a common learning community comprises the following:

- arrange and facilitate joint meetings, conferences and events of all the projects in the programme, together with the staff of the co-ordination unit,
- support projects working at overlapping objectives in coordinating activities in these fields,
- form and facilitate regional clusters between partners in the same and in neighbouring countries,
- form and facilitate subject clusters or working groups on issues several projects are working on in parallel.

An active role should be offered to as many partners of all projects as possible. Thus a general facilitator, not involved in monitoring activities, is needed, who is

- bringing together the community of the programme, including as many partners as possible,
- organising general meetings and working groups on issues of general interest (e.g. data collection, wastewater reuse in agriculture, best practice for wastewater treatment, best practice for watershed management etc.), and
- taking care of the continuing communication and adjustment of activities among all project partners. This includes close communication with the EU-delegation in Amman.

Besides the general facilitator several regional focal points are necessary who will bring together project partners and activities within their area. They should also be responsible for heading and organising working groups on issues specially emphasised in their organisation / region. These working groups should be entrusted – among other issues –

with the co-ordination of legislative and technical recommendations in their respective country / region.

General facilitator and regional focal points would have to be open to any emerging co-operation possibility or need. Besides they should address well identified aspects, e.g. research (SWM), planning (design up to tender documents), project implementation (national/ international tendering) and operation and maintenance (including tariff strategy). These recommended corner stones are most helpful for EC and other donors to promote innovative solutions.

General facilitator and regional focal points would be keeping in mind they have to remain facilitators inter pares and must not become a superstructure. This organisation would make the proposed structure of a learning community rather lean.

6.4. Cooperation among projects within the programme

Due to the program design direct co-operation of projects was possible and did occur to a rather limited extent only. Thus Zer0-M actively participated in an electronic training by EMWATER and MEDAWARE and Zer0-M organised one conference together. Zer0-M also contributed to videos produced by EMPOWERS, because the participative approach of EMPOWERS to water management planning was deemed instrumental in spreading SWM. Other attempts, e.g. to cooperate with EMPOWERS and merge the participatory planning process with the sustainable water management approach, was not possible because it would have needed additional funds, which could not be mobilised in a timely manner and were not available in the programme.

In MEDA Water some particular co-operations between two or more projects of the programme, as mentioned in the previous paragraph, would have been desirable. This could not be planned in detail during the proposal phase, as the projects to be funded were not known at that stage. Nevertheless, during operation, such cooperation opportunities emerged and would have been very beneficial for the whole programme. EMPOWERS and Zer0-M drafted a proposal for a joint extension of their activities, but had to learn that no funds were available for such addendums (see also chapter 7.1.3 Intra-programme cooperation).

6.5. Appropriation of the results by the EU

Much emphasis and effort was put in the sustainability of the project results, meaning in this context, that the work of the projects would be continued and the achievements not be lost after the projects' end. Actually due to the partnerships all projects, not least Zer0-M, were designed to be carried on by the Mediterranean partners, anchored in their national networks.

The EU being a major partner of the MPC, both in terms of trade, e.g. of agricultural products, and funding of activities, it would be helpful if the EU appropriated the results of its own programme and includes them as a standard in further project layouts and a condition in bilateral funding negotiations with Mediterranean countries. Actually, in the design of such a programme a provision could already be included that the EU representations of the region tightly cooperate with the regional programme and take its work into consideration in their bilateral activities at an early stage.

For the results of Zer0-M this would mean that the EU takes into consideration the strategy for further introduction of SWM outlined in chapter "7.3 Strategic aspects concerning introduction of the new paradigm" below and suggests incorporation of elements, e.g. further research and construction of more SWM pilot systems in a first step, in future negotiations of water and sanitation projects. Ultimately this should then lead to a wide application of SWM and the results of Zer0-M and the programme would find its way into mainstream projects.

7 Recommendations for Future Action

7.1. Administrative aspects

7.1.1. Coordination structure for inter-project exchange

The recommendations below should in no way be construed as a critic of the teams involved in the MEDA Water program. On the contrary the Delegation and the RMSU have largely contributed to the success of the programme. Nevertheless the experience in the programme would suggest some modifications of the structure in the future could increase the efficiency of the teams involved.

Instead of an external, private organisation for monitoring it could possibly be more efficient from the projects' point of view to reinforce the EU staff, which would monitor the projects and assist them in administrative issues directly as the decision making authority. This would avoid losses through a two tier programme coordination.

On the other hand an independent body, analogical to the RMSU, could be specifically charged with the coordination tasks discussed under 6.3. The separation could both increase the efficiency of the administrative unit and guarantee the independence of and trust into the facilitator of inter-project exchange and learning. Trust and openness of all involved are very important aspects with coordination and exchange of information and experience and are easily jeopardised. In this respect the combination of monitoring and coordination is counterproductive.

This exchange and learning platform could be used to develop the needed reporting and other templates, which should be ready latest for the end of the first reporting period.

7.1.2. Appropriation of results by the EU

Appropriation of the results by the EU from an early stage onwards and beyond the programme could be eased through some type of formalised and pre-planned exchange between the programme and the EU decision making and programme design bodies.

7.1.3. Intra-programme cooperation

Given the way projects are designed, i.e. by independent groups responding to a call, it could be helpful to build into the programme a mechanism which would allow inter-project cooperation once the work has started and synergies are discovered. Generally this kind of initiative will need additional funds. These could be covered from a certain portion of the programme budget dedicated to such later additional activities or a provisional item in project budgets.

As an example for such emerging opportunities it would have been very interesting to combine the approaches of participatory planning of water related activities developed in EMPOWERS and the SWM approach of Zer0-M in order to achieve a participatory planning of sustainable water infrastructure. There were attempts to realise such a cooperation but the programme finally did not have the possibility to fund a new initiative emerging in the course of its implementation.

In a future programme such emerging cooperation possibilities could be taken into consideration from the outset and be encouraged, even at the call stage, by making the projects aware of the possibility and requesting them to take this into consideration in the project design.

7.1.4. Contractual issues in the context of multi-national (research) projects

The regional projects of the MEDA Water programme were operated by consortia of equal partners in Mediterranean and European countries. They involved several countries, non-EU countries among them, languages and legislations in most of the projects. This led to substantial administrative problems to match the various regulations with the Contract used for this programme. Especially procurement procedures were delayed and even blocked due to conflicting regulations which the partners were bound, however, to apply. This was aggravated by the fact that partners, if not NGOs, had to be public entities (which on the other hand guaranteed the high degree of appropriation of the results by the partner countries and thus was a positive aspect of the programme). The impression could not be avoided that the Contract was not designed and not perfectly appropriate for the type of operation targeted with the MEDA Water programme. It did not take into consideration either the greater need of flexibility in research projects compared to development or infrastructure projects as is provided by Contracts in the Framework Programmes in DG Research.

With a highly challenging programme, like a research programme about water in the Mediterranean Region, the design of the programme could take into consideration that time would be needed to introduce change and that one typical programme phase is insufficient to reach final results. Thus the programme could be designed in several phases from the outset, with only the first being clearly defined and each next phase being adapted according to the most promising directions of the current one. This could also allow the flexibility needed to respond to the issue of the previous paragraph, i.e. inter-project cooperation.

7.2. Activities which could be carried on

It is obvious that the effort to introduce the new paradigm of sustainable water management must be continued in order to guarantee wide application and that the frame for the next phases must probably be different (see chapter 6.5 above). There are, however, activities started or carried out in Zer0-M, the continuation of which could be interesting but where independent funding would be difficult. If funds to finish these activities or to carry on with them were available they would deserve such funding.

a. The one day V-learning course was a first experience by the Zer0-M team on invitation by the Tunisian Chamber of Architects, which is preparing such V-learning tools for their members and possibly members of the three Maghrebian Chambers. While Zer0-M covered a one day course the standard format is 5 days. There would be ample material for architects to prepare a 5 day course provided there is enough time to prepare this material specifically for the format of V-learning. Given the outreach of the V-learning course to all architects in Tunisia and possibly to all in the Maghreb this would be an interesting tool to spread the Zer0-M approach.

b. The Zer0-M Journal Sustainable Water Management was quite a success and had a wide outreach. It would be interesting for the Mediterranean water technician community to continue its publication, possibly in two languages, English and French.

c. The pilot system in Morocco, comprising the greywater collection and treatment of greywater from a hammam for landscaping and the substitution part of the fuel wood for water heating with solar energy has raised a lot of interest all over the Maghreb, were these public baths are still in wide use. The wide application of this example would need the examination of several different baths for standardisation of the system for existing and new baths, a manual for its implementation and some more training for water and solar technicians and architects. The system is economically highly viable, saves important amounts of water and fuel wood and has an impact on the whole population using these baths making their operation more environmentally friendly and resource efficient.

d. A small targeted project is to try and develop a standard for participatory planning of sustainable water management. Indeed the team which has developed this approach in EMPOWERS still exists as such. It could be very feasible to identify a case where within a period of two years such an approach could be implemented and a standard developed in the process. Such an undertaking was already discussed and preparation started during implementation of the two respective projects but could finally not be realised despite the high stock taken in it by the involved parties, i.e. the Delegation, the RMSU and the projects involved.

e. Establishment of a network of centres around the Mediterranean Sea working at and interested in SWM. This would include Zer0-M partners. Other organisations, which have already shown their interest are CEMAGREF, France, CENTA, Spain and Morocco, SEKEM with its branch Heliopolis University, Egypt. Possible other candidates for such a network are the water and wastewater utilities, e.g. ONEP, Morocco, ONAS, Tunisia, the Holding Company for Water and Wastewater, where contacts have already been established and who have shown interest in the approach. Such a network would have to cooperate with or be linked to existing efforts, e.g. MED-EUWI, EMWIS or ASKNET, the African Sanitation Knowledge Network.

7.3. Strategic aspects concerning introduction of the new paradigm

As far as Zer0-M is concerned the MEDA Water programme has allowed the introduction of the concept of Sustainable Water Management (SWM) in 4 MEDA partner countries and, indeed, through exchange mechanisms and dissemination tools beyond these four countries. Four MEDA partners, universities or research institutes, together with their European partners, have adapted known technology to MEDA conditions and developed new techniques towards closing the loop of water and nutrients in water and wastewater management. The developed know-how was first applied in small scale demonstration systems and then upscaled to real size pilot plants in each country, implemented together with national authorities and implementing organisations.

These authorities and implementing organisations are now asking for the Zer0-M partners' support for wider application of the developed systems. On the other hand the project has also shown that for wider application further questions have to be tackled, which could not be included in the current phase. The answers to these questions will partly come from experiences with additional real scale implementations, partly from further technology development efforts.

Some of the questions are:

- How to optimise the reuse of nutrients in agriculture? Work with agronomists and agro-economists on this issue will be needed.
- Can the developed SWM systems, especially the household centred approach, be transferred to the urban context with its generally higher domestic water needs?
- How to organise a large number of decentralised rural (or urban) systems?
- Adapt regulations, which are focusing on water presently, for nutrient reuse.

The project and the programme as a whole have also yielded a few lessons, which should be taken into consideration:

- Change towards a sustainable approach to water and sanitation will take time
- The countries need more examples, to test and prove the systems and not least to get information about real system cost.
- In order to achieve this it is paramount to invite other EC bodies to provide support (e.g. the EC Delegations by considering the MEDA Water results in bilateral funding negotiations).
- Whereas the MEDA Water programme relied on non-profit organisations it will be important for an implementation phase to include engineering competence, to rely on experts who were trained in Zer0-M and invite more consultants to trainings.
- A next phase with a larger implementation phase will need to dwell more on necessary structural changes within the operation of water supply and wastewater institutions and the participation and commitment of consumers to the new, household centred approach.

The water and wastewater institutions in the partner countries are:

Egypt	Holding Company for Water and Wastewater
Morocco	ONAS, Ministry of Interior for rural centres and villages
Tunisia	SONEDE, ONAS, possibly Génie Rural, according to regional task sharing
Turkey	The municipal water and wastewater authorities, eg. Istanbul Water and Sewerage Administration.

Other partners to directly work with in order to promote implementation are ministries managing substantial infrastructure parks, e.g. ministry of education, health, defence, etc. and private bodies and developers, e.g. tourism federations and their members, chambers of architects, federations of bath owners.

It is suggested to carry on in two main directions. On one side the development has to be continued and expanded and must again be combined with dissemination in order to spread the new approach including related techniques, e.g. those developed in EMWATER and MEDWA, to implementing organisations and their personnel. This should also include further networking of the involved research organisations, the partners of Zer0-M and other MEDA Water projects (EMWATER, MEDWA, MEDAWARE) plus institutions, which have already shown their interest.

On the other hand a specific effort must be directed towards implementation of concrete examples, to respond to the pressing need of the populations of the countries involved to become served in sanitation, to assist the concerned authorities, very interested to cooperate, and to gain experience at a larger scale. The SWM of the Zer0-M approach should be combined with the participatory planning approach of EMPOWERS in order to speed the path towards implementation. Funding organisations have to adopt the SWM approach in their policies in order to fund projects with appropriate, resource efficient infrastructure in the future. In order to achieve this, organisations with experience in SWM, e.g. the SWM centres of excellence created in the 4 MEDA countries or the European Zer0-M partners, could be involved in such funding negotiations at an early stage. This is actually already happening in Morocco and Tunisia and could be generalised on the EU side.

Until now there are different reuse regulations currently applied in different countries. There is not yet one common EU and regional standard. This creates confusion to consider which regulation should be applied in which case. There is an urgent need to develop one set of commonly accepted regulation based on the new WHO Guidelines for the safe use of wastewater, excreta and greywater.

The water supply sector in most Mediterranean countries has made substantial progress. Wastewater treatment however is lagging behind. One chance could be a sustainable approach to water management. This, however, needs to integrate water, wastewater, other-non conventional water sources, IWRM, reuse of nutrients in agriculture, especially urban agriculture, energy consumption, etc. Working along sector lines will not be sufficient in the future. In order to achieve this type of trans-sectoral integration a tight co-operation between the national and regional authorities dealing with these aspects will be necessary. This should also be reflected in the design of projects and in funding programmes, which should become equally trans-sectoral from the outset.

8 Annexes

1. Log Frame

2. Conference recommendations prepared at the final conference in Tunisia

3. TDC report

4. Pilot plant reports

A. Egypt, SEKEM
B. Morocco, El Attaouia
C. Tunisia, Chorfech

5. Tabular overview of deliverables and contracts

Table 41: Overview of training events
Table 42: Theses in Zer0-M
Table 43: Overview of conferences
Table 44: Overview of dissemination material
Table 45: Technical reports
Table 46: Supply contracts (costs in EUR)
Table 47: works contracts (costs in EUR)
Table 48: Service contracts (costs in EUR)

6. Annex part 2

6.1. Training Documentation, overview and single trainings documentation
6.2. Excursion, Italian part
6.3. Excursion, German part
6.4. Acceptance Study at the TDC in Tunisia
6.5. Case study report
6.6. DSS Paper Tool
6.7. Inventory and transfer certificates

7. DVD 1

Film “The innovative Turn” in 5 languages (Arabic, English, French, German and Turkish)

Film “Flush and Forget” in 2 languages (Arabic, English)

Zer0-M Documents about the following topics

- Water in each country
- Sustainable water management
- Saving water
- Hygienic requirements
- Water reuse and reclamation
- Rainwater harvesting
- Greywater recycling
- Constructed wetlands
- Membrane reactors
- Wastewater ponds
- Anaerobic treatment
- Sludge disposal and reuse
- Planning tools

- Water regulations
- Pilot plants
- Journals Sustainable Water Management
- Train the trainer seminar

8. DVD 2

Film “Waste not Waste”, BBC World Earth Report (English)

9. DVD 3

Film “La Récupération des Eaux Pluviales en Tunisie” (French)

Annex 1. Log Frame

	Intervention logic	Objectively verifiable indicators of achievement	Sources and means of verification	Assumptions
Overall objectives	*Contribution to the reduction of water abstraction*	*Amount of water abstraction (m^3/a)*	*National monitoring programs*	*Programme of SWM introduction continues and reaches a large scale*
	Contribution to guaranteeing the quality of treated wastewater receiving bodies	*Water quality indexes (BOD, NH_3, NO_3 and other chemical, microbiological and/or biotic indexes)*	*National environmental statistics*	
	Contribution to the restoration of the biogeochemical cycle	*Amount of artificial fertilisers replaced (t./a)*	*National agriculture statistics*	*Farmers and agricultural authorities accept biosolids and liquids from wastewater as fertiliser*
	Contribution to the alleviation of health and social problems due to insecurity of water supply and wastewater disposal		*National health statistics*	
Project purpose	*Enable in each of the MPC a technical centre to promote SWM*	*Number of pilot installations of the project*	*Number of persons / person equivalents served through project surveys during design*	*Cooperation of authorities concerned;* *Cooperation of water experts;* *Cooperation of pilot site owners/responsibles;* *Granting of necessary permits*
Expected results	*1. More exchange about water and wastewater management in partner countries*	*Homepage available* No of visits to the homepage *6-monthly journal published*	*Internet homepage* *Counter on the homepage* **Circulation and download figures**	*Access of technical and administrative experts to internet and journals and use of these media for information and knowledge exchange*

	Intervention logic	Objectively verifiable indicators of achievement	Sources and means of verification	Assumptions
			download figures	
	2. Knowledge about water and wastewater management in partner countries improved	*4 MCP training centres familiar with SWM technology* *MPC experts trained in SWM* *Training material available*	*Reports* *Reports, Training course records* *Material*	*Sufficient interest for the approach in target groups of MPCs*
	3. SWM implementations available	*SWM Demonstration plants available in 4 MCP training centres* *3 real scale pilot plants with SWM components*	*Reports, site visit* **Reports, site visit**	*Granting of permits;* *Cooperation of potential owners / responsibles of plants and users*
	4. Concepts and design tools for integrated sustainable water and wastewater management available	*Tools for spatial representations available* *Economic model for SWM measures available* *Multi-criteria analysis of SWM components available* *4 case studies carried out*	*Reports, physical check* *Project Report* *Project reports,* *Project reports, Design reports*	*Suitable input data available at affordable price*
	5. Awareness for sustainable water and wastewater management raised	*Number of decision makers attending Zer0-M events* *Size of circulation of information material* *Number of broadcast of videos, No. of videos distributed*	*Events records* *Circulation figures* *Project reports, national broadcasting programs*	

Activities		Means	Costs	
1.1	*Installation of a long-term living internet network on Zero-M concepts*	*Personnel; computers; internet provider domain, technical assistance*	*Personnel cost, investment cost, Lump sum costs, Reimbursables* *(See budget)* *Effectiveness of expenditures and project progress are verified by a formative mid-term external and a final project evaluation*	*Technical and administrative experts use and have access to internet*
1.2	*Starting the publication of semestrial journal*	*Personnel, computer, technical assistance, publication costs*		*and journals for information and knowledge exchange*
1.3	*Legislation up-date*	*Personnel, computer*		
1.4	*First conference*	*Personnel, computer, technical assistance, travels*		
1.5	*Second conference*	*Personnel, computer, technical assistance, travels*		
1.6	*Third conference*	*Personnel, computer, technical assistance, travels*		
2.1	*Preparation of training material*	*Personnel, computer, technical assistance,*		
2.2	*Legislation up-date*	*Personnel, computer, technical assistance, travels*		
2.3	*Training the trainers intensive course*	*Personnel, computer, technical assistance, travels*		
2.4	*Training excursions to EU countries*	*Personnel, computer, technical assistance, travels*		
2.5	*Training courses and thematic Workshops organised by MPC*	*Personnel, computer, technical assistance, travels*		*Staff must be sent to workshops by municipalities and other organisa-*

Activities		Means	Costs	
	training centres			*tions*
3.1	*Realisation of training and demonstration centres*	*Personnel, computer, technical assistance for design, Construction materials, equipment and labour*	345.000	
3.2	*Realisation of real scale pilot systems*	*Personnel, computer, technical assistance for design, Construction materials, equipment and labour*	*565.000*	*Authorisation of regional Authorities is needed before construction works can start.*
4.1	*Preparation of tools for spatial representations*	*Personnel, spatial digital data (topographic maps, aerial photographs, satellite scenes)*		*Spatial digital data in sufficient quality available*
4.2	*Preparation of a software tool for economic assessment of Zero-M measures*	*Personnel, computer, technical assistance, travels*		
4.3	*Multi-criteria analysis of Zero-M components in MPC environment (environment/health/social aspects)*	*Personnel, computer, technical assistance, travels*		*Input of Data from Municipalities and other institutions*
4.4	*Case study analysis*	*Personnel, computer, technical assistance, travels*		*Identification of appropriate sites* *Input of Data from Municipalities and other institutions*
5.1	*Video production*	*Personnel, computer, technical assistance, reproduction costs*	*Empowers contribution 30.000* *Innovative Turn 30.000* *Waste not Waste 93.000* *Rainwater harvesting 20.000*	

Annex 2. Conference recommendations prepared at the final conference in Tunisia

Recommendations, summary of presentations and discussions
Tunis 22 - 24 mars 2007

Recommendations

Whereas we need to acknowledge that 75% of the water consumed is used in agriculture,
Whereas we have to keep in mind the socio-cultural aspects,
Whereas we must not under-estimate the effects of good information and sensitisation of all involved persons,
Whereas we can revive old traditions of rainwater harvesting and economical use of water.
Whereas we can disseminate economical use of water examples (e.g. Saragossa in Spain).
Whereas we have to go towards more complex systems, closer to natural cycles and more cost effective
The following detailed recommendations were extracted from the five sessions of the conference.

Recommendations concerning:

1 -Reuse of nutrients: Nitrogen, Phosphate

It is absolutely mandatory to reuse the nutrients from wastewater for conservation of limited resources and environment protection.

Co-operation with agronomists for the management of nutrients from wastewater in accordance with crop requirements.

Facilitate the use of resources by segregating different wastewater flows (urine, faeces, grey water) using urine diversion toilets, etc.

Work on technologies to condition nutrients from wastewater for easy use: ammonia, phosphate.

2 - Reuse of waste water

Give importance to water reuse, one of the most efficient methods to save the resource.

Exploit existing experiences with segregation of household wastewater streams, especially in urban areas (example building of KfW, Germany, Seoul and Hamburg).

Develop robust wastewater treatment systems guaranteeing required quality standards.

Encourage the use of non-conventional water resources.

3 - Risks

Protect public health accepting that zero risk is not possible.

Take a minimum risk approach comparing different options:

- Conventional versus non-conventional systems;

- Risks coming from wastewater reuse compared to other risks;
- Risks of one technology compared to risks not using this technology.

Educate users of the new technologies in order to minimizing risks involved.

4 – Legislation

Harmonise national legislations and international recommendations concerning reuse of wastewater and irrigation practice (reference: Guidelines for the Safe Use of Wastewater, Excreta and Greywater, WHO, 2006).

Distinguish pollutants and nutrients and prepare management recommendations for the latter.

Check:
- risks of reuse (often over-estimated for non-conventional systems);
- quality standards, strategy to protect crops and groundwater against pollution by nutrients from wastewater.

5 – Technologies

Dimension wastewater treatment according to quality requirements adapted to local needs (e.g. experiences with extensive treatment in Jordan, Palestine).

Promote new technologies, i.e. bio-membrane reactor, sequencing batch reactor for greywater, solar desalination of brackish or sea water.

Develop new technologies especially for the needs of rural areas.

Take into consideration whole-life cost (investment, operation, maintenance, reinvestment, dismantling and reprocessing for the next use) from cradle to cradle.

Evaluate energy demand of treatment technologies with an LCA approach.

Use treatment technologies based on renewable energy with little impact on the environment.

Seek intelligent technology combinations for wastewater treatment in order to achieve a water quality appropriate for reuse in industrial production processes.

Encourage cleaner production aiming at “zero waste”, with emphasis on prevention and not the treatment of wastes.

Use treated municipal wastewater, possibly after further treatment by the industry, as service waters for industrial processes.

Summary

This list of recommendations is certainly not comprehensive to achieve sustainable water management: This quite complex issue requires taking into consideration a multitude of factors and the co-operation, (the search for complementarities, for synergies) of all stakeholders involved, often spread over vertical structures with sometimes even competing interests.

Annex 3.

TDC report

A. CERTE, Tunisia

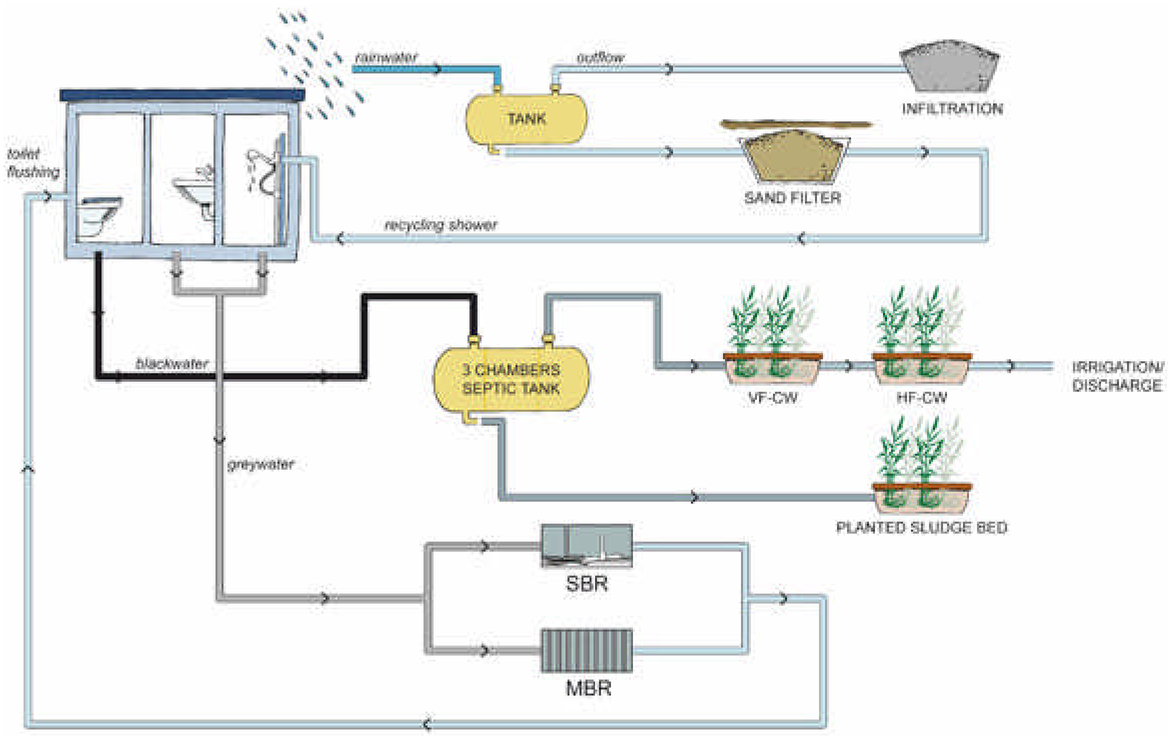


Figure 4: TDC of the CERTE at INAT in Tunis

The Tunisian TDC is located at the INAT in Tunis and supplements respectively modifies the existing water systems of a student hostel for girls.

The number of student houses is important in Tunisia and they host a growing number of students of approximately 69.000 for the year 2005, equivalent to the population of a Tunisian town. The student house buildings present a facility of segregation of grey and black water since the showers or toilets are grouped in one space for common use. In addition these buildings have an important roof surface for rainwater harvesting.
The student house selected for the installation of the TDC is a public building of three floors for female engineering students of a capacity of 212 persons. The bath area is equipped with 18 showers and situated in the ground floor. Each floor has 10 washbasins and 5 toilets.

The TDC scheme (Figure 1) is divided into three treatment lines relating to grey water, black water and rain water and three objectives of re-use for toilet flushing, landscaping and showering, respectively. Technologies to be established are membrane bioreactor MBR, (BUSSE GmbH, Germany), sequencing batch reactor SBR (PONTOS GMBH, Germany) and constructed wetlands. Research studies are conducted by Zer0-M partners to optimise and evaluate the performances of these technologies with respect to grey or black water.

Grey Water: The grey water is first introduced from a manhole to a tank serving as storage and homogenizing unit. Coarse and fine particles are removed by screens placed in the manhole and the holding tank. The designed flow is $1m^3/d$. Two technologies of treatment are selected, MBR and SBR. The principle of the SBR is a biological treatment in a compact reactor with different sequences (example: aerobic/anoxic/settlement) of which the order, the number and the duration are variable and have to be optimized according to the nature of the effluent. The disinfection of treated water is ensured by UV lamp.
Black water: The black water is introduced to a storage tank and then 1m3/day is treated in three chambers septic tank followed by subsurface horizontal flow (SSHF) and subsurface vertical flow (SSVF) constructed wetland. The treated water is stored in a tank for green area irrigation.
Rain water: The rainwater is collected from the roof of the student house building (approximately $600m^2$) in a storage tank (14 m^3) after screening. The outflow of the storage tank discharges into sand bed for rainwater infiltration. The pumped water is filtered with sand filter and heated using solar energy before to be recycled to supply one shower.
Sludge produced by the TDC is treated in a planted composting bed.

The Ministry of High Education and CERTE (Wastewater and Recycling laboratory) concluded an agreement for scientific research and technology for the period 2007-2010. This provides for a budget of 20 000 TND for the TDC O+M.

Discussion of results obtained

I-Blackwater treatment train

During the measuring campaign from April to Mai by the student Alaa's end of study thesis blackwater was determined to have an average organic load, COD varying between 463 and 880 mg O_2 /L, and high ammonium concentration (table 19).

Table 19: Analysis of raw wastewater

Parameter	Min	Max	Average	St. Dev.
COD (mg O_2/l)	463	880	620	128
BOD_5 (mg O_2/l)	168	300	224	43,1
pH	7,7	8,7	8,2	0,3
Conductivity (µs/cm)	1600	2453	2029	338
TKN (mg N/l)	159	185	172	8,6
Ammonium (mg/l)	129	279	204	20,9
Nitrate-Nitrite (mg/l)	4,1	4,9	4,5	0,35

The outflow of the septic tank (table 20) shows less organic load with the COD always under 600mg O_2 /L and a slightly reduced nitrogen load.

Table 20: Analysis of the outlet of the septic tank

Parameter	Min	Max	Average	St. Dev.
COD (mg O_2/l)	210	600	393	161,4
BOD_5 (mg O_2/l)	134	232	182	47,4
pH	7,5	8,7	8	0,4
Conductivity (µs/cm)	1420	2248	1855	344,5
TKN (mg N/l)	161	171,5	166	5,4
Ammonium (mg/l)	122	167	144	17,4
Nitrate-Nitrite (mg/l)	4,1	4,8	4,4	0,28

The outlet of the two stage constructed wetland (table 21) shows some nitrification.

Table 21: Analysis of the outlet of the two stage constructed wetland

Parameter	Min	Max	Average	Sample #	St. Dev.
COD (mg O_2/l)	30	88	55	8	18,9
BOD_5 (mg O_2/l)	26	31	28	8	1,8
pH	7	8,3	7,6	8	0,4
Conductivity (µs/cm)	1064	2230	1647	8	408,7
TKN (mg N/l)	85	160	123	8	27,8
Ammonium (mg/l)	47	94	71	8	21,2
Nitrate-Nitrite (mg/l)	8,0	10,2	9,1	8	0,96

The following figures summarise the average treatment efficiency obtained per treatment step, figure 5 for chemical parameters and figure 6 for microorganisms.

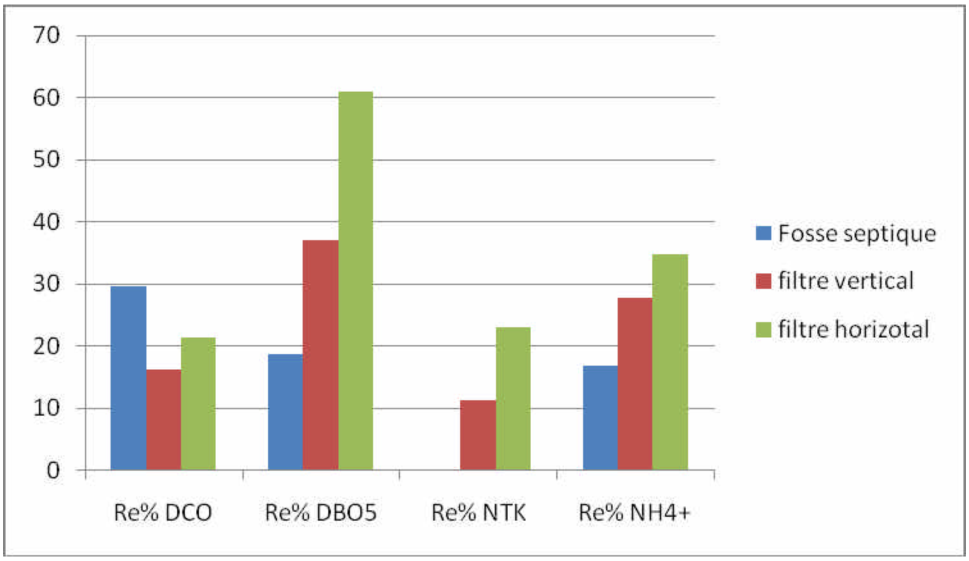


Figure 5: Evolution of four parameters (COD, BOD, TKN, NH_4^+) throughout the treatment train (batch feeding 10min/2h)

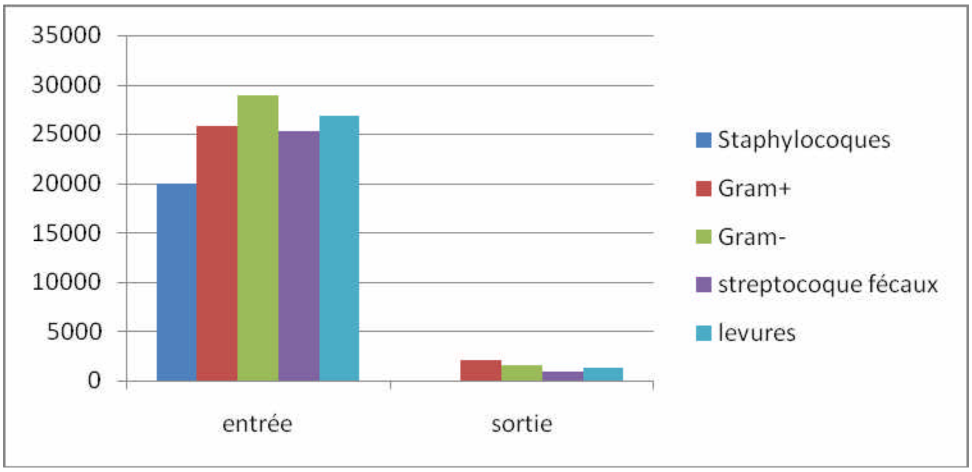


Figure 6: Evolution of micororganisms, staphylococci, gram+, gram-, streptococci and yeast, throughout the treatment train (batch feeding 10min/2h)

II-Greywater train

The loads of COD, ammonium nitrogen ($N\text{-}NH_4^+$), nitrate ($N\text{-}NO_3^-$), nitrite ($N\text{-}NO_2^-$), total nitrogen (TN), total phosphorus (TP), anionic surfactants (AS) and cationic surfactants (CS) was monitored in greywater originating from the showers of the residence hall. Two samples were taken per week. Table 22 summarises the results for the parameters listed above

Table 22: Characterisation of greywater.

Parameter	Unit	Min	Max	Average	St. Dev.	Sample #
COD	mg O_2 L^{-1}	56	269	164	59	15
NO_3^-	mg N L^{-1}	0,12	1,11	0,33	0,24	15
NO_2^-	mg N L^{-1}	0,03	0,10	0,07	0,02	15
NH_4^+	mg N L^{-1}	0,10	5,40	2,60	2	15
TN	mg N L^{-1}	4,71	19,30	11,50	5,6	13
TP	mg P L^{-1}	0,12	2,69	1,23	0,6	15
AS	mg L^{-1}	2,00	9,80	6,00	2	15
CS	mg L^{-1}	0,20	0,83	0,42	0,17	15

These results match well values of greywater with the same origin (showers, bath tubs, washing basins) reported in literature.

II-1 MBR Treatment

The MBR was monitored by student Ahlem Romdhane with two different operation modes.

- Mode 1: Feeding, rest phase without aeration of 20 min, coarse bubble aeration 1min, fine bubble aeration 20, coarse bubble aeration 1min, filtration stop of 3 min to relax membrane and slow down fouling. These sequences are repeated until reaching the low water level. Filtration is then stopped and the cycle ends with 45 min of resting and 15 min of aeration. After 2 hours feeding restarts.
- Mode 2: same as mode 1, but without the initial rest phase upon feeding.

Table 23, table 24 and table 25 summarise the performance of the MBR treatment with respect to concentrations and treatment efficiency for both operation modes.

Table 23 : Summary of performances of the MBR with respect to concentrations, Mode 1

	Mode 1				
	Max	Min	Average	St. Dev.	Sample #
COD	18	0	5,7	5,5	9
NH_4-N	1,1	0,0	0,6	0,4	9
NO_2-N	0,8	0,1	0,3	0,2	9
NO_3-N	9,1	0,6	3,7	2,8	9
NT	31,2	1,4	9,3	9,3	8
TP	2,1	0,2	1,0	0,7	9
AS	1,0	0,5	0,7	0,2	9
CS	0,8	0,1	0,1	0,1	9

Table 24 : Summary of performances of the MBR with respect to concentrations, Mode 2

	Mode 2				
	Max	Min	Average	St. Dev.	Sample #
COD	14,6	7	12,0	5,2	8
NH_4-N	0,6	0	0,3	0,2	6
NO_2-N	0,5	0	0,2	0,2	6
NO_3-N	8,7	0,6	4,0	3,7	6
NT	11,0	4	7,0	3,0	6
TP	0,3	1,4	0,5	0,5	6
AS	1,0	0,5	0,7	0,2	6
CS	0,2	0,08	0,1	0,1	6

Table 25 : Summary of performances of the MBR with respect to reduction efficiency, Mode 1 and 2

	Mode 1					Mode 2				
	Max %	Min %	Average %	St. Dev.	Sample #	Max %	Min %	Average %	St. Dev.	Sample #
COD	100	84,2	96,2	5,2	9	95,0	82,3	91,2	3,7	8
TP	80,0	1,0	40,0	30,0	9	89,0	44,4	68,3	17,3	6
AS	94,3	75,0	87,2	7,5	9	92,3	65	85,6	10,5	6
CS	91,1	9,1	60,3	27,3	9	83,5	63	74,9	8,0	6

These data lead to the following conclusions

- The COD reduction is better in mode 1 comprising the resting period.
- Nitrification is more efficient in mode 2, as oxygen saturation occurs earlier in the cycle
- There is no difference regarding surfactants degradation between the two modes.

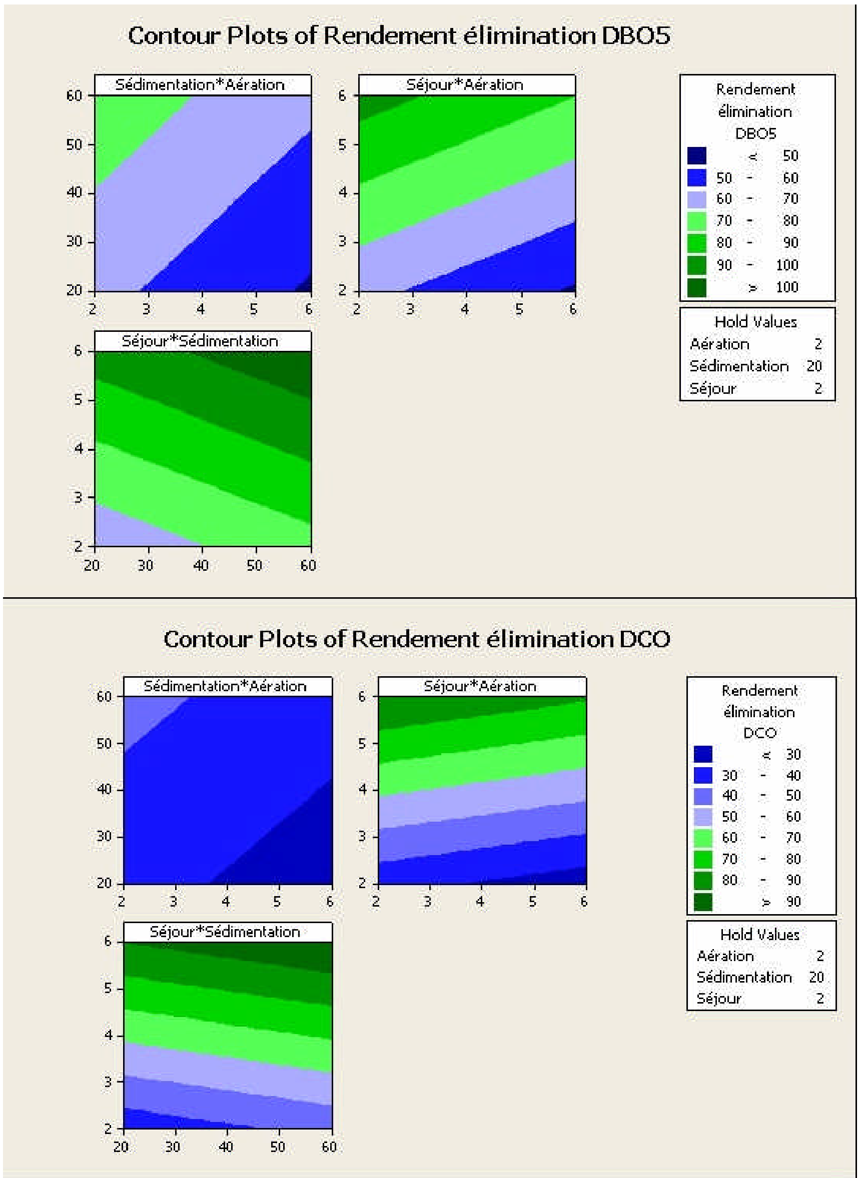
II-2 SBR Treatment

A first phase of monitoring of the SBR was carried out by student Anissa Chihi allowing to determine the SBR performances before optimisation (see table 26).

Table 26: Raw and treated greywater characteristics and performance of the SBR

	Inlet			Outlet		
Parameter	Sample #	Average mg/L	St. Dev.	Sample #	Average mg/L	St. Dev
TSS	11	73,86	39,64	-	-	-
COD	14	160,28	65,12	12	55,58	19,94
BOD_5	12	127,50	51,33	12	22,33	2,28
NH_4^+	15	16,40	4,28	15	2,88	3,32
PO_4^{3-}	15	2,01	0,53	15	1,41	0,56

The optimisation of the operation mode of SBR was based on the aeration and sedimentation and the hydraulic retention time. The monitoring followed the COD, BOD5 and TSS (figure 7)



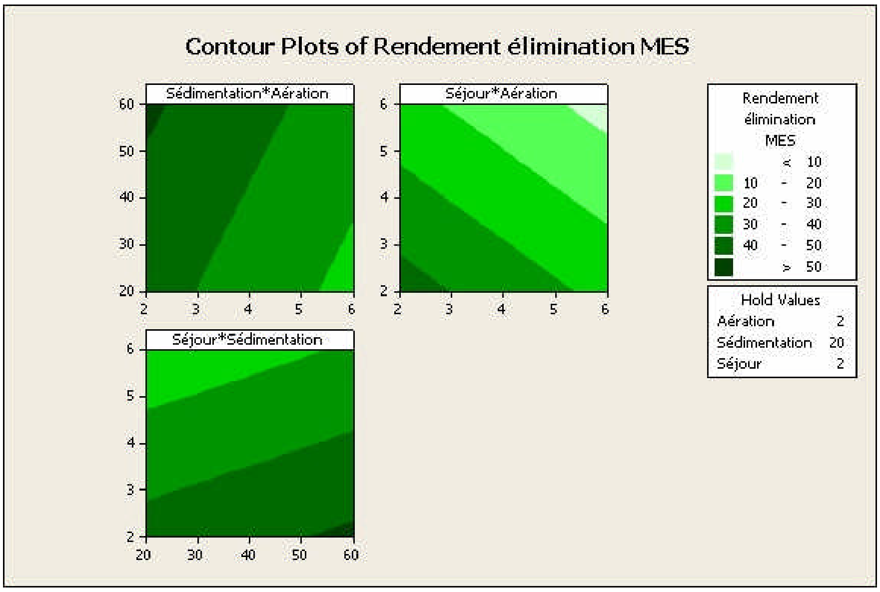


Figure 7: Variation of the COD, BOD5 and TSS as a function of the operation parameters

Photo documentation, TDC_CERTE, Tunisia

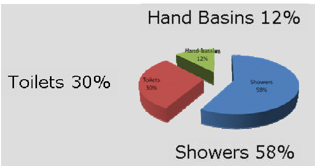


Figure 7: (1) Student hostel for girls student hostel for girls; (2) SBR Reactor; (3) MBR membrane; (4) Constructed wetland

Cost of main items

Wastewater segregation, rainwater harvesting and small solar heating infrastructure at the residence hall, TDC, consisting of pipes, chambers and CWs :	69.140,00 €
MBR, including commissioning and training	8.920,00 €
SBR, including commissioning and training	7.330,00 €

B. IAV, Morocco

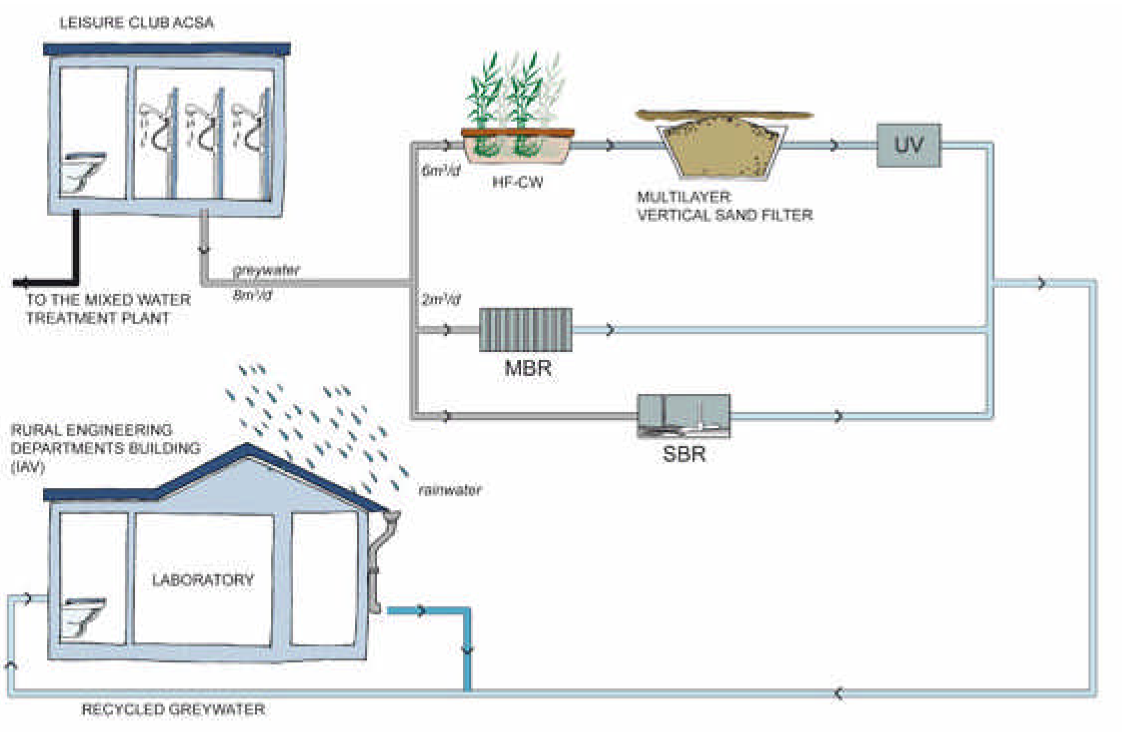


Figure 8: TDC parts of the IAV built by Zer0-M at its premises in Rabat, Morocco

The TDC is constructed in the area harbouring the existing wastewater treatment plant of the IAV Campus. The later was constructed in late 1996 to be used as a research and teaching support and has therefore many associated components and facilities. But the principal biological techniques tested are: Two-Step Upflow Anaerobic Reactor (TSUAR), a high-rate algae pond followed by a maturation ponds and a multi-stage constructed wetland.

The European funds are mainly used to widen the TDC capabilities to include some of the closed loop, low cost and environmentally friendly techniques. The TDC is used as a support to the numerous training sessions also funded by Zer0-M. Different greywater treatment and recycling systems and a hybrid-multistage constructed wetland were added to the existing treatment plant.

The greywater is collected in the club of the "Association Culturelle et Sportive de l'Agriculture" (ACSA) adjacent to the Campus of IAV Hassan II in Rabat. Some 10 m^3 of GW are daily collected from a battery of 10 showers linked to the gym room. GW is segregated from the toilet effluent and collected separately in a reservoir built outside the gym room from which, 8 m^3/d are pumped to the wastewater treatment facility located inside the IAV Campus. There, GW is treated then recycled for flushing the four toilets of the Department of Rural Engineering inside the campus.

Greywater treatment

Greywater is treated in three different units inside the campus namely:

- Constructed wetland (CW) followed by a Vertical-flow sand filter followed by UV disinfection,
- Submerged Membrane Sequencing Batch Reactor (SM-SBR) and
- SBR without membrane including UV disinfection.

The last two are compact and mechanically aerated units.

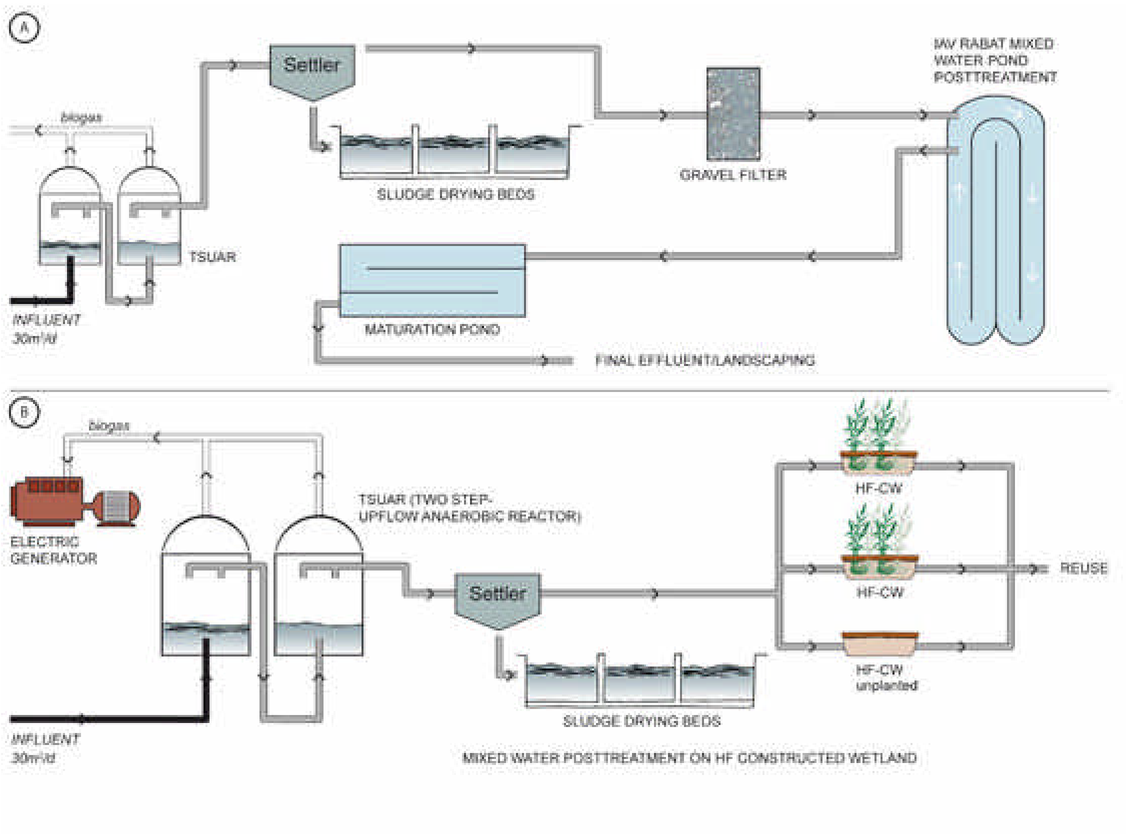


Figure 9: Existing TDC components of the IAV at its premises in Rabat, Morocco

The Constructed wetland / sand filter / UV disinfection

Planted gravel filter

The CW was constructed in reinforced concrete and has the following characteristics: length 2,25 m, width 2.0 m, depth 0.8 m, cross sectional area 1.6 m² and bottom slope 2%. The bed filling material consists of limestone aggregates with an effective diameter of 5,5 mm. The uniformity coefficient (UC; d60/d10) is 1,60, the porosity 47%, and the clean Darcy's hydraulic conductivity, k, is 60 10^{-3} m/s. The bed is planted with reed; *Phragmites sp*. The hydraulic loading rate is 1,8 m/d with an organic load of 210 g COD/(m²*d).

Sand filter

The second step consisted of a vertical multilayer sand filter also made in reinforced concrete and having the same dimensions as the CW. Five sand layers 0,14 m thick each with particle sizes going from 0,55 to 6 mm are used. The measured clean Darcy's hydraulic conductivity, k, of the unit is 25.10^{-3} m/s. The effluent of this unit is then disinfected in an UV Teflon system (Iritech Finmeccanica, Italy).

UV disinfection

Treated greywater is pumped upward in a Teflon pipe placed in an aluminium box with dimensions of 0,20 m x 0,20 m x 1,70 m. The Teflon pipe is surrounded by four 0,90 m long low-pressure mercury tubes of 30 Watts each emitting at 253.7 nm and placed at a distance of 0,03 m from the Teflon tube. The contact time is adjusted to 6,35 s leading to a dose of 400 $mJcm^{-2}$.

Some 2 m^3/d are taken apart to be treated inside the water lab of the DWEI using two high tech units namely, a membrane bioreactor (MBR) and a sequencing batch reactor (SBR) with the aim of introducing later such technologies in tourist developments where land is expensive and often not available to implement low cost ecological technologies.

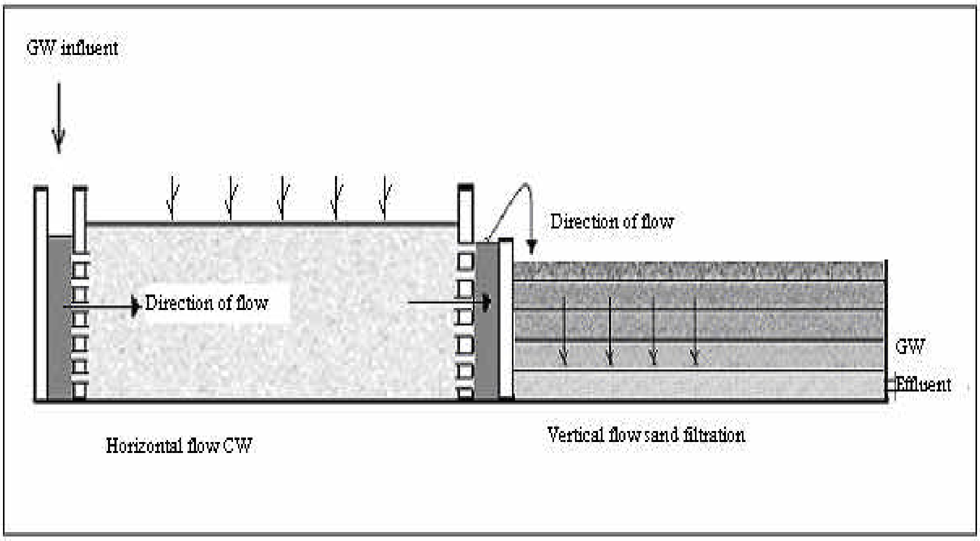


Figure 10: Definition sketch for the CW treatment unit for GW.

The MBR technology combines activated sludge process, for the removal of biodegradable pollutants, and membrane filtration for solid/liquid separation. The equipment used is from Busse, Germany, type MF-GW-HKA 4 (one reservoir). The membrane is a 5 m² "frame and plates" made of polyelectrolyte complex (Kubota, Japan) with a nominal pore size of 0,4 µm. The operating conditions were as follows: cycle duration 3 h (8 cycles/d); contact time 25 min (treatment aeration) then intermittent aeration (10 min every one hour); flow 675 L/d and HRT 19,5 h. After some time, the cycle was reduced to 2h, (12 cycles/d) to treat 980 L/d at HRT of 13,5 h. The purchase of the large unit was preceded by bench-scale experiments (see (Merz et al., 2007). The COD load was decreased from 0,16 to 0,14 g COD/(g VSS*d) when the cycle was reduced from 3 to 2 hours.

The SBR is an activated sludge unit in which the biomass grows inside small floating foam cubes. The unit used is an Aquacycle 900 from Pontos, Germany. It includes 3 reservoirs, two for a two stage treatment and the third for storing the UV-disinfected effluent. Operating conditions were as follows: Cycle duration 3 h, i.e. 8 cycles/d; (3min aeration and 5 min rest) followed by 20 min settling period corresponding to 850 L/d and 16,5 h as HRT. The settled material was pumped out every 4 days. The operating conditions were later changed to a cycle of 2 hours i.e., 12 cycles/d (3 min aeration and 5 min rest) followed by 20 min settling period corresponding to 1100 L/d and 13 h HRT. The COD load was 0,2 g COD/(g VSS*d) for the 2-hour cycle.

GW recycling for toilet flushing
GW treated in the low-cost ecological unit was disinfected and stored in a black polyethylene reservoir. This reservoir is connected to the building of the DWEI to feed four toilets at the ground floor. A dual pipe network was adopted with the valve of drinking water staying permanently closed except when GW is not available. Also and to prevent GW from flowing back into the drinking water network, a gap of 4 cm was left between the

drinking water outlet pipe and the highest water level in the flushing reservoirs. Four similar toilets, located on the first floor of the DWEI building, were flushed with potable water for comparison.

1.2. Hybrid-raw wastewater constructed wetland: A hybrid-three-stage constructed wetland was implemented in April 2007 in the framework of the cooperation between IAV and University of Guelph in Canada. The system is based on the CEMAGREF design which normally includes two vertical planted filters in series. Here, recycling to a horizontal-flow planted filter (located between the two vertical-flow filters, was added to achieve a higher denitrification of the effluent. The unit is receiving 10 m^3/day of raw wastewater, which is subjected to sand and coarse material removals.

Costs of main items

MBR, including commissioning and training	9.270,00 €
SBR, including commissioning and training	7.730,00 €

Photo documentation


Figure 11: clockwise from top left, a training course visiting the TDC, practical work of trainees at the laboratory, greywater reuse at the Department for Rural Engineering for toilet flushing

C. MRC, Turkey

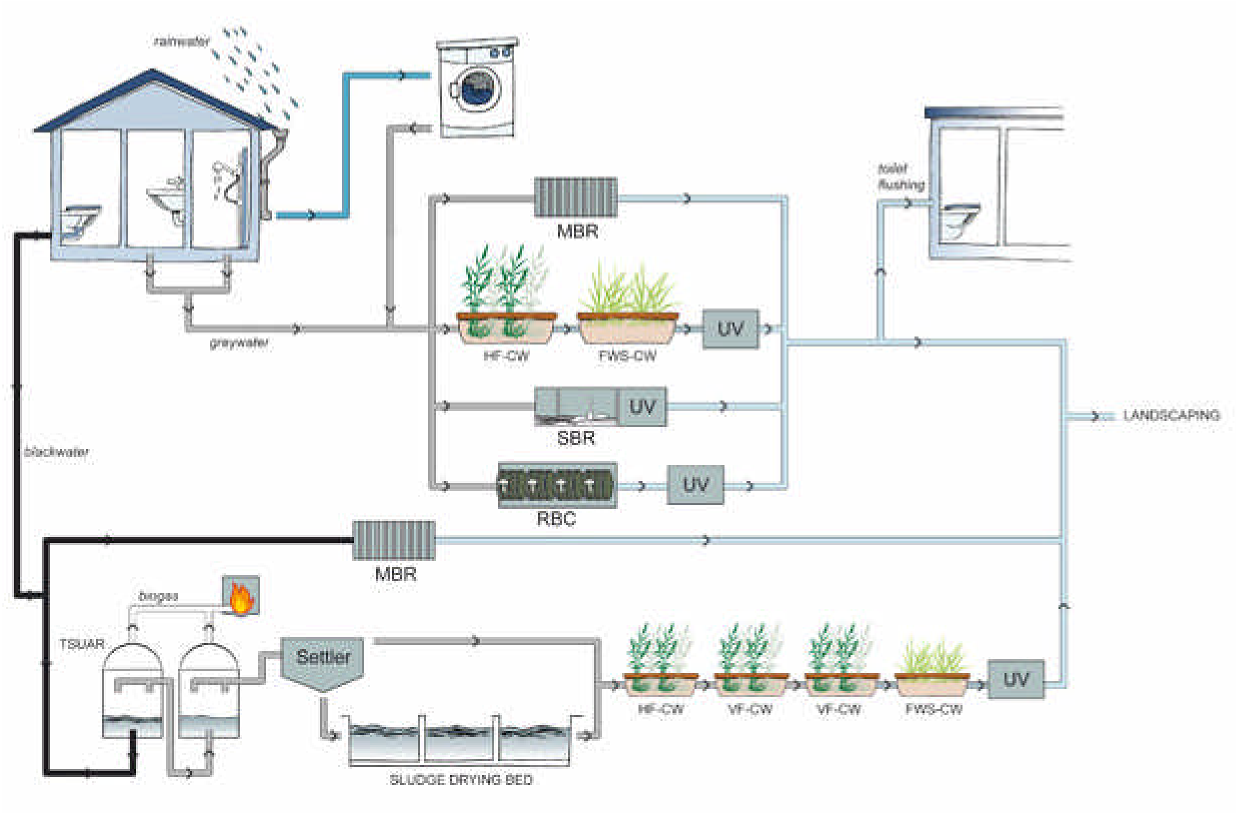


Figure 12: TDC of the MRC at its premises in Gebze, Turkey

Grey water

4 different technologies are assessed for the treatment of greywater as membrane bioreactor (MBR), sequencing batch reactor (SBR), rotating biological contactor (RBC) and constructed wetlands (CW).
The MBR used for grey water treatment have effective volume of 600L manufactured by BUSSE GmbH Company. It includes a submerged micro filtration plate and frame module (KUBOTA).
The SBR installed in the TDC has a total effective volume of 600L, manufactured by PONTOS GmbH. It consists of two serial tanks for biological reactions and a third tank for storage including UV disinfection.
The RBC process consists of discs with radial and concentric passages slowly rotating in a 4 serial tank and one settling tank for clarification.
The CW systems used in the TDC consists horizontal flow and free water surface systems. The raw GW is first fed to the horizontal flow CW by gravity flow and then in the second step it flows to a free water surface CW system for disinfection.

Depending on the technical options employed, pollutant load, operational conditions, as low as 10-15 mg/l effluent COD (MBR), less than 5mg/l BOD_5 (MBR), 0.2-4 NTU turbidity, 2-10 mg/l suspended solids, 1-2 mg/l NH_4-N and 0 Total Coliform/100 ml sample were obtained for the grey water technological options operated. The results obtained indicated that for all cases relatively high removal efficiencies were attained and among these options the best removal performance was attained with the MBRs. However, all the alternatives complied at least with the criteria for agricultural reuse for food crops commercially processed of the EPA Suggested Guidelines for Water Reuse most of the time for gray water treatment and reuse.

The removal rates for the series of constructed wetlands (HF + FWS CW) were quite high for all parameters, with effluent concentrations generally below 10 mg/l for TSS, 50 mg/l for COD, 10 mg/l for BOD_5, 1 mg/l for NO_3^-, and 0,5 mg/l for NH_4^+. The final FWS provided the final disinfection, with 4-6 logs of removal and the concentrations of Total Coliforms were in the range of 1-200 cfu/100ml.

For the case of grey water treatment with RBC, average effluent BOD_5 concentration was to be 6-8 mg/l which corresponds to the BOD_5 removal efficiency of 94%. 83% TSS and 90% turbidity, 75% TKN removal efficiencies were obtained. Moreover, up to 2 log reduction for total coliforms was observed and complete removal of total coliforms was attained after the UV disinfection. The results were assessed comparing with the other grey water treatment systems The removal efficiency achieved by MBR resulted in 50-100% high efficient than RBC especially in terms of COD, BOD_5 and SS. However, RBC may be a promising for the point of operational ease, low cost of operation and maintenance very less technical personnel requirements and good effluent quality. But, time period needed for biomass growth during acclimatization and continuous electricity supply requirement should be considered in design and operation to achieve efficient removal performance. The energy requirement for RBCs was about 1.2 kWh/m^3 grey water treated and 3.5 kWh/kg COD removed. The relevant energy requirement obtained for grey water treatment by MBR was 1.7 kWh/ m^3. The energy requirement of grey water treatment by RBC is lower than the case of treatment by MBR. Along these lines, energy cost for treatment of grey water was estimated as 0.1 US $/$m^3$.

The treatment options tried were efficient provided that the designs are made in experienced way, the needs determined precisely and appropriate conditions including the technical staff and background for operation are available. During the operation it was experienced that the technology requiring the most qualified person was the MBR. The RBC and CWs are quite advantageous as far as ease of operation is concerned. It is recommended to install a disinfection unit for the effluent of the RBC for satisfaction of microbiological criteria for reuse. UV disinfection can be used for this purpose. Furthermore, as a precaution UV disinfection may also be employed for the effluent of FWS CWs.

Black water

2 different alternative technologies are assessed for the treatment of blackwater. One alternative is the MBR technology. The second alternative is combination of constructed wetlands with two stage anaerobic reactors as primary treatment stage.

The MBR used for blackwater treatment have effective volume of 600L manufactured by BUSSE GmbH Company. The MBR include a submerged micro filtration plate and frame module (KUBOTA).

Anaerobic treatment is designed as two stage system for the pre-treatment of blackwater. It consists of two anaerobic reactors in series and a reactor for settling (Two Stage Upstream Aerobic Reactor or TSUAR). Later anaerobic pre-treated blackwater is fed first into the horizontal flow CW and then consecutive two vertical flow CW systems. Finally it ends up into the free water CW systems.

For the black water treatment options, as low as 35-55 mg/l COD (MBR), 4-12 mg/l BOD5 MBR), suspended solids of 2 mg/l and again zero T. coliform/100 ml sample were obtained. It should be noted that TSUARs used for the pre-treatment of black water also proved to be quite efficient and very easy to operate. It would be certainly to be considered as a sustainable and reliable option for black water pre-treatment.

The TSUAR exhibited good performances, with an overall removal of about 85% for total suspended solids (TSS) and COD. The results attained indicated that primary treatment by high-rate anaerobic digester could improve systems treatment performance by preventing media clogging and minimizing area requirement for the CWs. The 2 VF CW provided adequate removal rates. The effluent concentrations were in the range of 7-35 mg/l for COD and 0.5 mg/l NH_4^+. The hybrid CW system had a FWS effluent with a mean concentration of less than 10 mg/l BOD_5, 20 mg/l COD, 0.2 mg/l NH_4^+, 1-2 mg/l TSS and 10 cfu/100 ml Total Coliforms. The presence of VF beds in the treatment scheme is essential for the removal of the high ammonium content, which is typical for this kind of wastewater.

For the case of black water treatment the results obtained were also satisfactory as in the case of grey water treatment technology options in general. However, for some cases due to the local irrigation water quality regulations, nutrient concentration in the effluent exceeded the criteria. Specific energy demand black water treatment by MBR for black water treatment was calculated to be 2.3 kWh/m^3 This value was given as about 0.92 kWh/m^3 in the literature.

It should be noted that grey water and black water flows are monitored continuously by tipping bucket systems. Other online monitored parameters were pH, Oxidation Reduction Potential (ORP), Dissolved Oxygen (DO), temperature, TransMembrane Pressure (TMP) for the MBRs, plus flow of the treated water of MBRs and SBR. In addition to that water consumption for one of the buildings was also monitored.

Rainwater Harvesting

Rainwater is collected from the 350 m 2 roof of the one lodging house building and 100 m 2 TDC housing building. A vortex type rainwater filter is used for the separation of coarse matters before the storage tank.

Re-use options

Reuse of treated wastewater for minor domestic purposes as flushing, garden watering but also crop irrigation or landscaping are planned. Moreover, as it is emphasized, rainwater harvesting and reuse options are assessed in the TDC.

Cost of main items

Wastewater segregation infrastructure at MRC, consisting of pipes and chambers	8.356,11 €
TDC and second building wastewater segregation infrastructure at MRC, consisting of pipes, chambers, UASB and CWs	35.068,00 €
MBRs (2 units), including commissioning and training	15.400,00 €
SBR, including commissioning and training	7.630,00 €

Photo documentation

Figure 13: TDC anaerobic treatment and lab

Figure 14: Constructed wetlands

Figure 15: Two MBRs, one for blackwater, one for greywater, and on SBR for greywater treatment

D. NRC, Egypt

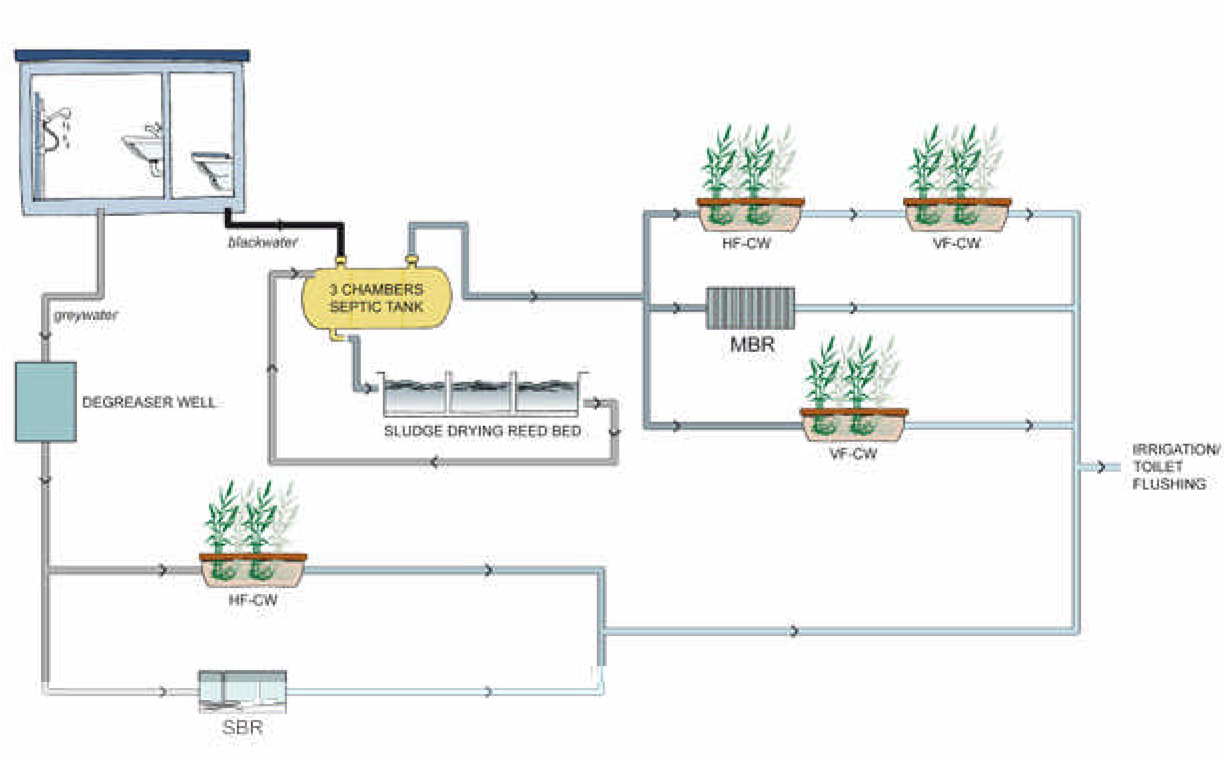


Figure 16: TDC of the NRC at its premises at Dokki, Ghiza Egypt

The wastewater is collected at an Apartment house opposite to the NRC-compound, where greywater and blackwater are segregated at the source. The treatment systems are installed at the premises of the NRC. About 20 inhabitants are connected providing a flow of 2 m³/d of wastewater, divided into black and grey.

Greywater: The system comprises a primary treatment followed by a Pontos, Germany, SBR including a UV disinfection and a horizontal flow constructed wetland in parallel.

Blackwater: Two primary treatments, a septic tank and a UASB are compared. Secondary treatment consists of three trains in parallel: a two stage constructed wetlands with a horizontal flow and a vertical flow bed in series, a membrane bio-reactor from Busse, Germany, and a one stage vertical flow constructed wetland.

Dry sanitation: Besides these treatments there are experimental installations of

- a waterless urinal, Keramag Centaurus
- a urine diversion toilet
- a composting toilet

These are used by the staff when working at the TDC.

Sludge: The sludge from the primary treatments, the MBR and the SBR is treated in a composting reed bed.

Reuse: The treated wastewater is used for drip irrigation of decorative plants and fruit trees planted specially for this purpose on the TDC. There is also a test installation of a hydroponics plantation.

Urine is collected and will be used for plant fertilisation and the faecal matter composted on site in the two composting bins, used alternatively, will be used as soil conditioner on the plantations at the TDC

The Egyptian NRC CWs exhibited high COD reduction, from 66 to 86%, and nitrification, from 82 to 89%, in the black water line BW3 (Figure 17). The results obtained on lines BW1 and BW2 are fitting the range of performances obtained for BW3.

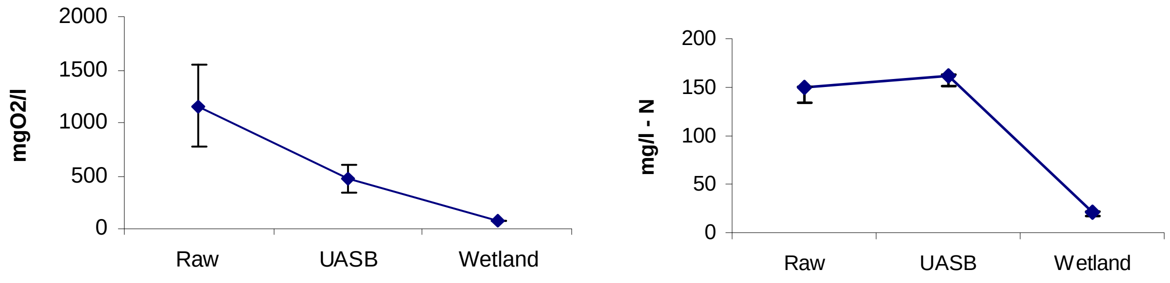


Figure 17: Average COD and NH_4^+ concentrations in the TDC Black water line.

Cost of main items

Wastewater segregation infrastructure at adjacent house, TDC infrastructure at NRC, consisting of pipes, chambers, an on-site lab, UASB and CWs:	35.200,00 €
MBR, including commissioning and training	9.520,00 €
SBR, including commissioning and training	7.630,00 €

Photo documentation

Figure 18: counter clockwise from top, TDC overview with lab, UDDT and CWs; composting bins for faecal matter; typical apartment buildings in Cairo with outside plumbing where greywater segregation is easy to implement.

Annex 4. Pilot Plants

A. Egypt, SEKEM

Location	SEKEM
Lifespan	50 years
Capacity	170 m³ per day

Introduction

The SEKEM farm is producing natural drugs by growing various herbs and extracting the active substances from them by an industrial cycle that ends up in the final products. It's a community, a few hundred people are living and working there, and there's also a school for about 500 students. A second part is a production facility for dairy products, vegetables, dry fruit and fruit juices, dried herbs and natural drugs.

The new installed wastewater treatment plant is part of the overall water, and environmental, strategy of SEKEM.
The plant shall allow the treatment and safe reuse of the wastewater produced by part of the SEKEM farm for irrigation purposes.
If the present example is successful further similar systems will be implemented, which are already under discussion, for villages located around the farm.

The high profile of SEKEM (http://www.sekem.com) throughout Egypt and the reputation of its founder, Dr. Ibrahim Abouleish, give the pilots a high visibility in Egypt.

Situation

The **first target area** for the pilot project comprises the school and boarding school of the farm, a few office buildings, the campus kitchen and a laundry room. The wastewater is composed of 100 % domestic wastewater.

Because of the positive experiences with the first pilot plant a next stage at a **second target area** was planed which deals with water from several settlement, the factories on the farm and the wastewater of nearby villages.

In the past the wastewater of the first target area was treated in a hybrid constructed wetland, comprising a primary treatment and a sequence of vertical filter (VF) +horizontal filter (HF) + storage tank. In a former time the effluent contained in the storage tank was pumped to fields for irrigating.
The old vertical flow CW was clogged due to massive under sizing. The whole treatment system was by-passed. The raw wastewater was used for irrigation, being pumped directly from the septic tank to the fields. The septic tank itself was in dire condition.

The wastewater of the rest of the farm was treated in a septic tank. The roughly treated wastewater was reused for minor purposes (irrigation of a wood plantation) because of its poor quality. Due to the quite big amount of available wastewater the irrigation system should been enlarge for the irrigation of further green areas. Fore that reason an improvement of the water quality was absolute necessary.

System requirements

Some of the troubles, which occurred in the old treatment systems, are due to a lack of maintenance of the mechanical components (e.g. pumps). Thus a robust system, as “simple” and “low-tech” as possible was designed.

SEKEM was advised to repair all fixtures in order to stop leakages. The treatment and re-use system comprised the parts in the table below. For more details reference is made to the design report.

At the factory the approach was to separate the different flows. There is

- Toilet wastewater
- wastewater from dairy production
- vegetable and fruit washing water
- cooling water

The first is diverted and treated separately. This eliminates pathogenic germs from the rest. Cooling water is diverted and reused. It does not need treatment. The wastewater from dairy and the washing water is treated in a constructed wetland for reuse as irrigation water.

The two systems have a capacity of 20 and 150 m^3 respectively. They have the following components, which only differ in size.

- Collection system
- 3 - Chamber pre-treatment tank
- Pumping well
- Divisor
- Horizontal flow constructed wetland
- Outlet well
- Storage tank / pond

System Description

First Target Area - “School” Plant

A1. Realized activities

The Zer0-M project therefore suggested the design described below for a pilot wastewater treatment plant as a solution for an efficient wastewater treatment.
The intention of the plant is to increase the available water for agricultural purposes and at the same time solve the problem of uncontrolled wastewater disposal in the targeted area.

Table 27: The realized design for the first pilot treatment plant consists of:

- 3 - Chamber pre-treatment tank
- Pumping well
- Divisor
- Horizontal flow constructed wetland
- Outlet well.
- Storage pond.

It was planned to reuse and adapt some parts of the existing decommissioned treatment plant. The structures were not in very good condition. The old storage pond has been extensively renovated and adapted to the new applications.

The condition of the existing septic tank made any further use impossible. For security reasons the construction has been backfilled.

B1. Dimensioning Criteria

The wastewater production in the target area is about 15 m³ per day. Because of the constant increase of the population in the last few years an additional flow of 5 m³/d has been taken into consideration for the dimensioning of the components of the plant.

Design flow rate:

Daily wastewater production	15,0	m³/d
Unused capacity (actual) - security factor	5,0	m³/d
Design flow rate	**20,0**	**m³/d**

The farm had extension plans for the served area, which were not 100 % sure at the date of the design.

A possibility to extend the wastewater treatment by 50% of the present design flow to a stage 2 was taken into consideration.
Where an easy extension of components is possible, space has been provided for such an extension otherwise the extended flow of stage 2 was considered the design flow.

To immediately base the design on the increased design flow and implement the larger constructed wetland would mainly lead to higher evapo-transpiration losses. The construction of stage II was not useful for the actual flow rate (15m³/d).

Flow rate stage I:	Q_{fI}	20	m³/d
Flow rate stage II (extension stage):	Q_{fII}	30	m³/d

Construction of the extension stage (stage II):

The pre-treatment cannot be easily increased and has therefore been dimensioned for the higher flow rate of 30 m³/d (Stage II – extension stage).

The biological stage of the plant can easily be increased without any construction changes to the presently implemented treatment plant by adding a 2nd horizontal flow wetland on the prepared extension area.
The inlet pipe of the extension constructed wetland has only to be connected to the divisor well. The divisor well was designed in order to divide the flow into three streams of which two are going to be used immediately and the third remains idle until the extension is implemented.

C1. Treatment system

Pre-treatment Unit - 3 - Chamber pre-treatment tank:

To reduce the amount of solids in the inflow and to minimize the risk of clogging of the filter bed a pre-treatment was required.

According to Austrian Standards, ÖNORM B 2505, “The minimum volume for the pre-treatment unit should be not less than 0.25 m^3/PE. The surface area has to be at least 0.06m^2/PE. The minimum water level has to be at least 1,30m.

For pre-treatment a 3-chamber septic tank with an effective volume of 56 m^3 was planned. In order to improve the treatment efficiency the pre-treatment unit was divided into 3 chambers. To increase the mechanical treatment effect dip pipes have been installed between the pre-treatment chambers. The sludge settling in the first chamber has to be removed from time to time. Removal becomes necessary if the sludge volume reaches a height of 1/3 of the useable height in the first chamber.

Retention time

Stage I:	= 56 m^3 / 20 m^3/d = 2,8 days
Stage II (Extension):	= 56 m^3 / 30 m^3/d = 1,9 days

Pumping well:

The treatment system is located in a very flat area. The use of a pump to feed the constructed wetland from the pre-treatment unit is necessary. After this point the wastewater flows by gravity trough the treatment system to the storage pond. An alarm unit with horn and floater has been provided (acoustic alarm) to ring an alarm in case of failure of the pump.

Submerged faecal pump:

max. flow rate	300 l/min
Distance of end points of float switch	400 mm

Splitter well:

For optimal and accurate distribution of the water on the CW a splitter well has been provided. An installed divider weir splits the incoming water flow into two equal flows in stage I and into three equal partial flows in stage II (expansion stage). The weir is made of stainless steel.

Horizontal flow constructed wetland – (SFS-h):

Description of the constructed wetland
SFS-h (submerged horizontal flow) systems consist of basins containing inert material with selected granulometry. The bottom and the walls of the basins has to be correctly waterproofed using a layer of clay, if available on site and under adequate hydrogeologi-

cal conditions, or, as is more frequent, using synthetic membranes (HDPE or LDPE, 1,5 to 2 mm thick, or a sandwich of a thinner membrane with two layers of geotextile) or exceptionally concrete. The inlet and the outlet consist of two strips of coarse material along two opposite edges of the basin. At the inlet side a feeder pipe with large holes (e.g. Ts) at regular intervals runs along the edge near the surface. In the outlet gravel pack a drainpipe is put at the bottom to collect the treated water. The drainpipe goes into a riser pipe in a shaft. The height of the opening of this riser pipe determines the outlet water level in the basin. The path of any water percolating through the basin should have a length between 3 to 10 m. Accordingly water is either fed on the short (for small basins) or on the long side of the basin. Emerging plants, generally reed (*phragmites australis*) are grown in the basins.

Table 28: Technical Specification of the Horizontal Flow Constructed Wetland – (SFS-h):

Item	Unit	Value
Total bottom surface	[m²]	200
Bottom length	[m]	20,0
Bottom width	[m]	10,0
Average medium height	[m]	0,80
Inlet medium height	[m]	0,75
Outlet medium height	[m]	0,85
Bank slope	[°]	90
Medium porosity (gravel ∅ 5-10 or 8-12 mm)		0,35
Average water level	[m]	0,7
Bottom slope		1 %

Function:
The inert material in the basins has to provide a filtering effect and growth support for microorganisms but also assures an adequate hydraulic conductivity (filling media mostly used are sand and gravel); these inert materials represent the support for the growth of the roots of the emerging plants.; The water remains always under the surface of the absorbing basin and flows horizontally thanks to a slight difference between the inlet and the outlet levels. The filling material of the basin is saturated with water but for the uppermost few centimetres.

During the passage of wastewater through the ryzosphere of the macrophytes, organic matter is decomposed by microbial activity, nitrogen is denitrified, if in presence of sufficient organic content, phosphorus and heavy metals are partly fixed by adsorption on the filling medium; the contribution of the vegetation to the treatment process can be represented both by the development of an efficient microbial aerobic population in the ryzosphere and by the action of pumping atmospheric oxygen from the emerging part of the plants to the roots and so to the underlying soil portion, with a consequently better oxidation of the wastewater and creation of an alternation of aerobic, anoxic and anaerobic zones. This succession of zones leads to the development of different specialized families of micro organisms and a good reduction of pathogens, highly sensitive to rapid changes in dissolved oxygen content.

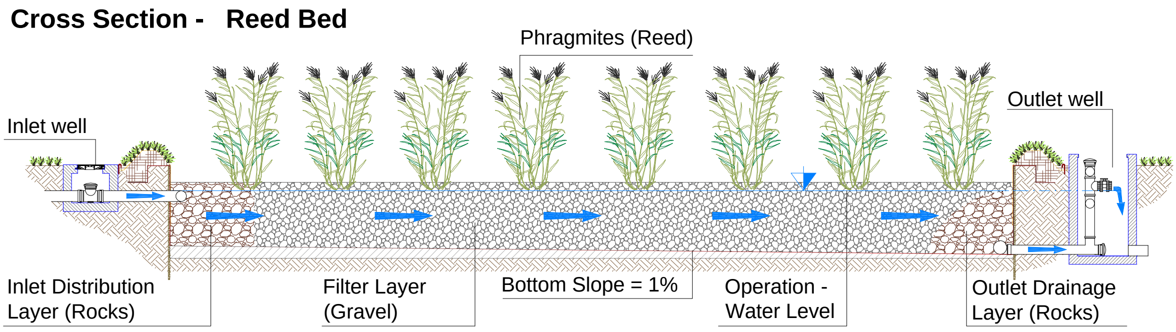


Figure 19: Cross Section of the Reed Bed

Guidance chronology of construction and technical details

- Along the edges of the bed, dig a small trench to tuck in the geotextiles and the liner;
- Cover the bottom and the banks with a non-woven geotextile (minimal density 250 g/mq);
- Put a sand layer on the bottom of the bed to achieve a slope of 1%;
- Put the PE liner and pass the pipes through the liner as specified in the drawings;
- Cover the bottom and the banks with a second layer of geotextile (minimal density 250 g/mq);
- Put the edges of the sheets into the boundary trench and backfill with the excavation material;
- Put the drainage system;
- Put a rock layer on the drainage system;
- Put a rock layer (50 cm high) in the inlet zone;
- Put the feeding system on the rock layer and cover with rock until the designed height, as specified in the technical drawings;
- Fill the bed with gravel: it is strongly recommended that the gravel be well washed and round. The final filling surface must be horizontal, i.e. have no slope towards the outlet.
- Plant the reeds in the gravel, with a density of 4 plants/m^2.

Storage Pond:

The existing storage pond has been renovated and adapted for a further use (collection and buffering of treated water). The treated water is now used for irrigation. For a thorough cleaning it was necessary to empty the pond completely. The tightness has been checked. A partial renovation and sealing of the pond was required.

Volume storage pond	[m^3]	63

First monitoring results and wastewater quality considerations

The values for the organic load of the wastewater of the school system, expressed as COD and BOD_5 show normal values. The ratio of 2,2:1 for CDO:BOD_5 is also standard and indicates that the wastewater is well suited for biological treatment.

Table 29: COD and BOD_5 of inlet and outlet of the school system

	Min	Max	Average	St.Dev.
COD in	298	1330	800	359
COD out	112	223	174	36
Efficiency			78%	
BOD_5 in	159	504	357	118,3
BOD_5 Septic tank	105	255	193	46,5
BOD_5 out	56	149	102	30,5
Efficiency			71%	

During the monitoring the plant cover at the constructed wetland was still very week. Nevertheless the treatment efficiency and the outlet values are convenient for the use of the outlet as irrigation water for trees (for the use of treated wastewater in agriculture reference is made to the WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater, Volume 2, 2006). No reduction of nutrients was targeted with this treatment system. While phosphorus may still be adsorbed to the filter material during the first year or two, this adsorption capacity will fade out with time. Part of the organic nitrogen is transformed into ammonium in the septic tank and the horizontal flow constructed wetland. The reduction of the total nitrogen concentration is very limited. Thus the nutrients from the wastewater are transferred to the tree plantation and into the tree biomass.

No helminth eggs can pass a constructed wetland. The reduction of the microbial load however does not exceed 2 logs. Therefore the farm personnel should wear protective gear, especially boots, while working at the irrigation.

Second Target Area - "Factory" Plant

The second plant based at the same design and uses the same components, which only differ in size from the first plant.

<u>A2 Realized activities</u>

The Zer0-M project therefore suggested the design described below for a pilot wastewater treatment plant as a solution for an efficient wastewater treatment.
The intention of the plant is to increase the available water for agricultural purposes and at the same time solve the problem of uncontrolled wastewater disposal in the targeted area.

Table 30: The realized design for the second pilot treatment plant consists of:

- 3 - Chamber pre-treatment tank
- Pumping well
- Divisor
- Horizontal flow constructed wetlands
- Outlet wells.
- Storage tanks

It was planned to reuse and adapt the existing septic tank. The structure was not in very good condition. The tank have been renovated and adapted to the new applications. A covering of the primary open tank has been constructed.

B2 Dimensioning Criteria

The present wastewater production on the Farm and the factories is about ~250-300 m³ per day. In the past the domestic wastewater of the farm and the production wastewater of the factories were mixed together.
The major part of factory wastewater, is composed of the unpolluted cooling water from the fruit juice production and marginal polluted washing water from the fruit and vegetables washer (together approximately ~150-200m³ per day) This amount of wastewater has been separated from the rest of the farm and factory wastewater.
The separation of this water has reduced the daily wastewater production going to the treatment plant from 250-300 m³ per day to 100-120 m³ per day. The cooling and fruit washing water is used directly without a biological treatment for tree irrigation.

For the daily amount of wastewater brought from the nearby villages a treatment capacity of 30m³/ day was intended.

Design flow rate:

Daily wastewater production farm	120,0	m³/d
Waste water evacuation from the villages	30,0	m³/d
Actual design flow rate	**150,0**	**m³/d**

For the near future it's planed to decrease the amount of wastewater coming out of the factory by increasing the efficiency of the different production processes in the factory. The free treatment capacity shall be allow increasing the water contingent of the villages.

The plant has been designed to adopt easily (by adding an additional reed bed) to a prospective increasing amount of wastewater.

To immediately base the design on the increased design flow and implement the larger constructed wetland would mainly lead to higher evapo-transpiration losses. The construction of stage II was not useful for the actual flow rate (150m³/d).

Flow rate stage I:	Q_{fI}	150	m³/d
Flow rate stage II (extension stage):	Q_{fII}	180	m³/d

Construction of the extension stage (stage II):

The pre-treatment cannot be easily increased and has therefore been dimensioned for the higher flow rate of 180 m³/d (Stage II – extension stage).
The biological stage of the plant can easily be increased without any construction changes to the presently implemented treatment plant by adding a 6. horizontal flow wetland on the prepared extension area.
The inlet pipe of the extension constructed wetland has only to be connected to the divisor well. The divisor well is designed in order to divide the flow into six streams of which five are going to be used immediately and the sixed remains idle until the extension is implemented.

C2 Treatment system

Pre-treatment Unit - 3 - Chamber pre-treatment tank:

To reduce the amount of solids in the inflow and to minimize the risk of clogging of the filter bed a pre-treatment was required.

According to Austrian Standards, ÖNORM B 2505, “The minimum volume for the pre-treatment unit should be not less than 0.25 m^3/PE. The surface area has to be at least 0.06m^2/PE. The minimum water level has to be at least 1,30m.

For pre-treatment a 3-chamber septic tank with an effective volume of 190 m^3 was planned. In order to improve the treatment efficiency the pre-treatment unit will be divided into 3 chambers. The existing septic tank with an effective volume of 100 m^3 has been reconstructed and is used in function of the first chamber of the 3-Chamber System. A new erected tank with an effective volume of 90 m^3 separated into two equal cambers takes the function of chamber 2 und 3.

To increase the mechanical treatment effect dip pipes has been installed between the pre-treatment chambers. The sludge settling in the first chamber has to be removed from time to time. Removal becomes necessary if the sludge volume reaches a height of 1/3 of the useable height in the first chamber.

Retention time

Stage I:	= 190 m^3 / 150 m^3/d = 1,3 days
Stage II (Extension):	= 190 m^3 / 180 m^3/d = 1,1 days

Pumping well:

The treatment system is located in a very flat area. The use of a pump to feed the constructed wetland from the pre-treatment unit is necessary. After this point the wastewater will flow by gravity trough the treatment system to the storage tanks. An alarm unit with horn and floater has been provided (acoustic alarm) to ring an alarm in case of failure of the pump.

Submerged faecal pump:

max. flow rate	> 300 l/min
Distance of end points of float switch	400 mm

Splitter well:

For optimal and accurate distribution of the water on the CW a splitter well has to be provided. The installed divider weir splits the incoming water flow into 5 equal flows in stage I and into 6 equal partial flows in stage II (expansion stage). The weir is made of stainless steel.

Horizontal flow constructed wetland – (SFS-h):

The constructed wetland of the second plant has the same design and function as the first plant. The constructed wetland only differs in size and number of reed beds.

Table 31: Technical Specification of the Horizontal Flow Constructed Wetland – (SFS-h):

Item	Unit	Value
Number of Reed Beds	[n]	**5**
Dimensioning of a bed		
Bottom length	[m]	18,25
Bottom width	[m]	15,0
Bottom surface of one Bed	[m²]	274
Total bottom surface (5 Beds)	[m²]	**1370**
Average medium height	[m]	0,80
Inlet medium height	[m]	0,75
Outlet medium height	[m]	0,85
Bank slope	[°]	90
Medium porosity (gravel ∅ 5-10 or 8-12 mm)		0,35
Average water level	[m]	0,7
Bottom slope		1 %

Storage tank:

Two new erected storage tank is used for the collection and buffering of treated water. The usage of prefabricated concrete for the tank was intended. The water will be used for irrigation. Inside the storage tank a pump for the distribution of the treated water to the irrigation system was installed.

Volume storage tanks	[m³]	2 x 15

Operation and maintenance requirements

The plants, as any device, will need regular inspection, especially the pre-treatment units and the feeding system of the constructed wetlands No other regular maintenance operation is required.

Once per year the reed can be cut to maintain young and fresh looking plants. In case of failure of any part, this must be remedied. Given the fact that the electro-mechanical equipment and moving parts in general are minimal, failure of equipment can be expected to be rare.

Approximately eight working hours per week will be sufficient to maintain the two plants in good conditions. No input of any materials or chemicals is needed.
It must be expected that the pumps have to be replaced every 10 years approximately.

In order to guarantee the well functioning and keep records of the plant a visit by an expert once a month, combined with a sampling campaign and analysis of inlet and outlet is recommended. The maintenance staff will keep a logbook of the status of the plant and maintenance activities carried out.

Cost

Item	Unit	Qu.	Amount (EUR)
Cost of treatment system			
1. Target Area "School Plant"	Lump Sum	1	18.400,00
2. Target Area "Factory Plant"	Lump Sum	1	61.600,00
Operation and Maintenance water systems			
Treatment plants	year	1	2610,00

Cost – Benefit analysis

Present value (1000 EUR)		
	Investments	80,0
	Reinvestment	21,3
	Operation cost	50,0
	Total cost	151,3
	Total Benefits	409,5
Net Present Value		258,2
Internal Interest Rate		31%
Benefit-Cost Ratio		2,71
Pay-back period (in years)		4
Water price	EUR/m³	0,16

The treatment plants are designed (1. stage) to treat a amount of maximum 170 m³ wastewater per day. The cost – Benefit analysis was calculated on a basis of a lower wastewater production with 140 m³/d.

Ownership

An agreement between the NRC, representing Zer0-M and SEKEM about the implementation of the pilot system, the funding and final ownership by SEKEM was concluded before implementation.

Photo documentation

First Target Area - "School" Plant

Figure 20: View in a chamber of the 3-chamber pre-treatment tank - raw wastewater

Figure 21: Stainless Steel Divisor inside the Splitter Well

Figure 22: Finished, unplanted CW

Figure 23: The Outflow, Treated Wastewater

Figure 24: renovated storage Pond, the treated Water is used for Tree Irrigation

Second Target Area - “Factory” Plant

Figure 25: Division box

Figure 26: Reed bed – unplanted

Figure 27: Storage tanks for the collection of the treated water, pump for feeding the irrigation system

Attachments

Economic study spreadsheet water system

Wastewater Treatment and Reuse for Irrigation of Agricultur Areas

Economical Feasibility Study

Treatment of Wastwater

SEKEM

Item	Unit	Quant.	U.-Price [Eur]	Amount [Eur]
Investment cost including E&M equipment	LS	1	79.957,06	79.957,06
Electro-mecanical equipment	LS	1	2.493,39	2.493,39
O&M cost				
Personnel	h	400,00	1,66	664,00
Repair	LS	79.957,06	0,01	799,57
Power for pumping	kWh	8.350	0,05	417,50
Sludge Removal	p	1,00	727,24	727,24
Total O&M and reinvestment				2.608,31
Water consumption				
Volume of Sewage	m³/d	140	351	49.140
Water benefit		49.140	0,21	10.210,41
Agricultur Income	23 Fdn	1	11.150,97	11.150,97
				21.361,39
Interest rate	5%			

Social Interest Rate		**5%**
Present value (1000 EUR)		
	Investments	**80,0**
	Reinvestment	**21,3**
	Operation cost	**50,0**
	Total cost	**151,3**
	Total Benefits	**409,5**
Net Present Value		**258,2**
Internal Interest Rate		**31%**
Benefit-Cost Ratio		**2,71**
Pay-back period (in years)		**4**
Water price	**EUR/m³**	**0,16**

Year	Yearly income	Payments Invest/Reinve	O&M	Net Benefit	Present value Benefit	Invest/Reinve	O&M	Total Benefit	Cost	Cumulation Benefit	Cost	Net Benefits	Pay-off time
1	21.361,39	79.957,06	2.608,31	-61.203,98	21.361,39	79.957,06	2.608,31	-61.203,98	82.565,37	21.361,39	82.565,37	-61.203,98	0
2	21.361,39		2.608,31	18.753,08	20.344,18	0,00	2.484,10	17.860,08	2.484,10	41.705,57	85.049,47	-43.343,90	0
3	21.361,39		2.608,31	18.753,08	19.375,41	0,00	2.365,81	17.009,60	2.365,81	61.080,98	87.415,28	-26.334,30	0
4	21.361,39		2.608,31	18.753,08	18.452,77	0,00	2.253,15	16.199,62	2.253,15	79.533,75	89.668,44	-10.134,69	0
5	21.361,39		2.608,31	18.753,08	17.574,07	0,00	2.145,86	15.428,21	2.145,86	97.107,81	91.814,30	5.293,52	1
6	21.361,39		2.608,31	18.753,08	16.737,21	0,00	2.043,68	14.693,53	2.043,68	113.845,02	93.857,98	19.987,05	2
7	21.361,39		2.608,31	18.753,08	15.940,20	0,00	1.946,36	13.993,84	1.946,36	129.785,22	95.804,33	33.980,88	3
8	21.361,39		2.608,31	18.753,08	15.181,14	0,00	1.853,68	13.327,46	1.853,68	144.966,36	97.658,01	47.308,35	4
9	21.361,39		2.608,31	18.753,08	14.458,23	0,00	1.765,41	12.692,82	1.765,41	159.424,59	99.423,42	60.001,17	5
10	21.361,39		2.608,31	18.753,08	13.769,74	0,00	1.681,34	12.088,40	1.681,34	173.194,33	101.104,75	72.089,57	6

11	21.361,39	2.493,39	2.608,31	16.259,69	13.114,04	1.530,72	1.601,27	9.982,04	3.132,00	186.308,37	104.236,75	82.071,62	7
12	21.361,39		2.608,31	18.753,08	12.489,56	0,00	1.525,02	10.964,54	1.525,02	198.797,93	105.761,78	93.036,15	8
13	21.361,39		2.608,31	18.753,08	11.894,82	0,00	1.452,40	10.442,42	1.452,40	210.692,75	107.214,18	103.478,57	9
14	21.361,39		2.608,31	18.753,08	11.328,40	0,00	1.383,24	9.945,16	1.383,24	222.021,15	108.597,42	113.423,73	10
15	21.361,39		2.608,31	18.753,08	10.788,95	0,00	1.317,37	9.471,58	1.317,37	232.810,10	109.914,79	122.895,31	11
16	21.361,39		2.608,31	18.753,08	10.275,19	0,00	1.254,64	9.020,55	1.254,64	243.085,30	111.169,43	131.915,86	12
17	21.361,39		2.608,31	18.753,08	9.785,90	0,00	1.194,90	8.591,00	1.194,90	252.871,20	112.364,33	140.506,86	13
18	21.361,39		2.608,31	18.753,08	9.319,90	0,00	1.138,00	8.181,91	1.138,00	262.191,10	113.502,33	148.688,77	14
19	21.361,39		2.608,31	18.753,08	8.876,10	0,00	1.083,81	7.792,29	1.083,81	271.067,20	114.586,13	156.481,06	15
20	21.361,39		2.608,31	18.753,08	8.453,43	0,00	1.032,20	7.421,23	1.032,20	279.520,62	115.618,33	163.902,29	16
21	21.361,39	2.493,39	2.608,31	16.259,69	8.050,88	939,73	983,04	6.128,11	1.922,77	287.571,51	117.541,10	170.030,40	17
22	21.361,39		2.608,31	18.753,08	7.667,51	0,00	936,23	6.731,28	936,23	295.239,01	118.477,34	176.761,68	18
23	21.361,39		2.608,31	18.753,08	7.302,39	0,00	891,65	6.410,74	891,65	302.541,40	119.368,99	183.172,42	19
24	21.361,39		2.608,31	18.753,08	6.954,66	0,00	849,19	6.105,46	849,19	309.496,06	120.218,18	189.277,88	20
25	21.361,39		2.608,31	18.753,08	6.623,48	0,00	808,75	5.814,73	808,75	316.119,54	121.026,93	195.092,61	21
26	21.361,39		2.608,31	18.753,08	6.308,08	0,00	770,24	5.537,84	770,24	322.427,61	121.797,17	200.630,45	22
27	21.361,39		2.608,31	18.753,08	6.007,69	0,00	733,56	5.274,13	733,56	328.435,31	122.530,73	205.904,58	23
28	21.361,39		2.608,31	18.753,08	5.721,61	0,00	698,63	5.022,98	698,63	334.156,92	123.229,36	210.927,56	24
29	21.361,39		2.608,31	18.753,08	5.449,15	0,00	665,36	4.783,79	665,36	339.606,07	123.894,72	215.711,35	25
30	21.361,39		2.608,31	18.753,08	5.189,67	0,00	633,68	4.555,99	633,68	344.795,74	124.528,40	220.267,34	26
31	21.361,39	79.957,06	2.608,31	-61.203,98	4.942,54	18.500,26	603,50	-14.161,22	19.103,76	349.738,29	143.632,17	206.106,12	27
32	21.361,39		2.608,31	18.753,08	4.707,18	0,00	574,77	4.132,42	574,77	354.445,47	144.206,93	210.238,54	28
33	21.361,39		2.608,31	18.753,08	4.483,03	0,00	547,40	3.935,64	547,40	358.928,50	144.754,33	214.174,18	29
34	21.361,39		2.608,31	18.753,08	4.269,55	0,00	521,33	3.748,23	521,33	363.198,06	145.275,66	217.922,40	30
35	21.361,39		2.608,31	18.753,08	4.066,24	0,00	496,50	3.569,74	496,50	367.264,30	145.772,16	221.492,14	31
36	21.361,39		2.608,31	18.753,08	3.872,61	0,00	472,86	3.399,75	472,86	371.136,91	146.245,02	224.891,89	32
37	21.361,39		2.608,31	18.753,08	3.688,20	0,00	450,34	3.237,86	450,34	374.825,12	146.695,37	228.129,75	33
38	21.361,39		2.608,31	18.753,08	3.512,57	0,00	428,90	3.083,67	428,90	378.337,69	147.124,27	231.213,43	34
39	21.361,39		2.608,31	18.753,08	3.345,31	0,00	408,48	2.936,83	408,48	381.683,00	147.532,74	234.150,26	35
40	21.361,39		2.608,31	18.753,08	3.186,01	0,00	389,02	2.796,98	389,02	384.869,01	147.921,76	236.947,24	36
41	21.361,39	2.493,39	2.608,31	16.259,69	3.034,29	354,17	370,50	2.309,62	724,67	387.903,30	148.646,44	239.256,86	37
42	21.361,39		2.608,31	18.753,08	2.889,80	0,00	352,86	2.536,95	352,86	390.793,10	148.999,29	241.793,81	38
43	21.361,39		2.608,31	18.753,08	2.752,19	0,00	336,05	2.416,14	336,05	393.545,30	149.335,35	244.209,95	39
44	21.361,39		2.608,31	18.753,08	2.621,14	0,00	320,05	2.301,09	320,05	396.166,43	149.655,40	246.511,03	40
45	21.361,39		2.608,31	18.753,08	2.496,32	0,00	304,81	2.191,51	304,81	398.662,75	149.960,21	248.702,54	41
46	21.361,39		2.608,31	18.753,08	2.377,45	0,00	290,30	2.087,15	290,30	401.040,20	150.250,50	250.789,70	42
47	21.361,39		2.608,31	18.753,08	2.264,24	0,00	276,47	1.987,76	276,47	403.304,44	150.526,98	252.777,46	43
48	21.361,39		2.608,31	18.753,08	2.156,42	0,00	263,31	1.893,11	263,31	405.460,85	150.790,28	254.670,57	44
49	21.361,39		2.608,31	18.753,08	2.053,73	0,00	250,77	1.802,96	250,77	407.514,58	151.041,05	256.473,53	45
50	21.361,39		2.608,31	18.753,08	1.955,93	0,00	238,83	1.717,11	238,83	409.470,51	151.279,88	258.190,64	46
	1.068.069,43	167.394,27	130.415,40		409.470,51	101.281,95	49.997,93	258.190,64	151.279,88				4
				31%	19,17								

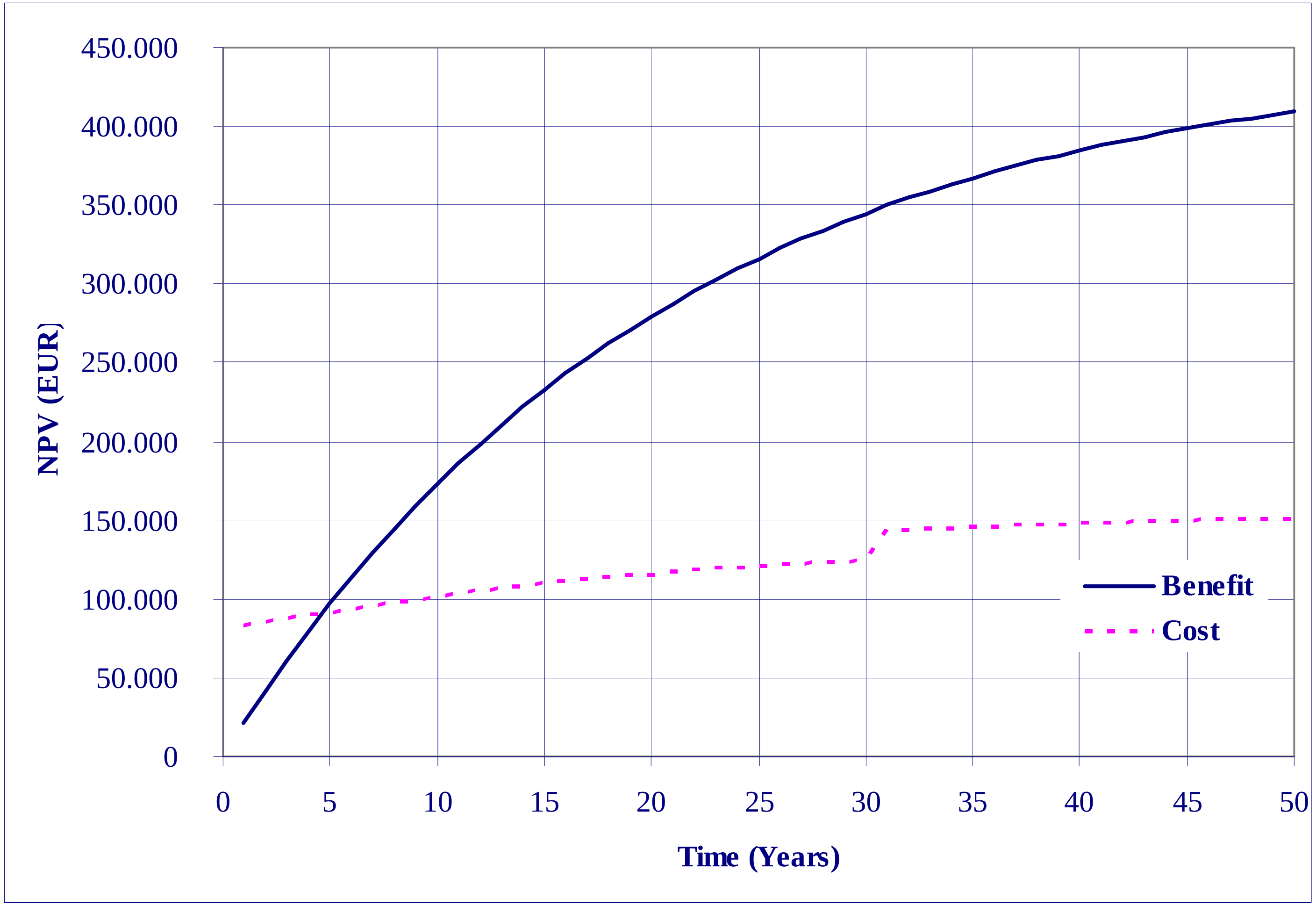


Figure 28: Wastewater treatment system SEKEM, net present value over the life time, break-even after 4 years

B. Morocco, El Attaouia

Introduction

The pilot activity in El Attaouia was a partnership between the project "Sustainable concepts towards a Zero Outflow Municipality (Zer0-M), mainly the Moroccan partner Institut Agronomique et Vétérinaire Hassan II (IAV Hassan II) in Rabat, and the Municipality of El Attaouia. Zer0-M is a project in the Euro-Mediterranean Regional Programme for Local Water Management (MEDA Water programme), funded by the European Commission and the national partners of the project.
The pilot activity was mainly meant as a demonstration of sustainable water management solutions as suggested by Zer0-M, in order to prove that these solutions work under real conditions and ultimately allow the further spreading of the demonstrated techniques. The pilot activity was also meant to help gain experience with the techniques implemented under real conditions and improve them if necessary until they could be recommended for wide use.
Last but not least they intended to ease the difficulties in water and wastewater management faced by the fast growing rural centre of El Attaouia, one town of many in Morocco, in a dry climate with constantly increasing water consumption and very limited financial resources for the supply and sound evacuation of the amounts of water required.

Situation

The small rural town of El Attaouia has a population of 20.000 inhabitants. It is located in the Province of Kelâa des Sraghna whose main activity is agriculture. El Attaouia has conventional sewerage and a connection rate over 80%. Recently, a 1,5 ha treatment plant was constructed for the city to treat an average daily flow of 780 m^3.
Attaouia is growing at a quite important rate. This has its impact also on the existing wastewater treatment plant, designed by the Moroccan project partner, Mr. El Hamouri. An extension of the primary treatment has already been prepared.
As a possible additional measure to both reduce water consumption and the pressure on the wastewater treatment plant segregation, on-site treatment and reuse of greywater would be an option. To demonstrate the feasibility of this concept pilot systems at a large public hammam (one of five) and an apartment house were implemented.

Greywater treatment for a public hammam:

Total water demand	60 m³ per day
Greywater reuse	irrigation of public green areas

Solar water heater for a public hammam:

Average hot water demand	25 m³ per day

Greywater treatment for an apartment house:

Apartments	17
Greywater collection	from all apartments
Greywater reuse	outside and in 4 apartments, corresponding to one vertical feeder line, for toilet flushing

The public hammam of El Attaïsir is used by an average of **400 visitors per day**. Peaks can reach 700 visitors for special events (marriages, religious events etc). Separate men and women sections are open from 6:00 in the morning till about 11 o'clock PM. Energy for space heating and hot water is generated by an improved wood boiler with an average daily consumption of **1-1.2 tons of wood per day**. The cost of firewood is about 500 MAD per ton (1 Euro = 11.3 MAD). A solar water heater was added to the existing boiler in order to save a significant quantity of wood.

The greywater segregation is expected to have a positive effect on the hydraulic load and treatment performance of the wastewater plant. The pilot at the hammam has an immediate effect, whereas for apartments this will only be true if the experience is multiplied. The town was planning to implement more greywater systems in future housing developments if the first experiment showed good results.
For the country as a whole the pilot action demonstrate the following advantages: reduction of water demand, of the national energy bill –which is a major problem facing Morocco's development – and the conservation of forest resources which face over-exploitation as wood is the primary energy source for water heating in hammams.

System Requirements

The pilot plants provide the possibility for safe reuse of greywater in outside uses (landscaping of green areas) and toilet flushing. The systems are operated as decentralised treatment plants by the municipality, i.e. by skilled personnel. The treatment system of the apartment house will have to be multiplied in great number in order to have an impact on the town water management. Therefore it needed to be particularly robust and work safely with little maintenance requirements.
All plants had to have a small footprint. This would have been best achieved by integration into existing open spaces in the urban landscape with as short transport distances as possible.
The solar water heater was integrated into an existing space and water heating unit, substituting part of the fuel wood for water heating with the requirement of not disturbing the space heating function.

System Description

A. Water efficiency

Greywater segregation should not be implemented without attention to water saving measures. The measures implemented comprised

- Water saver fixtures
- Double-flush toilets with the smallest possible cistern volume

It was not possible to inform the inhabitants about possibilities to contribute to efficient water use, e.g. fixing leaks, because no tenants moved into the apartment during the project period for reasons beyond the control of Zer0-M and unrelated to the greywater unit.
The water saver fixtures were installed in the apartment on advise of the project and were discussed with the hammam owner and installed there by him.

B. Greywater collection and distribution system

Hammam

Greywater and blackwater plumbing were separated inside the hammam where necessary (only in the female part, as the systems are already separated in the male part down to an outside manhole). Outside the hammam all greywater is collected in a manhole and pumping chamber, which has an overflow to the public sewer.
From the pumping chamber the water is conveyed via a 2000 m pipeline to the treatment plant in the nearest park, where most of the water is used for landscaping.
The treated water is buffered in a 25 m³ tank before reuse.
A distribution system with outlets at regular intervals for irrigation water in the town was also implemented to make the reuse of the greywater easy.

Apartments

The greywater collection system in the apartment house was installed during erection of the house as the project is already under discussion for some time. Because of communication problems between the implementing actors (company and municipal engineer) and the project the greywater and the rainwater collection system were combined. This is not ideal but could not be modified anymore. Given the long dry period in Attaouia the results of the greywater treatment will still be representative for similar systems run without rainwater.
Due to the combined collection system an overflow weir is implemented at the street level in front of the house, in order to limit the flow to the treatment system. The greywater flows by gravity to the treatment system at some 60 m of the house. The distance between the building and the treatment plant is not ideal but until such systems are taken into consideration at the time of space use planning, the only possibility is to do with what space is available. At the plant site a pump lifts the greywater into the treatment plant.
The treated water is buffered in a 2,5 m³ tank before reuse. From there a second pump sends the water back into the building where it is distributed to the toilets of four apartments connected to one riser.

C. Greywater treatment

The system suggested for El Attaouia is based on a two step constructed wetland successfully tested on greywater of a sports club in Rabat at the TDC of the IAV Hassan II. The treated greywater there is hygienised in a last step with a UV-lamp and than reused for toilet flushing too.
However, the specific bed size, the critical dimension, was increased and a siphon ahead of the second stage install in order to allow true vertical batch feeding. The siphon was developed at the IAV TDC.

Table 32: Comparison of specific load for reed bed at the IAV Hassan II TDC, the Hammam and the apartment house in Attaouia (st. stage, CW constructed wetland, UV ultraviolet disinfection)

	Unit	IAV	Hammam	Apartments
Daily load	m³/d	10	60	4,25
Total area	m²	9,0	160	8,4
Specific load	mm/d	1110	380	506
Trains	#	1	2	1
Treatment system		2 st. CW + UV	2 st. CW	2 st. CW + UV

st Stage
CW Constructed Wetland
UV UV-disinfection

A two stage constructed wetland treats the wastewater to a degree to make it useable for landscaping without further disinfection. The filter beds are made of concrete, the first stage sitting more or less on the ground, the second completely buried. The level difference between the two beds is used to operate the batch feeding system.

Stage one

The first stage constructed wetland consists of a more or less continuously fed horizontal flow coarse filter.

Stage two

The second stage consists of a vertical flow bed filled with fine material with batch feeding. This stage provides the final treatment for the wastewater.

Stage one and two are planted with reed (*phragmites communis*) to enhance the treatment efficiency. The shapes of the beds can be adapted to landscaping requirements in order to integrate them into an overall garden architecture.
To increase operation security the hammam system has two trains in order to be able to switch to one of the two temporarily for maintenance or other activities, which may become necessary.

The apartments system has a screen upstream of the constructed wetland, to prevent coarse material to enter the distribution pipes. A UV lamp is added after the second stage to guarantee hygienisation of the wastewater before reuse in the households. This measure is not deemed necessary for landscaping purposes.

The design was intended to comply with the following values:

TSS	< 10mg/l
Turbidity	< 2 NTU
COD	< 25 mg/l
BOD_5	< 10 mg/l
TKN	< 10 mg/l
TP	< 1 mg/l
FC (apartments)	0 U/100 ml

The water thus produced has bathing water quality. It is free of solids, has a very low turbidity, a clear colour and is perfectly suitable for irrigation or landscaping. With the UV disinfection added, in-house uses, e.g. toilet flushing or laundry washing, can be recommended.
The water is not treated to drinking water quality and should not be used as potable water!
The greywater being only slightly polluted any disturbance by bad odours even by the raw wastewater can be excluded. Due to the aerobic degradation processes the plant itself produces no bad odours.

D. Solar water heater at the hammam

The solar system implemented at the hammam is of dynamic type (see principle in figure 31). The most important element of such systems is that the solar collector arrays placed on the roof are associated to a pump-based water circulation. The installed capacity should provide at least **50%** of the energy for hot water generation, which would allow to save about **200 tons of firewood** per year. An initial estimate has yielded a collector area of **375 m²**.

The attached drawing shows the PID of the solar system as “integrated” in the existing hot water installations. Further analysis will allow the optimization of other components such as the hot water storage, the control strategy and the series/parallel combination of the solar collectors.

A simulation of various load situations has allowed to optimise the system both for energy and cost efficiency. A 300 m² solar collector and a solar preheating tank of 25 m³ will be chosen to supply approximately 80 % of the energy needed. See also the attached variant calculations.

E. Operation and maintenance requirements

The plants, as any device, will need regular inspection, especially of the screen, the feeding system of the constructed wetlands and the disinfection device. The screen of the apartment plant will have to be cleaned if necessary. No other regular maintenance operation is required.

Once or twice a year the reed can be cut to maintain young and fresh looking plants.
In case of failure of any part, this must be remedied. Given the fact that the electromechanical equipment and moving parts in general are minimal, failure of equipment can be expected to be rare.

In total about two working hours per week will be sufficient to maintain the two plants in good conditions. No input of any materials or chemicals is needed.
It must be expected that the pumps have to be replaced every 10 years approximately. The flexible pipes of the siphon may need replacement after a shorter time. No long-term experience is yet available with these pipes. In France similar devices are changed every year regardless of their condition.

In order to guarantee the well functioning and keep records of the plant a visit by an expert once a month, combined with a sampling campaign and analysis of inlet and outlet is recommended. The maintenance staff will keep a logbook of the status of the plant and maintenance activities carried out.

Cost

Item	Unit	Qu.	Amount (EUR)
Cost of treatment system			
Hammam greywater	Lump Sum	1	97.500,00
Hammam solar water heater	Lump Sum	1	127.000,00
Apartments	Lump Sum	1	21.000,00
Operation and Maintenance water systems			
Hammam greywater	year	1	7.750,00
Apartments	year	1	1410,00

Cost – Benefit analysis hammam greywater system

Present value (1000 EUR)

Investments	97,5
Reinvestment	38,6
Operation cost	148,5
Total cost	284,7
Total Benefits	645,9

Net Present Value		261,7
Internal Interest Rate		32%
Benefit-Cost Ratio		2,77
Pay-back period (in years)		4
Water price	EUR/m³	0,85

Cost – Benefit analysis apartment greywater system

Present value (1000 EUR)		
	Investments	21,0
	Reinvestment	12,3
	Operation cost	27,0
	Total cost	60,3
	Total Benefits	12,5
Net Present Value		261,7
Internal Interest Rate		32%
Benefit-Cost Ratio		2,77
Pay-back period (in years)		4
Water price	EUR/m³	2,03

Ownership

For the greywater treatment plant of the hammam an agreement between the IAV, representing Zer0-M and the municipality of El Attaouia about the implementation of the pilot system, the funding, final ownership and operation of the greywater system by the municipality was concluded before implementation.
Concerning the solar heater an agreement with the owners of the hammam was concluded.

For the apartments an agreement between the IAV, representing Zer0-M and the municipality of El Attaouia about the implementation of the pilot system, the funding, final ownership and operation of the greywater system by the municipality was concluded before implementation.

Photo documentation

Figure 29: Greywater constructed wetland at IAV

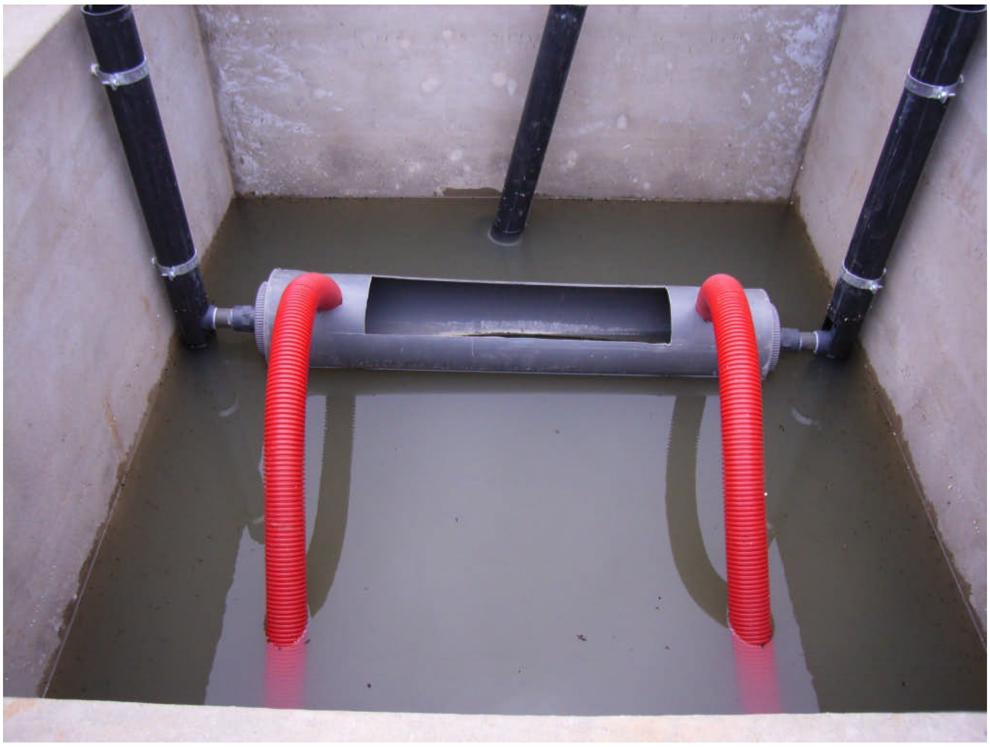


Figure 30: Batch feeding siphon developed at IAV.

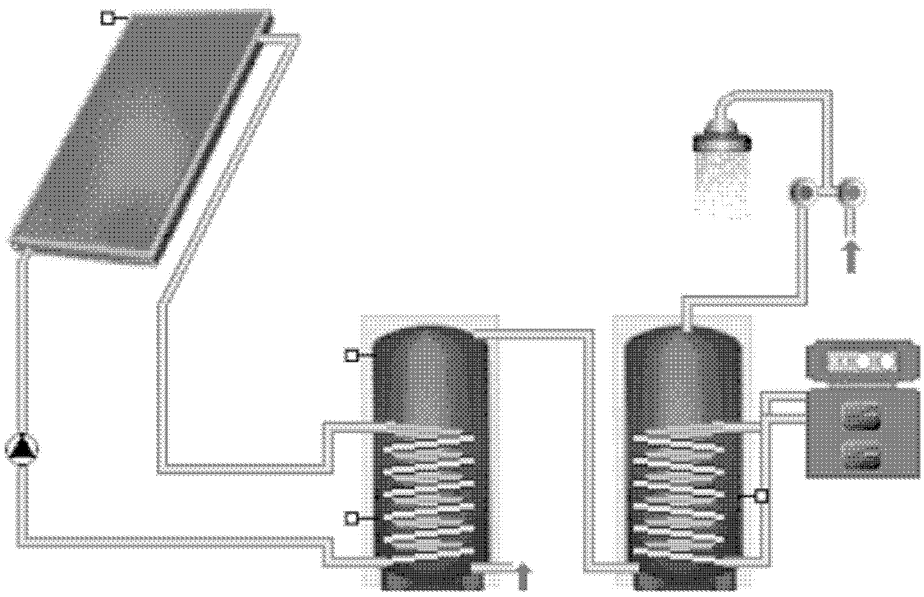


Figure 31: Sketch of a dynamic solar water heating system.

Figure 32: Greywater system, constructed wetland and treated water.

Figure 33: Solar water heater, one of the arrays with a total of 375 m².

Figure 34: Greywater system of the apartment house.

Attachments

Economic study spreadsheet hammam

Economic study spreadsheet apartments

Grey/Black Water Segregation
In a Hammam

Economical Feasibility Study

Recyclig of Treated Greywater of the Hammam in Parcs of
EL ATTAOUIA

Item	Unit	Quant.	U.-Price [Eur	Amount [Eur]
Investment cost including E&M equipment	LS	1	97.500,00	97.500,00
Electro-mecanical equipment	LS	1	14.200,00	14.200,00
O&M cost				
Personnel	h	400,00	3,51	1.404,00
Repair	LS	97.500,00	0,05	4.875,00
Power for pumping	kWh	11.300	0,13	1.469,00
UV-lamps	p	0,00	50,00	0,00
Total O&M and reinvestment				7.748,00
Benefit				
Average yearly "greywater" consumption, i.e.	m³/d	50	351	17.550
Water benefit, at mains rate		17.550	0,96	16.848,00
Wastewater benefit, at national rate		17.550	0,96	16.848,00
				33.696,00
Interest rate	5%			

Social Interest Rate		**5%**
Present value (1000 EUR)		
	Investments	**97,5**
	Reinvestment	**38,6**
	Operation cost	**148,5**
	Total cost	**284,7**
	Total Benefits	**645,9**
Net Present Value		**361,2**
Internal Interest Rate		**36%**
Benefit-Cost Ratio		**2,27**
Pay-back period (in years)		**4**
Water price	**EUR/m³**	**0,85**

Year	Yearly income	Payments			Present value			Total		Cumulation			Pay-off time
		Invest/Reinve	O&M	Net Benefit	Benefit	Invest/Reinve	O&M	Net Benefit	Cost	Benefit	Cost	Net Benefits	
1	33.696,00	97.500,00	7.748,00	-71.552,00	33.696,00	97.500,00	7.748,00	-71.552,00	105.248,00	33.696,00	105.248,00	-71.552,00	0
2	33.696,00		7.748,00	25.948,00	32.091,43	0,00	7.379,05	24.712,38	7.379,05	65.787,43	112.627,05	-46.839,62	0
3	33.696,00		7.748,00	25.948,00	30.563,27	0,00	7.027,66	23.535,60	7.027,66	96.350,69	119.654,71	-23.304,02	0
4	33.696,00		7.748,00	25.948,00	29.107,87	0,00	6.693,01	22.414,86	6.693,01	125.458,57	126.347,73	-889,16	0
5	33.696,00		7.748,00	25.948,00	27.721,78	0,00	6.374,30	21.347,48	6.374,30	153.180,35	132.722,02	20.458,32	1
6	33.696,00		7.748,00	25.948,00	26.401,70	0,00	6.070,76	20.330,94	6.070,76	179.582,05	138.792,79	40.789,26	2
7	33.696,00		7.748,00	25.948,00	25.144,47	0,00	5.781,68	19.362,80	5.781,68	204.726,52	144.574,46	60.152,06	3
8	33.696,00		7.748,00	25.948,00	23.947,12	0,00	5.506,36	18.440,76	5.506,36	228.673,64	150.080,82	78.592,82	4
9	33.696,00		7.748,00	25.948,00	22.806,78	0,00	5.244,15	17.562,63	5.244,15	251.480,42	155.324,97	96.155,44	5
10	33.696,00		7.748,00	25.948,00	21.720,74	0,00	4.994,43	16.726,31	4.994,43	273.201,16	160.319,40	112.881,76	6

11	33.696,00	14.200,00	7.748,00	11.748,00	20.686,42	8.717,57	4.756,60	7.212,25	13.474,17	293.887,58	173.793,57	120.094,01	7
12	33.696,00		7.748,00	25.948,00	19.701,35	0,00	4.530,10	15.171,26	4.530,10	313.588,93	178.323,67	135.265,27	8
13	33.696,00		7.748,00	25.948,00	18.763,19	0,00	4.314,38	14.448,82	4.314,38	332.352,13	182.638,04	149.714,09	9
14	33.696,00		7.748,00	25.948,00	17.869,71	0,00	4.108,93	13.760,78	4.108,93	350.221,84	186.746,97	163.474,86	10
15	33.696,00		7.748,00	25.948,00	17.018,77	0,00	3.913,27	13.105,50	3.913,27	367.240,61	190.660,24	176.580,37	11
16	33.696,00		7.748,00	25.948,00	16.208,35	0,00	3.726,92	12.481,43	3.726,92	383.448,96	194.387,16	189.061,80	12
17	33.696,00		7.748,00	25.948,00	15.436,53	0,00	3.549,45	11.887,08	3.549,45	398.885,48	197.936,61	200.948,88	13
18	33.696,00		7.748,00	25.948,00	14.701,45	0,00	3.380,43	11.321,03	3.380,43	413.586,94	201.317,03	212.269,90	14
19	33.696,00		7.748,00	25.948,00	14.001,38	0,00	3.219,45	10.781,93	3.219,45	427.588,32	204.536,49	223.051,83	15
20	33.696,00		7.748,00	25.948,00	13.334,65	0,00	3.066,15	10.268,50	3.066,15	440.922,97	207.602,63	233.320,34	16
21	33.696,00	14.200,00	7.748,00	11.748,00	12.699,67	5.351,83	2.920,14	4.427,70	8.271,97	453.622,64	215.874,60	237.748,04	17
22	33.696,00		7.748,00	25.948,00	12.094,92	0,00	2.781,09	9.313,84	2.781,09	465.717,56	218.655,69	247.061,87	18
23	33.696,00		7.748,00	25.948,00	11.518,97	0,00	2.648,65	8.870,32	2.648,65	477.236,53	221.304,34	255.932,19	19
24	33.696,00		7.748,00	25.948,00	10.970,45	0,00	2.522,53	8.447,92	2.522,53	488.206,99	223.826,87	264.380,12	20
25	33.696,00		7.748,00	25.948,00	10.448,05	0,00	2.402,41	8.045,64	2.402,41	498.655,03	226.229,28	272.425,76	21
26	33.696,00		7.748,00	25.948,00	9.950,52	0,00	2.288,01	7.662,52	2.288,01	508.605,56	228.517,28	280.088,27	22
27	33.696,00		7.748,00	25.948,00	9.476,69	0,00	2.179,05	7.297,63	2.179,05	518.082,24	230.696,33	287.385,91	23
28	33.696,00		7.748,00	25.948,00	9.025,42	0,00	2.075,29	6.950,13	2.075,29	527.107,66	232.771,62	294.336,04	24
29	33.696,00		7.748,00	25.948,00	8.595,64	0,00	1.976,47	6.619,17	1.976,47	535.703,30	234.748,09	300.955,21	25
30	33.696,00		7.748,00	25.948,00	8.186,32	0,00	1.882,35	6.303,97	1.882,35	543.889,62	236.630,44	307.259,18	26
31	33.696,00	97.500,00	7.748,00	-71.552,00	7.796,49	22.559,30	1.792,71	-16.555,52	24.352,01	551.686,11	260.982,45	290.703,66	27
32	33.696,00		7.748,00	25.948,00	7.425,23	0,00	1.707,35	5.717,89	1.707,35	559.111,34	262.689,80	296.421,55	28
33	33.696,00		7.748,00	25.948,00	7.071,65	0,00	1.626,04	5.445,61	1.626,04	566.182,99	264.315,84	301.867,15	29
34	33.696,00		7.748,00	25.948,00	6.734,91	0,00	1.548,61	5.186,29	1.548,61	572.917,90	265.864,45	307.053,45	30
35	33.696,00		7.748,00	25.948,00	6.414,20	0,00	1.474,87	4.939,33	1.474,87	579.332,09	267.339,32	311.992,77	31
36	33.696,00		7.748,00	25.948,00	6.108,76	0,00	1.404,64	4.704,12	1.404,64	585.440,85	268.743,96	316.696,89	32
37	33.696,00		7.748,00	25.948,00	5.817,86	0,00	1.337,75	4.480,11	1.337,75	591.258,72	270.081,71	321.177,01	33
38	33.696,00		7.748,00	25.948,00	5.540,82	0,00	1.274,05	4.266,78	1.274,05	596.799,54	271.355,75	325.443,78	34
39	33.696,00		7.748,00	25.948,00	5.276,97	0,00	1.213,38	4.063,60	1.213,38	602.076,51	272.569,13	329.507,38	35
40	33.696,00		7.748,00	25.948,00	5.025,69	0,00	1.155,60	3.870,09	1.155,60	607.102,20	273.724,73	333.377,47	36
41	33.696,00	14.200,00	7.748,00	11.748,00	4.786,37	2.017,05	1.100,57	1.668,75	3.117,62	611.888,57	276.842,35	335.046,22	37
42	33.696,00		7.748,00	25.948,00	4.558,45	0,00	1.048,16	3.510,29	1.048,16	616.447,02	277.890,51	338.556,51	38
43	33.696,00		7.748,00	25.948,00	4.341,38	0,00	998,25	3.343,13	998,25	620.788,40	278.888,76	341.899,64	39
44	33.696,00		7.748,00	25.948,00	4.134,65	0,00	950,71	3.183,93	950,71	624.923,05	279.839,47	345.083,58	40
45	33.696,00		7.748,00	25.948,00	3.937,76	0,00	905,44	3.032,32	905,44	628.860,81	280.744,92	348.115,89	41
46	33.696,00		7.748,00	25.948,00	3.750,25	0,00	862,33	2.887,92	862,33	632.611,06	281.607,24	351.003,81	42
47	33.696,00		7.748,00	25.948,00	3.571,66	0,00	821,26	2.750,40	821,26	636.182,72	282.428,50	353.754,22	43
48	33.696,00		7.748,00	25.948,00	3.401,58	0,00	782,15	2.619,43	782,15	639.584,31	283.210,66	356.373,65	44
49	33.696,00		7.748,00	25.948,00	3.239,60	0,00	744,91	2.494,70	744,91	642.823,91	283.955,57	358.868,34	45
50	33.696,00		7.748,00	25.948,00	3.085,34	0,00	709,44	2.375,90	709,44	645.909,25	284.665,00	361.244,24	46
	1.684.800,00	237.600,00	387.400,00		645.909,25	136.145,75	148.519,26	361.244,24	284.665,00				4
				36%	19,17								

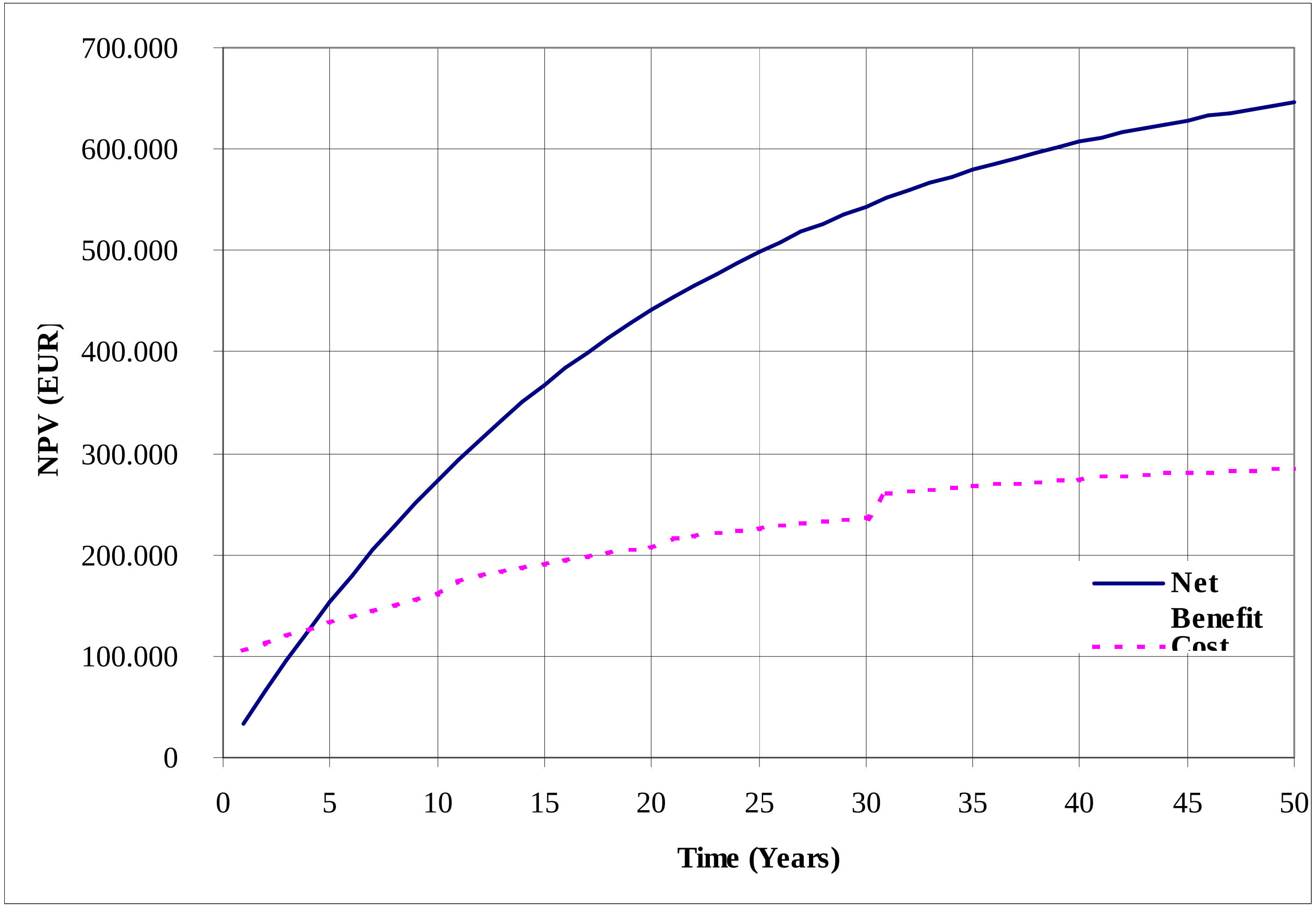


Figure 35: Greywater system hammam, net present value over the life time, break-even after 4 years

Grey/Black Water Segregation
In a Hammam

Economical Feasibility Study

Recyclig of Treated Greywater of the Hammam in Parcs of
EL ATTAOUIA

Item	Unit	Quant.	U.-Price [Eur]	Amount [Eur]
Investment cost including E&M equipment	LS	1	21.000,00	21.000,00
Electro-mecanical equipment	LS	1	6.600,00	6.600,00
O&M cost				
Personnel	h	200,00	3,51	702,00
Repair	LS	21.000,00	0,02	420,00
Power for pumping	kWh	650	0,13	84,50
UV-lamps	p	4,00	50,00	200,00
Total O&M and reinvestment				1.406,50
Water consumption				
Average yearly "greywater" consumption, i.e.	m³/d	4,25	365	1.551
Water benefit, at mains rate		1.551	0,21	326
Wastewater benefit		1.551	0,21	326
				651,53
Interest rate	5%			

Social Interest Rate		**5%**
Present value (1000 EUR)		
	Investments	**21,0**
	Reinvestment	**12,3**
	Operation cost	**27,0**
	Total cost	**60,3**
	Total Benefits	**12,5**
Net Present Value		**-47,8**
Internal Interest Rate		**Net loss**
Benefit-Cost Ratio		**0,21**
Pay-back period (in years)		**No break-even**
Water price	**EUR/m³**	**2,03**

Year	Yearly income	Payments			Present value			Total		Cumulation			Pay-off time
		Invest/Reinve	O&M	Net Benefit	Benefit	Invest/Reinve	O&M	Benefit	Cost	Benefit	Cost	Net Benefits	
1	651,53	21.000,00	1.406,50	-21.754,98	651,53	21.000,00	1.406,50	-21.754,98	22.406,50	651,53	22.406,50	-21.754,98	0
2	651,53		1.406,50	-754,98	620,50	0,00	1.339,52	-719,02	1.339,52	1.272,03	23.746,02	-22.474,00	0
3	651,53		1.406,50	-754,98	590,95	0,00	1.275,74	-684,78	1.275,74	1.862,98	25.021,76	-23.158,78	0
4	651,53		1.406,50	-754,98	562,81	0,00	1.214,99	-652,18	1.214,99	2.425,79	26.236,75	-23.810,96	0
5	651,53		1.406,50	-754,98	536,01	0,00	1.157,13	-621,12	1.157,13	2.961,80	27.393,88	-24.432,08	0
6	651,53		1.406,50	-754,98	510,49	0,00	1.102,03	-591,54	1.102,03	3.472,29	28.495,91	-25.023,62	0
7	651,53		1.406,50	-754,98	486,18	0,00	1.049,55	-563,37	1.049,55	3.958,47	29.545,46	-25.587,00	0
8	651,53		1.406,50	-754,98	463,03	0,00	999,57	-536,55	999,57	4.421,49	30.545,03	-26.123,54	0
9	651,53		1.406,50	-754,98	440,98	0,00	951,97	-511,00	951,97	4.862,47	31.497,01	-26.634,54	0
10	651,53		1.406,50	-754,98	419,98	0,00	906,64	-486,66	906,64	5.282,45	32.403,65	-27.121,20	0

11	651,53	6.600,00	1.406,50	-7.354,98	399,98	4.051,83	863,47	-4.515,32	4.915,30	5.682,43	37.318,95	-31.636,52	0
12	651,53		1.406,50	-754,98	380,93	0,00	822,35	-441,42	822,35	6.063,36	38.141,30	-32.077,94	0
13	651,53		1.406,50	-754,98	362,79	0,00	783,19	-420,40	783,19	6.426,16	38.924,49	-32.498,34	0
14	651,53		1.406,50	-754,98	345,52	0,00	745,90	-400,38	745,90	6.771,67	39.670,39	-32.898,72	0
15	651,53		1.406,50	-754,98	329,06	0,00	710,38	-381,31	710,38	7.100,74	40.380,77	-33.280,03	0
16	651,53		1.406,50	-754,98	313,39	0,00	676,55	-363,16	676,55	7.414,13	41.057,32	-33.643,18	0
17	651,53		1.406,50	-754,98	298,47	0,00	644,33	-345,86	644,33	7.712,60	41.701,65	-33.989,05	0
18	651,53		1.406,50	-754,98	284,26	0,00	613,65	-329,39	613,65	7.996,86	42.315,30	-34.318,44	0
19	651,53		1.406,50	-754,98	270,72	0,00	584,43	-313,71	584,43	8.267,58	42.899,73	-34.632,15	0
20	651,53		1.406,50	-754,98	257,83	0,00	556,60	-298,77	556,60	8.525,41	43.456,33	-34.930,92	0
21	651,53	6.600,00	1.406,50	-7.354,98	245,55	2.487,47	530,10	-2.772,01	3.017,57	8.770,97	46.473,90	-37.702,93	0
22	651,53		1.406,50	-754,98	233,86	0,00	504,85	-270,99	504,85	9.004,83	46.978,75	-37.973,92	0
23	651,53		1.406,50	-754,98	222,72	0,00	480,81	-258,09	480,81	9.227,55	47.459,56	-38.232,01	0
24	651,53		1.406,50	-754,98	212,12	0,00	457,92	-245,80	457,92	9.439,67	47.917,48	-38.477,81	0
25	651,53		1.406,50	-754,98	202,02	0,00	436,11	-234,09	436,11	9.641,69	48.353,59	-38.711,90	0
26	651,53		1.406,50	-754,98	192,40	0,00	415,34	-222,95	415,34	9.834,08	48.768,93	-38.934,85	0
27	651,53		1.406,50	-754,98	183,24	0,00	395,57	-212,33	395,57	10.017,32	49.164,50	-39.147,18	0
28	651,53		1.406,50	-754,98	174,51	0,00	376,73	-202,22	376,73	10.191,83	49.541,22	-39.349,40	0
29	651,53		1.406,50	-754,98	166,20	0,00	358,79	-192,59	358,79	10.358,03	49.900,01	-39.541,99	0
30	651,53		1.406,50	-754,98	158,29	0,00	341,70	-183,42	341,70	10.516,31	50.241,72	-39.725,41	0
31	651,53	21.000,00	1.406,50	-21.754,98	150,75	4.858,93	325,43	-5.033,61	5.184,36	10.667,06	55.426,08	-44.759,02	0
32	651,53		1.406,50	-754,98	143,57	0,00	309,94	-166,37	309,94	10.810,63	55.736,01	-44.925,38	0
33	651,53		1.406,50	-754,98	136,73	0,00	295,18	-158,44	295,18	10.947,36	56.031,19	-45.083,83	0
34	651,53		1.406,50	-754,98	130,22	0,00	281,12	-150,90	281,12	11.077,59	56.312,31	-45.234,72	0
35	651,53		1.406,50	-754,98	124,02	0,00	267,73	-143,71	267,73	11.201,61	56.580,04	-45.378,44	0
36	651,53		1.406,50	-754,98	118,12	0,00	254,98	-136,87	254,98	11.319,72	56.835,03	-45.515,31	0
37	651,53		1.406,50	-754,98	112,49	0,00	242,84	-130,35	242,84	11.432,21	57.077,87	-45.645,66	0
38	651,53		1.406,50	-754,98	107,13	0,00	231,28	-124,14	231,28	11.539,35	57.309,15	-45.769,80	0
39	651,53		1.406,50	-754,98	102,03	0,00	220,27	-118,23	220,27	11.641,38	57.529,42	-45.888,04	0
40	651,53		1.406,50	-754,98	97,17	0,00	209,78	-112,60	209,78	11.738,55	57.739,19	-46.000,64	0
41	651,53	6.600,00	1.406,50	-7.354,98	92,55	937,50	199,79	-1.044,74	1.137,29	11.831,10	58.876,48	-47.045,38	0
42	651,53		1.406,50	-754,98	88,14	0,00	190,27	-102,13	190,27	11.919,24	59.066,75	-47.147,52	0
43	651,53		1.406,50	-754,98	83,94	0,00	181,21	-97,27	181,21	12.003,18	59.247,97	-47.244,79	0
44	651,53		1.406,50	-754,98	79,94	0,00	172,58	-92,64	172,58	12.083,13	59.420,55	-47.337,43	0
45	651,53		1.406,50	-754,98	76,14	0,00	164,37	-88,23	164,37	12.159,26	59.584,92	-47.425,65	0
46	651,53		1.406,50	-754,98	72,51	0,00	156,54	-84,03	156,54	12.231,78	59.741,46	-47.509,68	0
47	651,53		1.406,50	-754,98	69,06	0,00	149,08	-80,02	149,08	12.300,84	59.890,54	-47.589,70	0
48	651,53		1.406,50	-754,98	65,77	0,00	141,99	-76,21	141,99	12.366,61	60.032,52	-47.665,92	0
49	651,53		1.406,50	-754,98	62,64	0,00	135,22	-72,58	135,22	12.429,25	60.167,75	-47.738,50	0
50	651,53		1.406,50	-754,98	59,66	0,00	128,78	-69,13	128,78	12.488,90	60.296,53	-47.807,63	0
	32.576,25	61.800,00	70.325,00		12.488,90	33.335,73	26.960,81	-47.807,63	60.296,53				No break-even
				#DIV/0!	19,17								

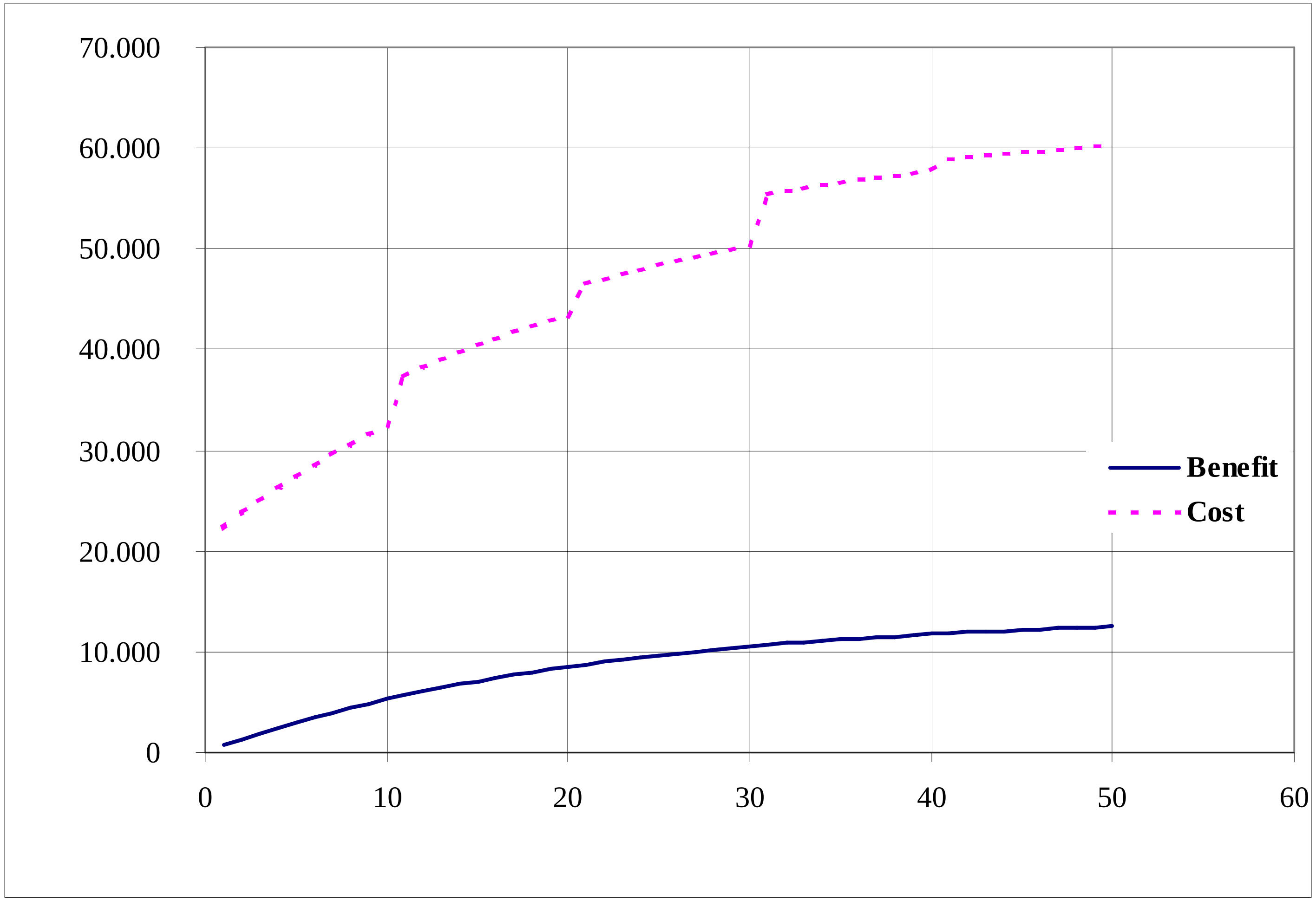


Figure 36: Greywater system apartments, net present value over the life time, no break-even to be reached.

C. Tunisia, Chorfech 24

Introduction

The pilot plant planned in Chorfech (Tunisia) is a partnership between the project "Sustainable Concepts Towards a Zero Outflow Municipality (Zer0-M), mainly the Tunisian partner Centre de Recherches et des Technologies des Eaux (ex. INRST, LEE), and the Office National d'Assainissement (ONAS). Zer0-M is a project in the Euro-Mediterranean Regional Programme for Local Water Management (MEDA Water programme), funded by the European Commission and the national partners of the project.

The pilot activity was mainly meant as a demonstration of sustainable water management solutions as suggested by Zer0-M (low-cost wastewater treatment), in order to prove that these solutions work under real conditions and ultimately allow the further spreading of the demonstrated techniques. The pilot activity was also meant to help gain experience with the techniques implemented under real conditions and improve them if necessary until they could be recommended for wide application in rural settlements in Tunisia.

Last but not least they intended to ease the difficulties in water and wastewater management faced by the growing community of Chorfech, a rural settlement in semi-arid climate with constantly increasing water consumption and very limited financial resources for water supply and sanitation services.

Chorfech is a rural settlement of about 50 houses counting 345 inhabitants (see figure 37). It is located in the Northwest of Tunis about 24 Km (national road GP8) between Tunis and Bizerte.

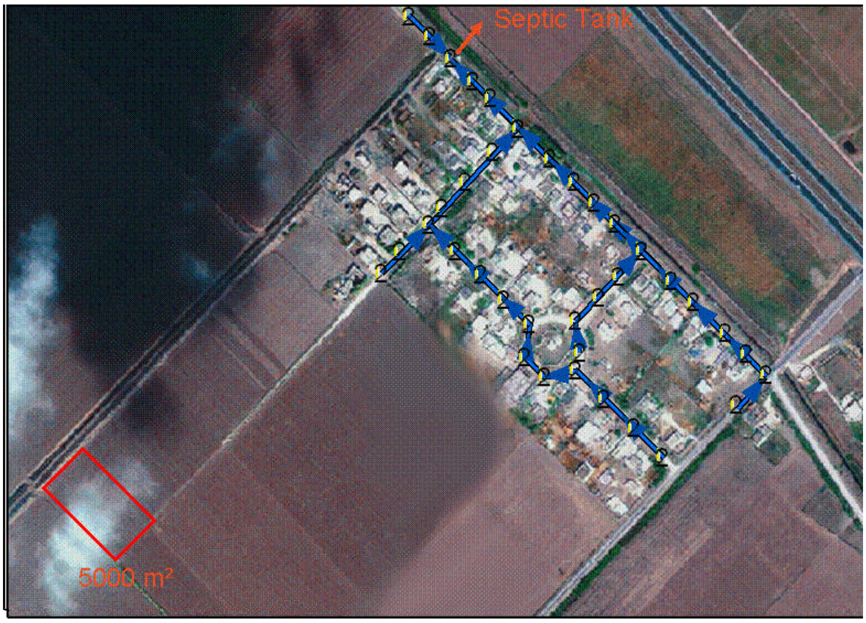


Figure 37: Overview of Chorfech settlement, sewerage network and pilot plant site (Google Maps)

The main activity at Chorfech is agriculture. The village has a conventional sewerage network linked to a septic tank. The diagnosis of the network, carried out by ONAS in spring 2007, showed some problems:

- problem of slope and quality of connections,
- rainwater infiltration into the sewerage network,
- isolated houses not connected to the network,
- grey water collected separately and discharged directly out of the houses

(1) (2) (3)

Figure 38: Manhole of network (1), evacuation of individual grey water (2) and drainage channel (3).

There are a total of 49 connecting points to the sewerage network and the last collector discharged the raw wastewater into a septic tank before it went into a drainage channel.

The pilot plant provides the possibility for safe reuse of the treated wastewater, and the systems is operated as demonstration and a good example for rural settlements in Tunisia with low operation costs.

Planning phase

The Zer0-M project suggested the design described below for a pilot wastewater treatment plant as a solution for an efficient wastewater treatment.

The plant was meant to increase the available water for agricultural purposes and at the same time solve the problem of uncontrolled wastewater discharge into the adjacent drainage channel. A "sludge treatment constructed wetland" for treating and composting the primary sludge accumulated in the Imhoff tank allows the reuse of the organic matter and part of the nutrients as soil conditioner and fertiliser on agricultural land.

It was necessary to design a robust system, as "simple" and "low-tech" as possible, even though a very high water quality at the discharge point was requested by the stringent national regulation for release of treated wastewater into water bodies, which was unavoidable at least during certain periods of the year.

Four alternatives were developed and discussed with the water authorities and the future owner, ONAS. They are shortly described and compared in table 33.

Table 33: Four alternatives for the treatment of the Chorfech wastewater.

	Treatment	**Remark 1**	**Remark 2**	**Pressure on Sinks**	**Invest-ment Cost (€)**	**O&M Cost (€)**
1	Septic tank + horizontal CW	Elimination of nitrogen insufficient for Tunisian Standards for wastewater reuse NT 106.02	Need energy for denitrification	COD (g/d): 1221 N (g/d): 1300 P (g/d): 196	93.000,00	1500,00
2	Imhoff tank + hybrid CW: HF, VF, and HF	Raising of the first CW by 1,5m is necessary. H + V during wastewater reuse.	No problem for feeding of pilot plant but needs to manage the site Area: about 1800m^2; evapo-transpiration loses the waters.	COD (g/d): 740 N (g/d): 270 P (g/d): 164	176.000,00	2000,00
3	Horizontal CW + Storage of treated wastewater	Storage in winter for summer reuse	Problem of mosquitoes and algae and water pollution	COD (g/d): 0 N (g/d): 0 P (g/d): 0	111.000,00	2300,00
4	Imhoff tank + HF+VF CW + free water system	Use the draining channel for free water system after improvement of circulation in the channel (course, gravel, dam….); self-purification : elimination of diffuse pollution	Risk the pollution of the groundwater and to disturb the hydraulic equilibrium Necessity to know the quality of water in the channel	COD (g/d): 23 N (g/d): 10 P (g/d): 158	90.000,00	1900,00

Figure 39: Participatory planning process, discussions with all the stakeholders, the utilities, the users, the authorities

The Alternative "O2" was chosen after a comparison of the 4 different options. The main arguments for this choice were:

- The alternative is the only one fully complying with the present Tunisian regulations for release of wastewater into the environment
- It uses standard components, compared to Alternative 04, which would take advantage of a semi-natural water body for treatment
- Irrigation is only possible during part of the year; storage of the remaining water volume after treatment in a one stage constructed wetland is rejected as there have been bad experiences with wastewater ponds in Tunisia
- Thus release of part of the wastewater into the surface water is unavoidable.

Table 34: Elements of the suggested design for the pilot treatment plant

Part	Part No.
- Pumping well at the end of the existing sewer	B101
- Inlet well	B102
- Imhoff tank	B103
- Partition well (2-ways) + by-pass valves to 2nd stage or 3rd stage	B104
- 1st stage HF CW	B105
- Outlet well + By-pass valves to 3rd stage	B106
- Partition well (2-ways)	B107
- Siphons wells	B108
- 2nd stage VF CW	B109
- Outlet well + by-pass valves to Discharge in the Channel or to Storage Tank for reuse in agriculture	B110

Part	Part No.
- 3^{rd} stage HF CW	B111
- Outlet well → Discharge in the Channel	B112
- Sludge emptying well (with pump)	B113
- Sludge treatment constructed wetland (drying/composting)	B114

The works at the plant included civil works, electro-mechanical works and supplies (piping system, pumps, valves).

Dimensioning Criteria

- Design Horizon: 2021
- 500 inhabitants (presently 345 inhabitants), 50 l/(cap.d) (25 m^3/d).

The present wastewater production in the target area is about 17 m^3 per day.

<u>Actual design flow rate:</u>

Daily wastewater production	17,25	m^3/d
Unused capacity (actual) - security factor	7,75	m^3/d
Actual design flow rate	**25**	**m^3/d**

The outlet water quality (treated wastewater) was requested to comply with the following values (Tunisian Standards for wastewater reuse NT 106.03):

pH	6.5 to 8.5
TSS	< 30mg/l
Turbidity	< 2 NTU
COD	< 90 mg/l
BOD_5	< 30 mg/l
Nematodes eggs	< 1 / 1 l

There is no limitation for the nitrogen in the case of reuse for irrigation.

If there is no reuse, the outlet quality for treated wastewater to be discharged into the aquatic environment must be satisfied (Tunisian Standards for Wastewater Discharge NT 106.02):

Physical and chemical	
pH	6.5 to <8.5
Colour	70 mg/l Platinum scale
TSS	30 mg/l
BOD_5	30 mg O2/l
COD	90 mg/l
Nitrogen (N-NH_4 and organic)	1 mg/l
NO_3	50 mg/l
NO_2	0,5 mg/l
Bacteria	

FC	2000 FC / 100ml
FS	1000 FS / 100ml
Salmonella	Absence / 5000 ml
Cholera (vibrion)	Absence / 5000 ml

The CW treatment system will produce an effluent with the following quality:

TSS	< 15 mg/l
BOD_5	< 20 mg O_2/l
COD	< 50 mg/l
Nitrogen (N-NH_4 and organic)	< 1 mg/l
NO_3	< 40 mg/l
NO_2	< 0,5 mg/l
Bacteria	
FC	< 2000 FC / 100ml
FS	< 1000 FS / 100ml
Salmonella	Absence / 5000 ml
Cholera (vibrion)	Absence / 5000 ml

Treatment system

The wastewater treatment consists of one Imhoff tank for pre-treatment, especially desludging and three stages of constructed wetlands:

- a first, horizontal flow stage, for carbon removal
- a second vertical flow stage, for nitrification
- a third horizontal flow stage, for denitrification in case of release of the wastewater into the aquatic environment.

For optimal and accurate distribution of the water the feeder pipes must not exceed a certain length. Thus the total area was divided in two in the first stage, and four in the second and third stage, which gave the possibility to operate two parallel trains. This in turn guarantees the permanent functioning of the plant. At every stage the total flow can be temporarily directed onto one train if necessary. Every stage can also be totally short-cut. After the second stage, i.e. before denitrification or removal of the nitrogen contained in wastewater, the treated effluent can be directed to a storage tank from where it can be taken for reuse.

The sludge settling in the Imhoff tank is stabilised in a sludge composting constructed wetland. Below the different elements of the plant are described.

<u>Pumping well (B101)</u>

The wastewater treatment plant is located in a flat area. At the end of the existing sewer a pumping chamber, 1,3 x 1,3 m wide and 3,35 m deep, was erected instead of the small septic tank, which was previously there and has been abandoned. One of two pumps alternately feeds the whole constructed wetland system, including the primary treatment (Imhoff tank). An alarm unit with horn and float (acoustic alarm) will ring an alarm in case of failure of one of the two pumps. In case of such failure one pump alone will operate, until the defect is remedied.

Submerged faecal pump:

max. flow rate	240 l/min
Distance of end points of float switch	400 mm

Inlet well (B102)

The inlet manhole contains a 90° curve for sampling of the raw wastewater. The size of the manhole, realised in concrete, is 120 cm width x 100 cm length x 75 cm height.

Pre-treatment Unit - Imhoff tank (B103)

To reduce the amount of solids in the inflow and to minimize the risk of clogging of the filter bed a pre-treatment is required.

For pre-treatment an Imhoff tank with an effective volume of 20 m³ was built. The sludge settling in the digester chamber has to be removed from time to time. It is transferred to the sludge treatment constructed wetland. Removal becomes necessary if the sludge volume reaches a height of 2/3 of the useable height in the first chamber.

Hydraulic retention time

Imhoff tank: = 20 m³ / 25 m³/d = 0.8 days

Partition (Splitter) well (B104)

For optimal and accurate distribution of the water on the two halves of the CW a partition well was provided. A weir splits the incoming water flow into two equal flows in stage I and into three equal partial flows in stage II (expansion stage). The weir is made of stainless steel.

Horizontal flow constructed wetland – (SFS-h) (B105 + B106)

Description of the 1st stage constructed wetland
The submerged horizontal flow (SFS-h) systems consist of basins containing inert material with selected granulometry. The bottom and the walls of the basins were waterproofed using a sandwich of an HDPE membrane with two layers of geotextile. The inlet and the outlet consist of two strips of coarse material along two opposite edges of the basin. At the inlet side a feeder pipe with large holes at regular intervals runs is laid along the edge near the surface. In the outlet gravel pack a drainpipe is put at the bottom to collect the treated water. The drainpipe goes into a riser pipe in an outlet chamber. The height of the opening of this riser pipe determines the outlet water level in the basin. The path of any water percolating through the basin has a length of 9 m. Emerging plants, in this case reed (*Phragmites australis*), are grown in the basins.

Table 35: Technical Specification of the 1st stage Horizontal Flow Constructed Wetland – (SFS-h):

Item	Unit	Value
Total bottom surface	[m²]	200
Bottom length	[m]	10,0
Bottom width	[m]	20,0
Average medium height	[m]	0,80
Inlet medium height	[m]	0,75
Outlet medium height	[m]	0,85
Bank slope	[°]	90
Medium porosity (gravel ∅ 5-10 or 8-12 mm)		0,35
Average water level	[m]	0,7
Bottom slope		1 %

Functioning

The inert material in the basins has to provide a filtering effect and growth support for micro-organisms but also assures an adequate hydraulic conductivity (filling media mostly used are sand and gravel). These inert materials represent the support for the growth of the roots of the emerging plants. The water remains always under the surface of the filling material and flows horizontally thanks to a slight difference between the inlet and the outlet levels. The filling material of the basin is saturated with water but for the uppermost few centimetres.

During the passage of wastewater through the ryzosphere of the macrophytes, organic matter is decomposed by microbial activity, nitrate is denitrified, if in presence of sufficient organic content, phosphorus and heavy metals are partly fixed by adsorption on the filling medium. The vegetation contributes to the treatment process both by the support of an efficient microbial aerobic population in the ryzosphere and by the action of pumping atmospheric oxygen from the emerging part of the plants to the roots and so to the underlying soil portion, with a consequently better oxidation of the wastewater and creation of an alternation of aerobic, anoxic and anaerobic zones. This succession of zones leads to the development of different specialised families of micro-organisms and a good reduction of pathogens, highly sensitive to rapid changes in dissolved oxygen content.
Chronology of construction and technical details

- Along the edges of the bed, dig a small trench to tuck in the geotextiles and the liner;
- Cover the bottom and the banks with a non-woven geotextile (minimal density 250 g/m², TNT liner in the drawings);
- Put a sand layer on the bottom of the bed to achieve a slope of 1%;
- Put the PE liner and pass the pipes through the liner as specified in the drawings;
- Cover the bottom and the banks with a second layer of geotextile (minimal density 250 g/m², TNT liner in the drawings);
- Put the edges of the sheets into the boundary trench and backfill with the excavation material;
- Install the drainage pipe;
- Place a rock layer on the drainage pipe;

- Place a rock layer (50 cm high) in the inlet zone;
- Place the feeding system on the rock layer and cover with rock until the designed height, as specified in the technical drawings;
- Fill the bed with gravel: it is strongly recommended that the gravel be well washed and round. The final surface must be horizontal, i.e. have no slope towards the outlet.
- Commission the structure (tightness test, checking of inlet and outlet, especially outlet level)
- Fill with water
- Plant the reeds in the gravel, with a density of 4 plants/m^2.

Partition (Splitter) well (B107)

For optimal and accurate distribution of the water on the four parts of the CW a partition well was provided for each outlet of the first stage. A weir splits the incoming water flow into two equal flows in stage I and into three equal partial flows in stage II (expansion stage). The weir is made of stainless steel.

Siphon well (B108)

For the batch feeding of the 2nd stage Vertical Flow CWs siphons are used. The tube-valve causes the rising of pre-treated water in the well up to a certain water level. Reaching that level it tips down and empties a certain quantity of water into the reed bed. The tube is fixed at the effluent pipe, one hinged part being lifted like a float switch with the rising water level. Reaching a certain angle it remains in position and the water enters into the tube. When the weight of the entered water exceeds buoyancy the moving part of the tube-valve tips down and a mechanism in the valve opens, thus releasing the water in the well down to ground level.

Vertical flow constructed wetland – (SFS-v) (B109 + B110)

In the vertical flow systems (VF) the wastewater is applied through a distribution system on the whole surface area and passes the filter in a more or less vertical path. The pre-treated wastewater is dosed on the bed in large batches (intermittent feeding), thus flooding the surface. During the time between the feedings the pores within the filter media can fill up with air which is trapped by the next dose of liquid. Thus oxygen requiring nitrifying bacteria are favoured and full nitrification can be achieved, but only a small part of the formed nitrate is denitrified under aerobic conditions. The treated water is collected in a bottom drainage system to be discharged to the following stage of the treatment. The water level can be maintained with a height of about 5-10 cm from the bottom of the bed, or otherwise the beds can be totally empty after each feeding pulse.
This kind of CW is particularly efficient in nitrification, carbon and suspended solids removal. Due to its prevalently aerobic conditions denitrification is poor.

The submerged vertical flow systems consist of 4 basins containing different layers of inert material with selected granulometry. The bottom and the walls of the basins were waterproofed using a sandwich of a thinner membrane with two layers of geotextile.

The inlet and the outlet systems consist of two main collector pipes, on the bottom and the top of the bed, connected to secondary pipes spreading the water over the whole surface and collecting it from the bottom. The drainage system is connected to the outlet well allowing to empty the bed after each batch of wastewater. Reed (*Phragmites australis*) is grown in the basins.

Table 36: Technical Specification of the Vertical Flow Constructed Wetland – (SFS-v):

Item	Unit	Value
Total bottom surface	[m²]	850
Bottom length	[m]	12,5
Bottom width	[m]	68
Excavation height	[m]	1,30
Filling material height	[m]	0,95
composed by (from bottom to top):	[m]	
Gravel ∅ 40-70 mm	[m]	0,15
Gravel ∅ 5-10 mm	[m]	0,10
Coarse Sand ∅ 0,02-0,1 mm	[m]	0,50
Gravel ∅ 5-10 mm	[m]	0,20
Bank slope	[°]	90
Bottom slope		0,5 %

Chronology of construction and technical details

- Along the edges of the bed, dig a small trench to tuck in the geotextiles and the liner;
- Cover the bottom and the banks with a non-woven geotextile (minimal density 250 g/m²);
- Put a sand layer on the bottom of the bed to achieve a slope of 0.5%;
- Put the PE liner and pass the pipes through the liner;
- Cover the bottom and the banks with a second layer of geotextile (minimal density 250 g/m²);
- Put the edges of the sheets into the boundary trench and backfill with the excavation material;
- Place the drainage system;
- Fill the bed with the different layers of gravels and sand: it is strongly recommended that the filling material be well washed and round. The final filling surface must be level, i.e. have no slope towards the outlet.
- Place the feeding system;
- Commission the structure (tightness test, checking of inlet system and outlet)
- Fill with water
- Plant the reeds in the gravel, with a density of 4 plants/m^2.

<u>Horizontal flow constructed wetland – (SFS-h) (B111 + B112)</u>

Same description and procedures as B105 + B106.

Table 37: Technical Specification of the Horizontal Flow Constructed Wetland – (SFS-h):

Item	Unit	Value
Total bottom surface	[m²]	750
Bottom length	[m]	12,5
Bottom width	[m]	60,0
Average medium height	[m]	0,80
Inlet medium height	[m]	0,74
Outlet medium height	[m]	0,86
Bank slope	[°]	90
Medium porosity (gravel ∅ 5-10 or 8-12 mm)		0,35
Average water level	[m]	0,7
Bottom slope		1 %

Sludge treatment constructed wetland (B113+B114)

Uncontaminated sewage sludge from domestic waste water contains a lot of nutrients and organic material, which, after a hygienisation, can be used as high quality fertiliser in agriculture.

The drying and composting of sewage sludge in a CW means dewatering, volume reduction and mineralisation, stabilisation and hygienisation of the material without chemicals and additional energy input. Due to dewatering, decomposition and compaction of the material the volume of the applied sludge is reduced by 85 % during the operation cycle. The total nitrogen content is reduced by about 50 %. Important minerals for agriculture like potassium, calcium and magnesium show only a slight decrease in relation to the original mineral content (sodium unfortunately does, too).

The final product “mineralised sludge” is a crumbly, light brown-coloured material with a typical earthy smell. Organic components and pathogenic micro-organisms are reduced and the final product is suitable as fertiliser and soil conditioner in agricultural.

The volume is chosen in order to allow a 10 year filling period with a 0,5 m sludge layer at the end of this period, taking into account a dry matter content of 30 to 40% (under Central European climatic conditions) and an 85% volume reduction. Under Tunisian climatic condition a higher dry matter content can be expected.

The CWs are batch fed to maintain aerobic conditions within the filter beds. The reed improve microbial growth, assist in the prevention of clogging and create a large drying and aeration network. Aerobic conditions on and in the filter prevent the emission of smell. Sludge accumulates on the surface. The leachate infiltrates into the filter and is directed to the first stage horizontal flow constructed wetland (B105) by a drainage system.

An outlet water control device for the sludge treatment constructed wetland had to be installed. The operating water level is fixed at 0,24 m. The outlet control device allows to completely empty the filter bed and gives also the possibility to flood the bed for weed control during the start up phase. The water level control device is made from PVC pipes and fittings.

Table 38: Technical Specifications of the Sludge Treatment Constructed Wetland:

Item	Unit	Value
Total bottom surface	[m²]	100
Surface per PE	[m²/pe]	0,20
Bottom length	[m]	10
Bottom width	[m]	10
Drainage Pipe		DN110
Drainage layer height (Gravel 20/40mm)	[m]	0,20
Filter layer height (Gravel 3/8mm)	[m]	0,30
Top filter layer height (Coarse Sand 0.3/0.5mm)	[m]	0,05
Total filter media height	[m]	0,55
Operating water level	[m]	0,24
Pieces of reed planted	[p/m²]	4-5

The school system

Social situation

The primary school of Chorfech 24 can not be connected to the sewerage network of the settlement. Therefore an individual system was implemented.

There are 60 pupils at the school, 8 teachers and 1 custodian plus the families of two teachers and the custodian. The total built area is 500 m². The school complex consists of

- 5 classrooms plus on office
- 2 houses for teachers
- 1 house for the custodian
- a large garden

The sanitary and hydraulic equipment comprised

- 2 washbasins with cold and hot water,
- 2 washbasins with cold water
- 4 urinals
- 2 squatting toilets for males
- 1 toilet for girls
- 1 toilet for teachers
- rainwater is infiltrated in the garden.

<u>Solution</u>

The water system implemented comprises rainwater harvesting for toilet flushing and irrigation, waterless urinals, urine separation for use of the urine as fertiliser, a septic tank and constructed wetland for the treatment of the wastewater which is then stored and used to supplement the irrigation water.

The sludge of the septic tank is emptied and transported to the village sludge composting reed bed at the wastewater treatment plant.

<u>Ownership</u>

An agreement between the CERTE, representing Zer0-M and the Ministry of Education about implementation of the pilot system, funding and final ownership operation of the system by the Ministry of Education was concluded prior to implementation. The system is integral part of the school buildings and will be managed by the school of behalf of the Ministry of Education accordingly.

Table 39: Daily load of nutrients in urine and faeces per capita

	Unit	Urine	Faeces
Volume	l/(cap*d)	1,2	0,15
Nitrogen	g/(cap*d)	11	2
Phosphorus	g/(cap*d)	1	0,6
Potassium	g/(cap*d)	2,5	0,6

<u>Dimensioning</u>

There are 60 pupils plus 10 adults, teachers, watchman, etc. at the school. With the data of table below we arrive at the following values.

1. An adult at school corresponds to 0,1 population equivalent.
2. A child is 60% of an adult
3. a pupil consumes 1 l of water for drinking per day and 2 for hand washing, but that in average only a third of all pupils use the facilities.
4. The flushing cisterns contain 6 l of water

This leads to the following figures:

- **Urine**
  60 * 0,1 * 0,6 * 1,2 litres = 4,3 litres
  10 * 0,1 * 1,2 litres = 1,2 litres
  <u>Total : 5,5, thus 6 litres / day</u>

- **WC flush water**
  60 * 0,1 * 0,6 * 6 litres = 21,6 litres
  10 * 0,1 * 6 litres = 6 litres
  <u>Total : 27,6, thus 28 litres / day</u>

- **Water**
  60 * 30% * 1 litre = 20 litres (drinking)
  60 x 30% x 2 litres = 40 litres (handwashing)
  <u>Total : 60 litres / day</u>

The cleaning of class rooms is estimated to be done once a week at a rate of 05 litres per m², with a total of 500 m² of classroom surface.

<u>Total : 250 litres / week</u>

This estimate lead to the following monthly figures, taking into account 6 schooldays per week.

Urine :	**144 litres per month**
WC flush water:	**672 litres per month**
Greywater: 1440 + 1000 =	**2440 litres per month**

- **Rainwater patential**

Roof surface	500 m²
Annual precipitation	500 mm
Efficiency	80%
Potential volume: 500 * 0,5 * 0,8 =	200 m³

System implemented

The following water system was thus chosen and implemented

The toilets of the school were completely refurbished and were equipped with two waterless urinals to save water. The urine from the urinals is collected for use as fertiliser.

The wastewater from the toilets and the washing basins is treated in a small septic tank and a horizontal flow constructed wetland of 3 * 5 m, i.e. 15 m².

The sludge of the septic tank is emptied and transported to the village sludge composting reed bed at the wastewater treatment plant.

Rainwater from the roofs is collected in a 50 m³ rainwater storage tank and used for toilet flushing. The treated wastewater and excess rainwater are collected in a second tank of the same size. Thus providing a total storage volume of 100 m³ and the possibility to use the wastewater a second time for irrigation. No water from the mains will be used for flushing.

Remark

The example of the Chorfech school has met a high attention at the Ministry of education. CERTE was invited to participate in the development of a standard for schools based on this experience.

It was noted that the refurbishing of the toilets was not used to properly balance the number of toilets for girls and boys. Indeed while there is only one toilet for girls there is also one toilet for boys plus two urinals. It would be reasonable to provide at least the same number of facilities to girls and boys, i.e. 3 toilets for girls and one toilet plus two urinals for boys. This should be taken into consideration as the example of Chorfech is multiplied throughout Tunisia.

Composting toilet

Location	Chorfech 24, single house basic sanitation
Lifespan	20 years
Capacity	10 family members

Social situation Some houses of Chorfech can not be connected to the sewer, either because they are too low or because they are too distant from the existing network. The project team discussed about dry toilets with the owners of these houses and one owner was willing to try such a toilet.

Type The house owner built a new toilet room, complete with tiles, wash basin, and bidet. The project provided a simple urine diversion dehydration toilet and a ventilation pipe.

Ownership Ownership of the toilet is with the house owner.

Cost

The investment cost broken down into the transmission pipeline, the part directly financed by ONAS, and the treatment plant are as in shown in table 40.

Table 40: Construction and maintenance cost of the proposed system (TND and EUR per year)

Item	Unit	Qu.	Amount (EUR)
Cost of wastewater transport	Lump Sum	1	46.893,11
Cost of treatment system	Lump Sum	1	193.184,06
Total investment cost	Lump Sum	1	240.077,17
Operation and Maintenance water system	year	1	9.700,00
Cost of school system	Lump Sum	1	28.781,10
Composting toilet (excl. labour by owner)	Lump Sum	1	500,00

Photo documentation

Figure 40: Chorfech 24 - the constructed wetlands are erected

Figure 41: Chorfech 24 - Feeder pipes are arranged on the 2nd stage vertical flow constructed wetland

Figure 42: Chorfech 24 – general view of the completed wastewater treatment plant, with the sludge composting bed in the foreground. The beds are still unplanted

Figure 43: Chorfech primary school – constructed wetland for wastewater treatment, storage tank and irrigation system

Figure 44: Chorfech primary school – rainwater storage tank

Figure 45: Chorfech primary school – waterless urinal, with a membrane odour trap

Figure 46: Chorfech UDD toilet, urinal and bidet in a private house

Figure 47: Zer0-M, a new outlook to water management

Attachments

Economic study spreadsheet of village wastewater system

Wastewater Treatment and Reuse for Irrigation of Agricultur Areas

Economical Feasibility Study

Treatment of Wastwater

Chorfech Wastewater Treatment Plant

Item	Unit	Quant.	U.-Price [Eur]	Amount [Eur]
Investment cost including E&M equipment	LS	1	241.432,59	241.432,59
Electro-mecanical equipment	LS	1	19.314,61	19.314,61
O&M cost				
Personnel	h	730,00	2,76	2.014,80
Repair	LS	241.432,59	**0,03**	7.242,98
Power for pumping	kWh	8.350	0,05	417,50
Total O&M and reinvestment				**9.675,28**
Water consumption				
Volume of Sewage	m³/d	25	365	8.943
Wastewater revenues		8.943	1,00	8.942,50
Irrigation water benefit		8.943	0,20	1.788,50
				0,00
				10.731,00
Interest rate	5%			

Social Interest Rate		**5%**
Present value (1000 EUR)		
	Investments	**241,4**
	Reinvestment	**77,7**
	Operation cost	**185,5**
	Total cost	**504,6**
	Total Benefits	**205,7**
Net Present Value		**-298,9**
Internal Interest Rate		**Net loss**
Benefit-Cost Ratio		**0,41**
Pay-back period (in years)		**No break-even**
Water price	**EUR/m³**	**2,94**

Year	Yearly income	Payments Invest/Reinve	O&M	Net Benefit	Present value Benefit	Invest/Reinve	O&M	Total Benefit	Cost	Cumulation Benefit	Cost	Net Benefits	Pay-off time
1	10.731,00	241.432,59	9.675,28	-240.376,87	10.731,00	241.432,59	9.675,28	-240.376,87	251.107,87	10.731,00	251.107,87	-240.376,87	0
2	10.731,00		9.675,28	1.055,72	10.220,00	0,00	9.214,55	1.005,45	9.214,55	20.951,00	260.322,42	-239.371,42	0
3	10.731,00		9.675,28	1.055,72	9.733,33	0,00	8.775,76	957,57	8.775,76	30.684,33	269.098,18	-238.413,85	0
4	10.731,00		9.675,28	1.055,72	9.269,84	0,00	8.357,87	911,97	8.357,87	39.954,17	277.456,05	-237.501,87	0
5	10.731,00		9.675,28	1.055,72	8.828,42	0,00	7.959,87	868,55	7.959,87	48.782,59	285.415,92	-236.633,33	0
6	10.731,00		9.675,28	1.055,72	8.408,02	0,00	7.580,83	827,19	7.580,83	57.190,61	292.996,76	-235.806,14	0
7	10.731,00		9.675,28	1.055,72	8.007,64	0,00	7.219,84	787,80	7.219,84	65.198,25	300.216,60	-235.018,35	0
8	10.731,00		9.675,28	1.055,72	7.626,32	0,00	6.876,04	750,28	6.876,04	72.824,57	307.092,64	-234.268,06	0
9	10.731,00		9.675,28	1.055,72	7.263,16	0,00	6.548,61	714,55	6.548,61	80.087,74	313.641,25	-233.553,51	0
10	10.731,00		9.675,28	1.055,72	6.917,30	0,00	6.236,77	680,53	6.236,77	87.005,03	319.878,02	-232.872,98	0

11	10.731,00	19.314,61	9.675,28	-18.258,88	6.587,90	11.857,49	5.939,78	-11.209,37	17.797,27	93.592,94	337.675,29	-244.082,35	0
12	10.731,00		9.675,28	1.055,72	6.274,19	0,00	5.656,93	617,26	5.656,93	99.867,13	343.332,23	-243.465,09	0
13	10.731,00		9.675,28	1.055,72	5.975,42	0,00	5.387,56	587,87	5.387,56	105.842,55	348.719,78	-242.877,23	0
14	10.731,00		9.675,28	1.055,72	5.690,88	0,00	5.131,01	559,87	5.131,01	111.533,43	353.850,79	-242.317,36	0
15	10.731,00		9.675,28	1.055,72	5.419,88	0,00	4.886,67	533,21	4.886,67	116.953,32	358.737,46	-241.784,15	0
16	10.731,00		9.675,28	1.055,72	5.161,79	0,00	4.653,97	507,82	4.653,97	122.115,11	363.391,43	-241.276,32	0
17	10.731,00		9.675,28	1.055,72	4.915,99	0,00	4.432,36	483,64	4.432,36	127.031,11	367.823,79	-240.792,69	0
18	10.731,00		9.675,28	1.055,72	4.681,90	0,00	4.221,29	460,61	4.221,29	131.713,00	372.045,08	-240.332,08	0
19	10.731,00		9.675,28	1.055,72	4.458,95	0,00	4.020,28	438,67	4.020,28	136.171,96	376.065,36	-239.893,40	0
20	10.731,00		9.675,28	1.055,72	4.246,62	0,00	3.828,84	417,79	3.828,84	140.418,58	379.894,20	-239.475,62	0
21	10.731,00	19.314,61	9.675,28	-18.258,88	4.044,40	7.279,47	3.646,51	-6.881,58	10.925,98	144.462,98	390.820,18	-246.357,20	0
22	10.731,00		9.675,28	1.055,72	3.851,81	0,00	3.472,87	378,94	3.472,87	148.314,79	394.293,05	-245.978,26	0
23	10.731,00		9.675,28	1.055,72	3.668,39	0,00	3.307,49	360,90	3.307,49	151.983,18	397.600,54	-245.617,36	0
24	10.731,00		9.675,28	1.055,72	3.493,71	0,00	3.149,99	343,71	3.149,99	155.476,89	400.750,53	-245.273,65	0
25	10.731,00		9.675,28	1.055,72	3.327,34	0,00	2.999,99	327,35	2.999,99	158.804,23	403.750,52	-244.946,30	0
26	10.731,00		9.675,28	1.055,72	3.168,89	0,00	2.857,14	311,76	2.857,14	161.973,12	406.607,66	-244.634,54	0
27	10.731,00		9.675,28	1.055,72	3.017,99	0,00	2.721,08	296,91	2.721,08	164.991,11	409.328,74	-244.337,63	0
28	10.731,00		9.675,28	1.055,72	2.874,28	0,00	2.591,51	282,77	2.591,51	167.865,39	411.920,25	-244.054,86	0
29	10.731,00		9.675,28	1.055,72	2.737,41	0,00	2.468,10	269,31	2.468,10	170.602,80	414.388,35	-243.785,55	0
30	10.731,00		9.675,28	1.055,72	2.607,06	0,00	2.350,57	256,48	2.350,57	173.209,86	416.738,92	-243.529,06	0
31	10.731,00	241.432,59	9.675,28	-240.376,87	2.482,91	55.862,06	2.238,64	-55.617,79	58.100,70	175.692,77	474.839,62	-299.146,85	0
32	10.731,00		9.675,28	1.055,72	2.364,68	0,00	2.132,04	232,64	2.132,04	178.057,45	476.971,66	-298.914,21	0
33	10.731,00		9.675,28	1.055,72	2.252,07	0,00	2.030,51	221,56	2.030,51	180.309,52	479.002,18	-298.692,65	0
34	10.731,00		9.675,28	1.055,72	2.144,83	0,00	1.933,82	211,01	1.933,82	182.454,36	480.936,00	-298.481,64	0
35	10.731,00		9.675,28	1.055,72	2.042,70	0,00	1.841,74	200,96	1.841,74	184.497,05	482.777,73	-298.280,68	0
36	10.731,00		9.675,28	1.055,72	1.945,43	0,00	1.754,03	191,39	1.754,03	186.442,48	484.531,77	-298.089,29	0
37	10.731,00		9.675,28	1.055,72	1.852,79	0,00	1.670,51	182,28	1.670,51	188.295,27	486.202,28	-297.907,01	0
38	10.731,00		9.675,28	1.055,72	1.764,56	0,00	1.590,96	173,60	1.590,96	190.059,82	487.793,24	-297.733,41	0
39	10.731,00		9.675,28	1.055,72	1.680,53	0,00	1.515,20	165,33	1.515,20	191.740,36	489.308,44	-297.568,08	0
40	10.731,00		9.675,28	1.055,72	1.600,51	0,00	1.443,05	157,46	1.443,05	193.340,86	490.751,48	-297.410,62	0
41	10.731,00	19.314,61	9.675,28	-18.258,88	1.524,29	2.743,56	1.374,33	-2.593,60	4.117,89	194.865,16	494.869,37	-300.004,22	0
42	10.731,00		9.675,28	1.055,72	1.451,71	0,00	1.308,89	142,82	1.308,89	196.316,86	496.178,26	-299.861,40	0
43	10.731,00		9.675,28	1.055,72	1.382,58	0,00	1.246,56	136,02	1.246,56	197.699,44	497.424,82	-299.725,38	0
44	10.731,00		9.675,28	1.055,72	1.316,74	0,00	1.187,20	129,54	1.187,20	199.016,18	498.612,02	-299.595,84	0
45	10.731,00		9.675,28	1.055,72	1.254,04	0,00	1.130,67	123,37	1.130,67	200.270,22	499.742,68	-299.472,46	0
46	10.731,00		9.675,28	1.055,72	1.194,32	0,00	1.076,82	117,50	1.076,82	201.464,54	500.819,51	-299.354,96	0
47	10.731,00		9.675,28	1.055,72	1.137,45	0,00	1.025,55	111,90	1.025,55	202.601,99	501.845,06	-299.243,06	0
48	10.731,00		9.675,28	1.055,72	1.083,29	0,00	976,71	106,57	976,71	203.685,28	502.821,77	-299.136,49	0
49	10.731,00		9.675,28	1.055,72	1.031,70	0,00	930,20	101,50	930,20	204.716,98	503.751,97	-299.034,99	0
50	10.731,00		9.675,28	1.055,72	982,57	0,00	885,91	96,67	885,91	205.699,55	504.637,87	-298.938,32	0
	536.550,00	540.809,00	483.763,89		205.699,55	319.175,17	185.462,71	-298.938,32	504.637,87				No break-even
				#DIV/0!	19,17								

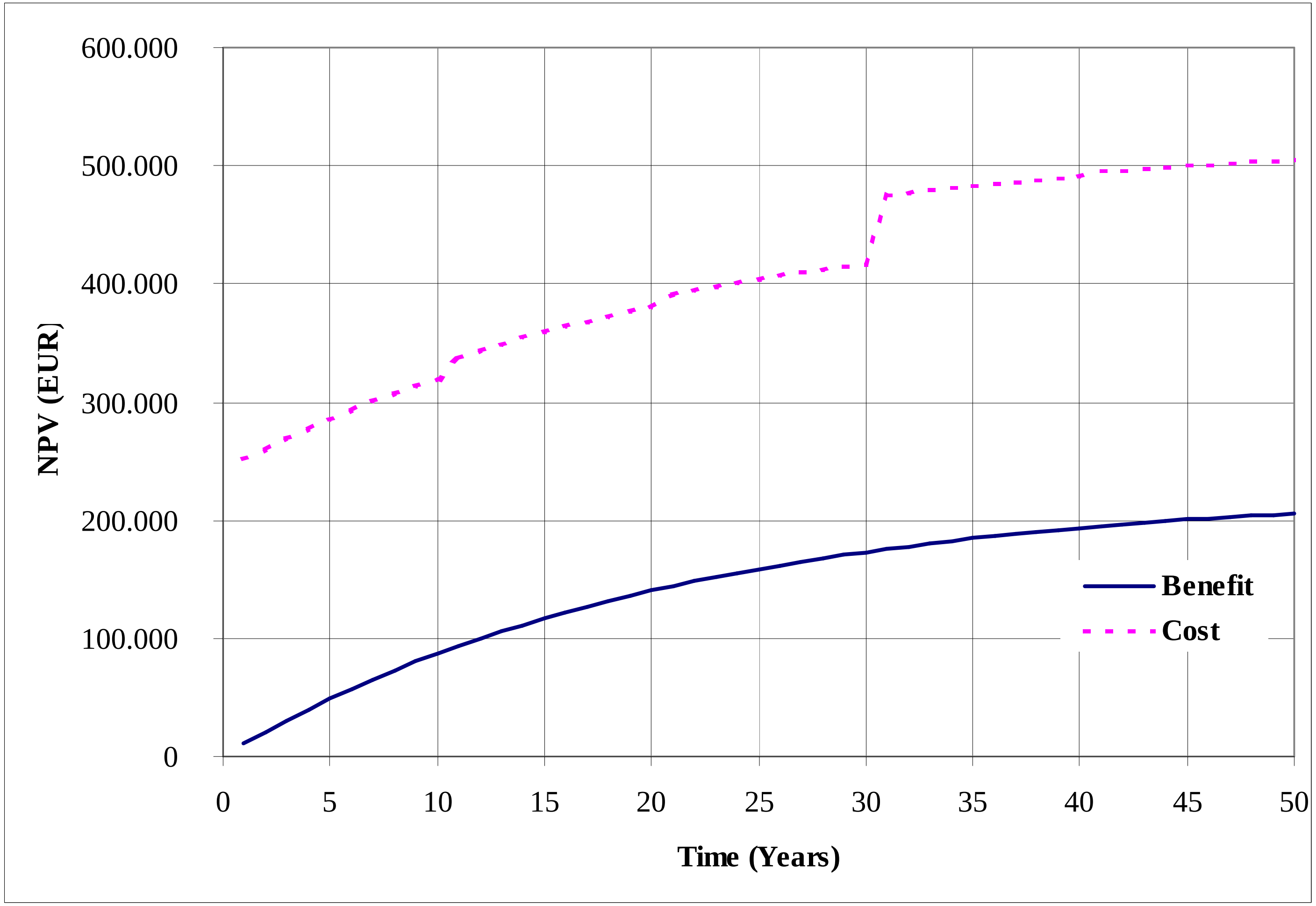


Figure 48: Wastewater treatment system at Chrofech 24, no break-even achievable

Annex 5. Tabular overview of deliverables and contracts

- Training events (formal courses, on-the-job, training seminars, field training)

Table 41: Overview of training events

Date	Venue	Contents	Participants	Remarks
28/06/08	CERTE, Tunisia	Wastewater treatment and recycling, water saving, harvesting of rainwater greywater urine separation and treatment, cleaner production,	8, architects	Video-learning material
27/06/08	CERTE, Tunisia	Wastewater treatment and recycling, water saving, harvesting of rainwater greywater urine separation and treatment, cleaner production,	25 from Minister of education and formation, responsible of environmental club in the school, professors	
07/05/08	Municipality of Attaouia, Morocco.	Decision makers, population representative, engineers and technicians	15 participants: engineers, technicians and NGOs	With the collaboration of the University of Guelph
8/04/08	MRC, Gebze - Turkey	7th Training Sustainable water management, ECOSAN approach, alternative water resources (rainwater harvesting and grey water-treatment-reuse) water saving devices, introduction of treatment technologies	47 participants from high school teachers and high school students	
4/04/08	MRC, Gebze - Turkey	6th Training Sustainable water management, ECOSAN approach, rainwater harvesting, water saving devices, greywater treatment, constructed wetlands, MBR,	11 participants from NGOs and interested public	External speakers: Erwin Nolde, Fabio Masi, Gerd Wach
2 -3/04/08	MRC, Gebze - Turkey	5th Training Reclamation of treated WW, constructed wetlands, greywater treatment, rainwater harvesting, water saving devices, urine separation, compost toilets, MBR, anaerobic treatment, RBC, ECOSAN approach and use of urine	50 participants from universities (lecturers and students)	External speakers: Erwin Nolde, Fabio Masi, Gerd Wach
31/03 to 01/04/08	MRC, Gebze - Turkey	4th Training Reclamation of treated WW, constructed wetlands, greywater treatment, rainwater harvesting, water saving devices,	41 participants from ministries, city planers, architects, private sector	External speakers: Erwin Nolde, Fabio Masi, Gerd Wach

Date	Venue	Contents	Participants	Remarks
		urine separation, compost toilets, MBR, anaerobic treatment, RBC, ECOSAN approach and use of urine		
26/03/2008	Municipality of Attaouia, Morocco.	Decision makers, population representative, engineers and technicians	61 participants	External speakers: Martin Regelsberger
12 to 13/03/08	CERTE, Tunisia	Wastewater treatment and recycling, water saving, harvesting of rainwater greywater urine separation and treatment, cleaner production,	13 participants from 7 NGOs	External speakers: Fabio Masi, Gerd Wach
10 to 12/03/08	CERTE, Tunisia	Wastewater treatment and recycling, water saving, harvesting of rainwater greywater urine separation and treatment, cleaner production,	25 from 13 consulting engineers (Bureaux d'études)	External speakers: Martin Regelsberger, Fabio Masi, Gerd Wach
24-28/02/2008	NRC, Cairo	Training course	6 participants	External speakers: Kemal Gunes
03-07/02/2008	NRC, Cairo	Training course	11 participants	
27-31/01/2008	NRC, Cairo	Training course	7 participants	
11/11/07	El Aouamra, Morocco	Wastewater treatment	28, Population representative, decision makers, technicians and farmers	
15-19/07/2007	NRC, Cairo	Water regulation, basic concepts, constructed wetlands, sludge drying beds, SBR	Researchers, engineers, technicians from municipal organisations	External speaker: Gerd Wach
1-5/07/2007	NRC, Cairo	Training course	3 participants	
8-11/05/07	IAV Hassan II, Rabat	Small bore sewerage, constructed wetlands, sustainable sanitation, hygiene aspects and risk assessment, sludge management, greywater systems (CW, MBR, SBR), including lab exercises	31 participants from water administration, consultants	Duncan Mara (University of Leeds), Pascal Molle (Cemagref, Lyon), Zer0-m Partner (AEE), E.McBean and C.Kinsley, Guelph, Canada
6-10/05/2007	NRC, Cairo	Water regulation, basic concepts, constructed wetlands, sludge drying beds, SBR	9 participants	
18-19/04/2007	MRC, Gebze - Turkey	3rd Training Reclamation of treated WW, constructed wetlands, greywater treatment, rainwater harvesting, water saving devices, urine separation, compost	53 participants from public and private sector	Content see document

Date	Venue	Contents	Participants	Remarks
		toilets, MBR		
16-17/04/ 2007	MRC, Gebze - Turkey	2nd Training Reclamation of treated WW, constructed wetlands, greywater treatment, rainwater harvesting, water saving devices, urine separation, compost toilets, MBR	53 participants from universities (lecturers and students)	Content see document
16/03/07	CERTE, Tunis	Wastewater treatment and recycling, water saving, greywater urine separation and treatment, cleaner production	8: Journalists, Media, TV	2nd training course in connection with the SWM conference and World Water day 2007
11-15/03/2007	NRC, Cairo	Training course	5 participants, PhD students, engineers from municipalities and research centres - partly international guests	
18-22/02/ 2007	NRC, Cairo	Training course	7 PhD students, engineers from municipalities and research centres - partly international guests	
17-21/12/ 2006	NRC, Cairo	Water regulation, basic concepts, constructed wetlands, sludge drying beds, SBR	13 PhD students, engineers from municipalities and research centres	Partly international guests
6/12/2006	Figuig, Morocco	Greywater treatment and reuse in public laundry facilities	15, Women association	With the collaboration of University of Guelph, Canada
5/12/2006	Figuig, Morocco	Wastewater treatment and sludge management	Decision makers, technicians and farmers	With the collaboration of University of Guelph, Canada
20-27/08/2006	NRC, Cairo	Training course		
02-06/07/2006	NRC, Cairo	Training course	15 participants	External speakers: Christian Platzer
13-15/06/2006	IAV Hassan II, Rabat	Training course: rainwater harvesting and reuse, ecological sanitation, WW primary treatment, CW, anaerobic treatment, greywater treatment, sludge management	13 participants from water administration, Water and wastewater agencies, local authorities infrastructure fund, consulting firms.	Partly International trainers from Zer0-m partners.
31/12/05-4/1/06	NRC, Cairo		11 PhD students, engineers from municipalities and research centres - partly international guests	External speakers: Fabio Masi
14-16/11/	CERTE, Tu-	Reclamation of treated	Attendees from minis-	External speak-

Date	Venue	Contents	Participants	Remarks
2005	nis	WW, CW, greywater treatment, rainwater harvesting, water saving devices, urine separation, compost toilets	tries, administrations, universities and tourism organisations	ers: Fabio Masi, Gerd Wach, Erwin Nolde
20 to 28/07/05	Italy and Germany	Technical excursion	Decision makers	
16-20/07/05	NRC, Cairo		16 PhD students, engineers from municipalities and research centres - partly international guests	Partly international guests
5 to 8/07/05	MRC, Gebze, Turkey	Pilot training, reclamation of treated WW, CW, greywater treatment, rainwater harvesting, water saving devices, urine separation, compost toilets, MBR	19 attendees from water/wastewater technicians and/or engineers from municipal organizations, especially in tourist areas	Content see document
02 to 08/09/04	Hanover	TtT seminar		
10 to 21/05/04	Rabat	Anaerobic treatment of sewage and agricultural use of treated effluents	17 Engineers from water and wastewater management agencies	Together with University of Guelph, Canada, Wageningen University and the IHE-Delft

Table 42: Theses in Zer0-M

Name	Institution	Title	Year	Type of work	Supervisor
Mouna Lamine	ENIS	Traitement des eaux grises par SBR & MBR	2006	Thèse	Ahmed Ghrabi, Latifa Bousselmi, CERTE
Jihene Sassi	INAT	Traitement des eaux noires par CW	2009	Thèse	Ahmed Ghrabi, Latifa Bousselmi, CERTE
Mehdi Ghourabi	ISB	Traitement des eaux grises par SBR, Optimisation	05/2009	PFE	Latifa Bousselmi, CERTE
Chihi Anissa	ESAM (Mograne)	Etude de la performance d'un réacteur biologique séquentiel pour le traitement des eaux grises	06/2008	PFE	Latifa Bousselmi, CERTE
Meher A.	ESET (Zaghouan)	Traitement des eaux grises par photocatalyse solaire	06/2008	PFE	Latifa Bousselmi, CERTE
Ahlem A.	INSAT	Etude d'un réacteur MBR	01/2009	PFE	Latifa Bousselmi, CERTE
Nawel Sendi	INAT	Caractérisation et traitement des eaux grises	06/2008	PFE	Latifa Bousselmi, Ahmed Ghrabi, CERTE
Mohamed Gharbia	INAT	La gestion locale de l'eau domestique: une nouvelle approche intégrant les eaux	06/2009	Mastère	Ahmed Ghrabi, CERTE

Name	Institution	Title	Year	Type of work	Supervisor
		pluviales			
Fatma Messaoudi	INAT	Gestion et dimensionnement des citernes pluviales en Tunisie	06/2007	PFE	Ahmed Ghrabi, CERTE
Anouar Khammassi	ESIER	Etude préalable à la conception et au dimensionnement d'une station à macrophytes : application à la localité de Chorfech 24	06/2006	PFE	Ahmed Ghrabi, CERTE
Serroukh Kaoutar	IAV Hassan II, Génie Rural	Utilisation des performances d'abattement de la pollution pour la détermination de la durée de la séquence alimentation/repos d'un filtre à macrophytes à écoulement vertical recevant de l'eau usée brute : effet de la densité des roseaux sur la durée de la séquence alimentation/repos.	2009	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II
Tanji Rajaa	IAV Hassan II, Génie Rural	Evaluation de l'approche "assainissement décentralisé - épuration par fosse septique et rhizofiltration" : cas de Douar R'Mel à Dar Bouazza (Casablanca).		Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II
Hasni Meriem	IAV Hassan II, Génie Rural	Performances d'élimination des pollutions organiques et azotées d'un filtre à macrophytes hybride alimenté par une eau usée brute.	2008	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II
El Aazzouzi Nezha	IAV Hassan II, Génie Rural	Récupération sélective, traitement et réutilisation des eaux grises d'un bain public (hammam) pour l'arrosage des espaces verts, projet pilote de la ville d'El Attaouia (fréquentation et performances préliminaires).	2008	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II
Ait Douch Abdellatif Ghazi Noura	IAV Hassan II, Génie Rural	Utilisation des technologies avancées compactes (boues activées: Membrane BioReactor (MBR) et Sequencing batch Reactor (SBR) pour le traitement des eaux grises du Club ACSA et leur recyclage à des fins domestiques.	2007	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II
Choujae Fatine	IAV Hassan II, Génie Rural	Ségrégation et réutilisation des eaux grises des bains maures pour l'arrosage des espaces verts : Projet pilote de la ville d'El Attaouia : (étude et dimensionnement).	2007	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II
Tall Abdou	IAV Hassan II, Génie Rural	Réalisation à l'IAV d'un pilote sur le Systèmes hybride de filtres plantés de roseaux (écoulement vertical + horizontal + vertical + recirculation)	2007	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II Christopher Kinsley, Université of Guelph, Canada

Name	Institution	Title	Year	Type of work	Supervisor
Bâ Amadou Lamine	IAV Hassan II, Génie Rural	Traitement des eaux usées des centres à forte variabilité et réutilisation éventuelle des eaux épurées	2007	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II Véolia
Malam Souley El Hadji Ibrahim	IAV Hassan II, Génie Rural	Schéma Directeur d'Assainissement Liquide de la ville d'Es-SMARA	2007	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II PROJEMA
Bey Imane	IAV Hassan II, Génie Rural	Projet pilote pour la ségrégation, le traitement et le recyclage des eaux usées grises du Club ACSA , pour la chasse des toilettes du nouveau bâtiment du Génie Rural	2006	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II
Lahjouj Jamila	IAV Hassan II, Génie Rural	Etude comparative des performances des systèmes pour le post-traitement des eaux usées “ lits plantés de roseaux à écoulement horizontal” et “chenal algal à haut rendement”	2006	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II
Melkaoui Abdelhadi	IAV Hassan II, Génie Rural	Etude d’extension du système de pré-traitement basé sur le réacteur anaérobie à flux ascendant à deux étapes (RAFADE) de la station d’épuration d’El Attaouia (passer de 15 à 25.000 habitants).	2006	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II
Maadane Sanae	IAV Hassan II, Génie Rural	Ségrégation, caractérisation, traitement et recyclage des eaux grises (eaux des douches et lavabos) pour la chasse des WC au club ACSA.	2005	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II
Serhane Narjiss	IAV Hassan II, Génie Rural	Influence du mode de distribution de l'influent et de collecte de l'effluent sur les performances d'épuration du réacteur anaérobie à flux ascendant à deux étapes (RAFADE).	2005	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II
Nazih Jihane	IAV Hassan II, Génie Rural	Utilisation du filtre planté de Roseaux à écoulement horizontal (Constructed wetland) pour l'Epuration des eaux usées des petites communautés : Caractéristiques hydrauliques et performances.	2005	Mémoire de fin d'études	Bouchaib El Hamouri, IAV Hassan II
Dr. Mohamed A. Mahmoud	NRC	Simple and advanced techniques for the treatment of municipal wastewater in Egypt	2008	Post-Doctor	Hussein Abdel-Shafy, NRC
Deena M. Metawee	Ain Shams Uni	Membrane Bioreactor for the treatment of black water	2008	Master	Hussein Abdel-Shafy, NRC
Basem Abbas	Cairo Uni	Evaluation of Water Reuse for irrigation in Egypt	2007	Master	Hussein Abdel-Shafy, NRC
Islam Osman	Al-Azhar Uni	Fate of bacterial contamination via wastewater treatment	2007	Master	Hussein Abdel-Shafy, NRC
Mohamed Shehata Abdou	Zagazig Uni	Upgrading of wastewater treatment via simple and advanced techniques	2004	Master	Hussein Abdel-Shafy, NRC
Neveen	Ain Shams	Wastewater treatment and re-	2003	Ph.D	Hussein Abdel-

Name	Institution	Title	Year	Type of work	Supervisor
Samir	Uni	use in Egypt			Shafy, NRC
Friederike Arnold	Humboldt-Universität Berlin	Schritte zur erfolgreichen Erfindung und Innovation: Unterstützung von Erfindern bei der Gestaltung technischer Innovationen durch die Entwicklung einer Methode zur Erfassung von Anwenderwissen in Schwellenländern und zu dessen Transfer nach Deutschland	2006	Ph.D	Harald A. Mieg
René Scheumann	TUB, Environnemental Engineering	Greywater Treatment with a Membrane Coupled Process and its Biokinetic Sludge Characteristics	2003	Ph.D	Matthias Kraume, TUB
Tino Schmidt	Technical University of Berlin (TUB), Environnemental Engineering	"Kohlenstoff- und Stickstoff-eliminierung bei Grauwasser in einem Submerged Membrane Sequencing Batch Reactor"	March 2008	Masters	Matthias Kraume, TUB
Wolf Raber	Technical University of Berlin (TUB)	"Untersuchung verschiedener Membranen hinsichtlich ihrer Verwendbarkeit zur direkten Grauwasserreinigung"	Dec. 2007	Masters	Matthias Kraume, TUB
Janek Hermann-Friede	Technical University of Berlin (TUB)	"Kinetic and removals in Greywater treated with SM-SBR"	March 2007	Masters	Matthias Kraume, TUB
Axelle Besançon	Technical University of Berlin (TUB)	"Simulation der biologischen Abbauprozesse in einem Submerged Membrane Sequencing Batch Reactor (SM-SBR) zur Grauwasserbehandlung"	August 2006	Masters	Matthias Kraume, TUB
Mersz Cornelia	Technical University of Berlin (TUB)	Membrane bioreactor (MBR) technology for the treatment and recycling of greywater from the sport and leisure club ACSA in Rabat, Morocco.	2006	Masters	Matthias Kraume, TUB Bouchaib El Hamouri, IAV Hassan II
Pierre Mandel	Technical University of Berlin (TUB)	"Analysis of operating conditions for a submerged membrane sequencing batch reactor applied to greywater treatment"	Feb. 2005	Masters	Matthias Kraume, TUB
Ewan McAdam	Technical University of Berlin (TUB)	"Comparison of membrane bioreactor and gravel and sand filter as greywater treatment options in Morocco"	June 2004	Masters	Matthias Kraume, TUB
Elisabeth Freiberger	BOKU	Sustainability Evaluation of Sanitation Projects	12/2007	Masters thesis	Raimund Haberl, BOKU, Martin Regelsberger, AEE INTEC
Ehrenfried Lepuschitz	BOKU	Nachhaltige Siedlungswasserwirtschaft im ländlichen Raum	02/2008	Masters thesis	Raimund Haberl, BOKU, Martin Regelsberger, AEE INTEC

- Conferences

Table 43: Overview of conferences

Date	Venue	Subject	Participants	Remarks
21 to 24/03/07	Tunis	MEDA Water Conference on Sustainable Water Management	150	In connection with world water day
8-10/6/2006	Marrakech	2nd Zer0-m conference	130	Together with MEDAWARE
15 and 16/03/05	Istanbul	1st Zer0-M Conference on Sustainable Water Management	100	

The conferences are thus complete.

- Dissemination materials (newsletters, brochures, videos, posters, etc)

Table 44: Overview of dissemination material

Date	Type of Material	Description	Target group	Remarks
2009	Paper	B. EL HAMOURI. Rethinking natural, extensive systems for tertiary treatment purposes: the high-rate algae pond as an example	Scientific and technical community	Desalination and water treatment
11/09	Journal	issue 150 of Desalination	Scientific and technical community	Papers of the 3rd Meda Water conference
04/09	Paper	Masi F., El Hamouri B., Abdel Shafi H., Baban A., Ghrabi A., Regelsberger M. Segregated black/grey domestic wastewater treatment by Constructed Wetlands in the Mediterranean basin: the Zer0-m experience	Scientific and technical community	Water Science & Technology
03/09	UNESCO-book on Water resources in Maghreb	Chapter titled: La gestion locale et durable de l'eau municipale. Une nouvelle approche : utiliser l'eau plusieurs fois vers le zéro rejet	Scientific and technical community	Book edited by regional office of UNESCO, Rabat-Morocco Authors: A. Ghrabi, A. Koundi and L. Bousselmi
2/09	DVD	Video about Rainwater harvesting in Tunisia	General public, technical community	Produced by Sapiens Productions
2/09	DVD	Final version of the Zer0-M DVD with two videos "The Innovative Turn" and "Flush and Forget" and supporting technical documentation	General public, technical community	Produced by Sapiens Productions
02/09	Presentation	fbr conference on greywater use	Water experts	Publication of proceedings as issue of fbr series
01/09	Journal	Sustainable Water Management 3-2008	Water experts	

Date	Type of Material	Description	Target group	Remarks
2008	Paper	B. El HAMOURI, BEY I., AIT DOUCH N., GHAZI N., and REGELSBERGER M. (2008). Greywater treatment and recycling for toilet flushing: comparison of low and high tech treatment approaches.	Scientific and technical community	Water Practice and Technology 3(2) 40-46
2008	Paper	Scheumann, R., and Kraume, M.: Operational Experiences in Greywater Treatment with a Submerged Membrane Sequencing Batch Reactor (SM-SBR)	Scientific and technical community	Desalination
12/08	Journal	Special issue wastewater and environment	Scientific and technical community	Related to Meda Water conference
12/08	Scientific report	Collecte des eaux pluviales en Tunisie pour une utilisation domestique	Scientific community, Students	CERTE, Preparation of Diploma (Mastère, INAT)
12/08	Conference: Abstracts (1 oral presentation and 2 posters)	Sustainable water management (Zer0-M project, TDC and Pilot plant)	Scientific and technical community	CERTE, GEOSS African Water Cycle Symposium
11/08	Conference: Abstract (Poster)	Local water management and technical demonstration centre	Scientific and technical community	CERTE, Desert and Technology conference (DT'9)
10/11/08	Oral Conference + debate	Cleaner Production	Study and design companies working in the environmental field	Course organised by CITET : Environmental impact study (EIS)
10/08	Journal	Sustainable Water Management 2-2008	Scientific and technical community	
08/08	DVD	V-Learning course on sustainable water systems for Tunisian Chamber or Architects	Architects, Water experts	Will be used by Tunisian Chamber of Architects for continuous training
21/08/08	Interview with national TV channel	Interview with CNN Türk, explanation of the concept, introduction of Zer0-M project and filming in the TDC	Public	MRC, shown in news
25/06/08	Oral Conference + debate	Cleaner Production	Study and design companies working in the environmental field	Course organised by CITET : Environmental impact study (EIS)
02/08	Journal	Use of Membrane Bioreactor Technology within the SustainableWater Management Concept	Water experts, decision makers	MRC Turkey
02/08	Journal	An Overview for the Technical and Demonstration Centres of the Zer0-M Project	Water experts, decision makers	MRC, IGR, NRC, CERTE,
02/08	Journal	Sustainable Water Management Technologies in Turkey	Water experts, decision makers	MRC, FBR, Hannover university

Date	Type of Material	Description	Target group	Remarks
02/08	Workshop	Rôle de la recherche scientifique dans le recyclage et la réutilisation des eaux non conventionnelles	Water experts, decision makers	CERTE, SONEDE workshop: 'Saving water in High Education Institutions
02/08	Conference	Abstract for IWA 10th International Conference on Wetland Systems for Water Pollution Control	Water experts	AEE INTEC, ALT
01/08	Conference	Abstracts RMSU MEDA Water event in Marrakech	Water experts, decision makers	AEE INTEC, CERTE, IAV, IGR, MRC, NRC
01/08	Journal	Sustainable Water Management 1-2008	Water experts, decision makers	AEE INTEC, Austria, MRC Turkey
2007	Paper	B. El HAMOURI, NAZIH J. and LAHJOUJ J. Subsurface-horizontal flow constructed wetland for sewage treatment under Moroccan climate conditions	Scientific community, water experts	*Desalination*, 215 (2007) 153-158
2007	Paper	Merz, C.; Scheumann, R.; El Hamouri, B. and Kraume, M.: Membrane bioreactor technology for the treatment of greywater from a sports and leisure club	Scientific community, water experts	Desalination 215, 2007, 37-43
12/07	Video	Waste Not Waste	General public, decision makers, water experts, water community as dissemination tool	Produced by TVE and broadcast by BBC World as Earth Report in 1/2008 and 1/2009 and shown at WWF, Istanbul
11/07	Conference	Constructed wetlands in small/medium size communities and tourism facilities: design optimization aimed to the effluent reuse and nutrients recovering	Water experts, decision makers	ALT, Smallwat 07 II International Conference
11/07	Conference	Greywater treatment as an option for effective wastewater treatment in small communities	Water experts, decision makers	IAV, TUB, Smallwat 07 II International Conference
11/07	Paper	Membrane Bioreactor treatment of segregated household wastewater for reuse	Scientific community, water experts	MRC, published in Clean Soil Air Water, Vol.35, No.5, November 2007
09/11/07	Interview with national TV channel	Interview on Zer0-M project and concept behind it with TRT-2 channel, and filming in the TDC	Public	MRC, shown in EU funded environment projects program
10/07	Conference		Water experts, decision makers	wb, Braunschweig, DE, Sewage Association of the City of Braunschweig, nearly 100 participants
10/07	Conference	Greywater Treatment with Membrane Bioreactors: Com-	Water experts, decision makers	TUB, MRC, IAV, 7. Aachener Tagung

Date	Type of Material	Description	Target group	Remarks
		parison of Three Different Reactors Operated with Synthetic and Real Greywater		Wasser und Membranen (7th conference on water and membranes, Aachen
09/07	Paper	Zer0-M, sustainable concepts towards a zero outflow municipality		MRC, published in Desalination, Volume 215, Issues 1-3, 5 September 2007
08/07	Journal	Sustainable Water Management 2-2007	Water experts, decision makers	AEE INTEC, Austria, MRC Turkey
08/07	Proceedings	Constructed Wetlands for Decentralised Wastewater Treatment	Scientific community, water experts	ALT; International Symposium: "Community-led management of river environment", by Kaprimo Project (Adelphi, ECCA-Nepal, partners), Kathmandu, Nepal
06/07	Scientific Report	Gestion et Dimensionnement des Citernes d'eaux pluviales en Tunisie	Scientific community, Students	Preparation of Diploma (Engineer, INAT)
28/05/07	Workshop	Presentation of Zer0-M project, introduction of the TDC in MRC	Water experts, decision makers, scientist	MRC, workshop of MEDAWARE project on Sustainable Environmental Technologies and Strategies, Ankara
15/05 to 18/05/07	Oral presentation	Scheumann, R., Besançon, A., Jefferson, B. and Kraume, M. Biological Parameters in Greywater Treatment with a Submerged Membrane Sequencing Batch Reactor.	Scientific community	4th IWA Membrane Conference in Harrogate
03/07	Proceedings and CD-Rom	MEDA Water Conference on Sustainable Water Management	Scientific Community, water experts	
03/07	Conference Oral presentation	Influence of different HRT for the operation of a Submerged Membrane Sequencing Batch Reactor (SM-SBR) for the treatment of greywater	Scientific community, water experts	MEDA WATER International Conference on Sustainable Water Management, Desalination
21-24/03/07	Conference Oral presentation	Grey water treatment by a Membrane Bioreactor and reuse options	Scientific community, water experts	MRC, MEDA Water Conference on Sustainable Water Management, Tunis
21-24/03/07	Conference Oral presentation	Treatment of black water by a pilot scale submerged Membrane Bioreactor	Scientific community, water experts	MRC, MEDA Water Conference on Sustainable Water Management, Tunis
02/07	Journal	Sustainable Water Management 1-2007	Water experts, decision makers	AEE INTEC, Austria, MRC Turkey
2006	Journal	Kostbares Wasser mehrfach nutzen.	General public	TUB, Germany
12/06	Oral presentation at seminar or-	Assainissement décentralisé et possibilités de réutilisation des eaux Collecte et utilisation Vers	Water experts, decision makers	CERTE, Tunisia

Date	Type of Material	Description	Target group	Remarks
	ganised by CITET	le rejet zéro		
11/06	Oral Communication in the seminar organised by JNTDE	Vers une nouvelle approche pour la gestion locale de l'eau. Le rejet zéro.	Water experts, decision makers	CERTE, Tunisia
09/2006	Conference	Restaurant Wastewater Treatment by Overland Flow Systems, 10th International Conference on Wetland Systems for Water Pollution Control	Scientific community, water experts	MRC/Turkey
07/06	Newspaper clip	Kreatives Spiel mit dem Abwasser	General public	IGR, Austria
07/06	Journal	Sustainable Water Management 2-2006	Water experts, decision makers	AEE INTEC, Austria, MRC Turkey
06/06	Papers	7 papers submitted to Desalination and accepted after peer reviewing.	Scientific community, water experts	Available at http://www.desline.com/proceedings/215.shtml
06/06	Scientific Report	Etude préalable à la conception et au dimensionnement d'une station à macrophytes : application à la localité de Chorfech 24.	Scientific community, Students	Preparation of Diploma (Engineer, ESIER)
06/06	Brochure, CD	RUWTR conference 2 abstracts	Scientific community, water experts	Zer0-M, MEDAWARE IAV, Morocco
25-26/1/06	Proceedings	Spatial Decision Support System für nachhaltige Wasserwirtschaft im Projekt Zer0-M	Scientific community, water experts	IGR
01/06	Journal	Sustainable Water Management 1-2006	Water experts, decision makers	AEE INTEC, Austria, MRC Turkey
2005	Paper	René Gildemeister, Anja Drews and Matthias Kraume, Greywater treatment with a submerged membrane sequencing batch reactor (SM-SBR)	Scientific community, water experts	Environment Protection Engineering 2005, Volume 31, Issue 3-4, p 39-52
2005	Paper	Ewan McAdam, Simon J. Judd, René Gildemeister, Anja Drews and Matthias Kraume: Critical analysis of submerged membrane sequencing batch reactor operating conditions	Scientific community, water experts	Water Research 2005, Volume 39, Issue 16, p 4011-4019
2005	Journal	Plant yield production and heavy metals accumulation as affected by sewage sludge application on desert soil	Scientific community, water experts	NRC
12/05	Poster	Zer0-M project poster	Water experts, decision makers	AEE INTEC, Austria

Date	Type of Material	Description	Target group	Remarks
12/05	Journal	Membrane Bioreactor for the Treatment of Wastewater in an Egyptian Plant	Scientific community, water experts	NRC
12/05	Journal	Fate of metalloid fungicide in subjected water, soil and plant in Egypt	Scientific community, water experts	NRC
11/05	Journal	Role of Industrial Wastewater on the Contamination of River Nile in Greater Cairo	Scientific community, water experts	NRC
11/05	Training material	Train the Trainer Seminar	Trainers in French speaking MEDA countries	Material in French
10/05	Paper	Wasser – Waffe, Ware, Menschenrecht? Wege zu einer nachhaltigen Wasserwirtschaft	Scientific community, water experts	TUB
10/05	Conference	Wastewater Reuse For Irrigation On The Desert Sandy Soil Of Egypt: Long-Term Effect	Scientific community, water experts	NRC
30/09/05	Oral Communication in the seminar organised by ONAS	Une nouvelle approche pour améliorer la réutilisation des eaux usées: Le concept 'rejet Zéro'	Water experts, decision makers	CERTE, Tunisia
19-21/09/05	Proceedings	Modeling and evaluation of nitrogen removal performance in subsurface flow and free water surface constructed wetlands	Scientific community, water experts	
09/05	Conference paper	Evaluation of nitrogen removal in subsurface flow and free water	Scientific community, water experts	MRC, Turkey, IWA Specialized Conference Nutrient Management in Wastewater Treatment Processes and Recycle Streams
09/05	Conference poster	Modelling and evaluation of nitrogen removal performance in subsurface flow and free water surface constructed wetlands	Scientific community, water experts	MRC, Turkey, IWA Specialized Conference Nutrient Management in Wastewater Treatment Processes and Recycle Streams
08/05	Journal	Sustainable Water Management 1-2005	Water experts, decision makers	AEE INTEC, Austria, MRC Turkey
07/05	Training material	Train the Trainer Seminar	Trainers in Turkey	Material in Turkish
09-10/06/05	Workshop	Presentation of Zer0-M project and concept behind it	Water experts, decision makers, scientist	MRC, workshop of MEDAWARE project on Reuse of Treated Domestic Wastewaters in Agriculture, Ankara
04/05	Paper	Greywater treatment in a submerged membrane se-	Scientific community, water	TUB

Date	Type of Material	Description	Target group	Remarks
		quencing batch reactor (SM-SBR)	experts	
15-16/03/05	Conference poster	Use of a Pilot-Scale Combined Constructed Wetland System for the Removal of BOD, N and P	Scientific community, water experts	MRC, 1.St Zero-M Conference on sustainable Water Management, Istanbul 15-16 March 2005.
03/05	Brochure	1st Zer0-M conference proceedings	Scientific community, water experts	MRC, Turkey
03/05	News item	auf dem Weg zur abwasserfreien Gemeinde - das Projekt Zer0-M	General public	TUB-kubus, Germany
02/05	Folder	Zer0-M project folder	Water experts, decision makers	wB, AEE INTEC, all partners
02/05	Conference paper	Wasser - Waffe, Ware, Menschenrecht? dezentrale Konzepte als Beitrag auf dem Weg zur abwasserfreien Gemeinde - das Zer0-M Projekt	Scientific community, water experts	TUB-kubus, Germany
01/05	Publication	Greywater treatment in a submerged membrane Sequencing Batch Reactor	Scientific community, water experts	TUB-VT, Germany
12/04	Journal	Levels of Heavy Metals in the Nile and Drainage Waters	Scientific community, water experts	NRC
12/04	Journal	Risk reduction of sewage disposal via treatment oxidation ponds in Aden, Yemen	Scientific community, water experts	NRC
11/04	Journal	Spectroscopic Study: Trace Metals in River Nile Sediments	Scientific community, water experts	NRC
09/04	Conference paper	Performances analysis and modelling of an experimental constructed wetland	Scientific community, water experts	MRC/Turkey
08/04	Training material	Train the Trainer Seminar	Trainers in MEDA countries	In English
06/04	Conference	Sustainable Concepts towards a Zero Outflow Municipality	Scientific community, water experts	AEE INTEC
06/04	Conference	Advanced Wastewater treatment by direct filtration system	Scientific community, water experts	NRC
04	Proceedings	Angepasste Kartographie und Geoinformatik als Werkzeuge für eine nachhaltige Wasserwirtschaft im Euro-Mediterranen Raum	Scientific community, water experts	IGR
12/03	Journal	Risk assessment of sewage reuse on the sandy soil of Abu-Rawash Desert	Scientific community, water experts	NRC
12/03	Proceedings	Risk of Heavy metals on the anaerobic digestion of sewage sludge.	Scientific community, water experts	NRC

- Technical reports

Table 45: Technical reports

Date of completion	Type of report	Description	Target group	Remarks
10/08	Manual	Maintenance Manual for the solar system of the hammam El Attaisir	Hammam El Attaisir	
09/08	Tender	Tender documents for pilot plant of Chorfech in Tunisia	Tenderers	Approved by EC
07/08	Tender	Tender documents for primary school of Chorfech 24 in Tunisia	Tenderers	Approved by EC
01/2008	Report	Chrofech primary school design report	School, Tunisian Ministry of Education	accepted
01/2008	Study	Chorfech Environmental Impact Study	Tunisian Authorities, Delegation	
12/2007	Report	Chorfech design report	Delegation, Tunisian Authorities	approved by EC
11/2007	Manual	Maintenance Manual for the SEKEM CW	SEKEM	
7/2007	Report	Design report for SEKEM pilot systems	EC Delegation, SEKEM	
7/2007	Report	Design report for El Attaouia pilot systems	EC Delegation, contractor	
6/2007	Study	Preliminary study for the El Attaouia pilot systems	Project team, local authorities, contractor	
6/2007	Study	TDC design in Egypt	Project team, local authorities	
1/2007	Tender	Tender documents for TDC in Tunisia	Tenderers	
06/2006	Study	Preliminary study for firmm pilot plant in Morocco	firmm, local authorities	
12/2005	Study	TDC design in Tunisia	Project team, local authorities	
3/2004	Study	TDC design in Morocco	Project team, local authorities	
10/2005	Tender	Tender documents for TDC in Turkey	Tenderers	
9/2005	Study	TDC design in Turkey	Project team, local authorities	
12/2003	Study	TDC systems	Project team	

Date of completion	Type of report	Description	Target group	Remarks
2004	Report	DSS Description	Project team	
11/2003	Report	Target definition for case studies	Project team	

- Supply contracts

Table 46: Supply contracts (costs in EUR)

Date of delivery	Description	Contractor	Recipient	Costs	Remarks
	Total			261.807,57	
16/03/08	Two acrylic compartments 15 litres effective volume each for the (RBC)		NRC	5.224,44	
03/03/08	Variable speed motor+pH & DO control unit+dosing pumps for (RBC)		NRC	8.097,89	
22/02/08	pump+compressor+steel shelves for the RBC		NRC	7.444,83	
06/12/07	Kjeldahl system		NRC	9.424,00	
06/12/07	Oximeter, COD reactor, lab furnace, turbiditymeter	TS-lab equipment	NRC	5.705,00	
02/09/08	Solar equipment	BBM	Hammam Attaisir	104.357,73	
08/07/08	Lab equipments (DL)	Dr. Lange.	CERTE	10.481,29	
18/05/07	Computer supplies	I.Com	CERTE	6.222,13	
20/12/06	Membrane Bioreactor	Busse	IAV	8.271,00	
20/12/06	Sequencing Batch Reactor	Pontos	IAV	7.628,50	
05/07/06	Membrane Bioreactor	Busse	CERTE	8.275,00	
13/06/06	Sequencing Batch Reactor	Pontos	CERTE	7.628,50	
21/03/06	car VW Transporter Pick-up	Societe Ennakl	CERTE	28.700,00	
05/07/06	Membrane Bioreactor	Busse	NRC	8.522,10	
13/06/06	Sequencing Batch Reactor	Pontos	NRC	7.328,50	
10/07/06	Laptop (3 items)	YÖNSIS Bilgisayar Sistemleri	MRC	6.371,56	
05/07/06	2 Membrane Bioreactors	Busse	MRC	14.396,60	
13/06/06	Sequencing Batch Reactor	Pontos	MRC	7.728,50	

- Works contracts

Table 47: works contracts (costs in EUR)

Date of completion	Place	Description	Contractor	Recipient	Costs	Remarks
	Total				661.132,43	
17/02/09	CERTE	Primary school	EROBAT	School	28.781,10	
17/02/09	CERTE	Pilot Plant of Chorfech	Rainbow	ONAS	193.184,06	
28/02/09	CERTE	ONAS, pumping station and transfer line	SGC	ONAS	46.893,11	
21/12/08	El Attaouia	Solar heater	MYFAK	Hammam Attaisir	15.860,76	
21/12/08	El Attaouia	Solar heater	SFTM	Hammam Attaisir	7.851,69	
15/08/08	NRC	TDC NRC	RSD	NRC	1.101,65	Extension
15/08/08	NRC	TDC NRC	RSD	NRC	21.977,34	
12/07	NRC	TDC NRC, constructed wetlands	Misr Trading	NRC	12.148,05	
20/08/08	SEKEM	Pilot wastewater treatment, part 2		SEKEM	52.814,37	
17/09/07	SEKEM	Pilot wastewater treatment, part 1		SEKEM	18.479,20	
11/07	El Attaouia	Pilot greywater for hammam	Societé A2L travaux publics	Municipality of El Attaouia	103.068,94	
11/07	El Attaouia	Pilot greywater for apartment house	Societé A2L travaux publics	Municipality of El Attaouia	24.800,00	
19/10/07	CERTE, INAT	TDC construction	SENEL	CERTE	69.139,24	
12/12/06	MRC, Gebze, Turkey	Road construction for TDC, addendum to TDC construction	YURT INSAAT	MRC	6.614,24	
14/12/06	MRC, Gebze, Turkey	TDC construction	YURT INSAAT	MRC	34.657,84	
23/11/06	MRC, Gebze, Turkey	TDC building improvement (siding, roof coverage, window, door PVC)	YAPISAN	MRC	7.529,89	
12/07/04	Rabat Morocco	Construction works TDC, grey- and blackwater separation	WAFACO	ACSA sports club	7.874,84	
10/03/04	MRC, Gebze, Turkey	Construction works for segregation process	A1 Yapi Endüstrisi	MRC	8.356,11	

- Service contracts

Table 48: Service contracts (costs in EUR)

Date of completion	Description of service	Contractor	Costs	Remarks
	Total		305.367,59	
	Audit	Deloitte	47.000,00	Excluding VAT
23/02/09	Supervision of works at pilot treatment plant	IRIDRA	18.672,00	
09/02/09	Rainwater short	Sapiens production	13.207,50	
21/12/08	Video: Flush and forget	TVE	92.865,00	
31/08/08	DSS design, environmental assessment	AMBIENTE ITALIA	19.385,12	subcontractor of ALT, nominated in the Contract
31/08/08	DSS, LCA	ECOBILANCIO	9.766,20	subcontractor of ALT, nominated in the Contract
31/08/08	Design of systems, consultancy	IRIDRA	20.185,93	subcontractor of ALT, nominated in the Contract
12/10/07	Video: Nor any drop to drink	IRC Empowers	30.000,00	
31/07/06	Conference organisation	Formatiscom	15.000,00	
30/01/07	Int. MEDAWATER conference	Alice Events	25.000,00	
31/03/05	Cost of conference, Publications, Translation, Printing	Turk Ekspres	14.285,84	