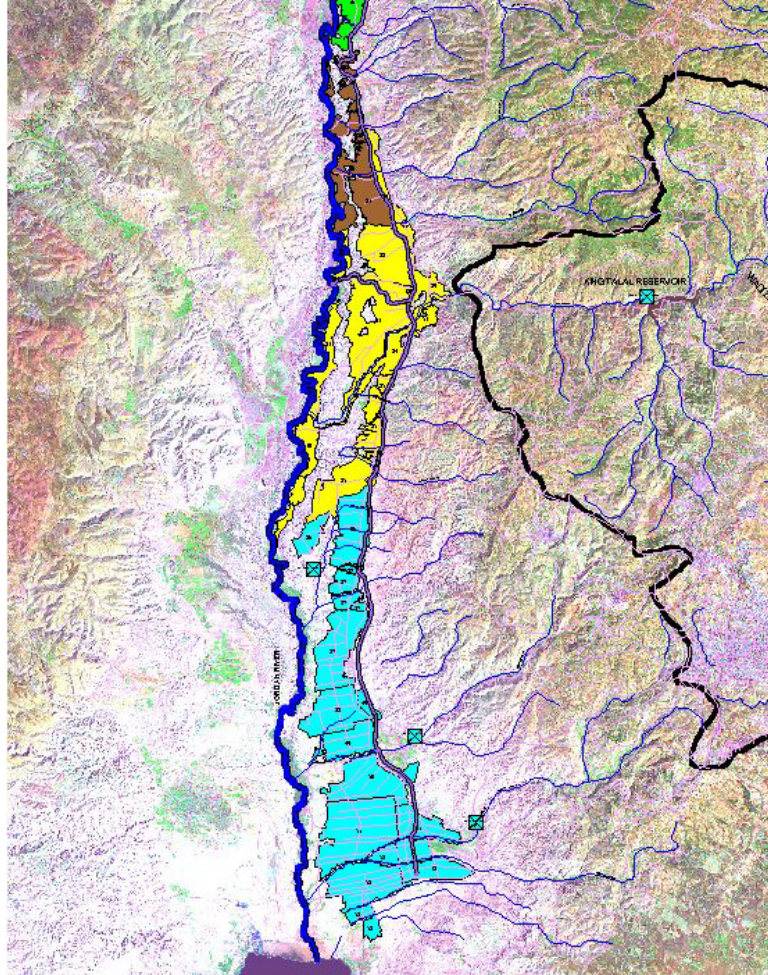


Hashemite Kingdom of Jordan
Ministry of Water and Irrigation

Use of Reclaimed Water in the Jordan Valley



Appraisal Mission
- Final Report -

Commissioned by
German Technical Cooperation
(GTZ)

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Abbreviations / Acronyms

BOD ₅	Biochemical oxygen demand
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development)
BWP	Brackish Water Project (JVA/GTZ)
CIDA	Canadian International Development Agency
COD	Chemical oxygen demand
dS/m	Electrical conductivity unit (deciSiemens/meter)
du	Area unit (1 du = 1,000 m ² = 0.1 ha)
FAO	Food and Agriculture Organisation of the United Nations
GCEP	General Cooperation for the Environment Protection
GDP	Gross domestic product
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (German Technical Cooperation)
JEPA	Jordan Exporters and Producers Association for Fruits and Vegetables
JISM	Jordanian Institute for Standards and Metrology
JOD	Jordanian Dinar (June 2002: 1 JOD = 1.62 EUR; 1 EUR = 0.62 JOD)
JS	Jordanian Standard
JVA	Jordan Valley Authority
JVFU	Jordan Valley Farmers Union
KAC	King Abdullah Canal
KAS	Khirbet As-Samra
KfW	Kreditanstalt für Wiederaufbau (German Financial Cooperation)
KTR	King Talal Reservoir
MCM	Million cubic meters
MoA	Ministry of Agriculture
MoH	Ministry of Health
MoWI	Ministry of Water and Irrigation
NCARTT	National Centre for Agricultural Research and Technology Transfer
ppm	parts per million
RSS	Royal Scientific Society
RW	Reclaimed water
TDS	Total dissolved solids
TOR	Terms of reference
TSS	Total suspended solids
TWW	Treated wastewater
USAID	United States Agency for International Development
WAJ	Water Authority of Jordan
WERSC	Water and Environment Research and Study Center (University of Jordan)
WHO	World Health Organisation
WWTP	Wastewater treatment plant

EXECUTIVE SUMMARY

- 1 The water sector is the focal area of cooperation between Jordan and Germany. Development cooperation between the two countries aims at integrated water resources management that is sustainable in economic, ecological and social terms. In particular it aims at an increased use of treated wastewater (reclaimed water) and brackish water as substitutes for fresh water, especially in the Jordan Valley.
- 2 Recognising the importance of the use of reclaimed water in agriculture the governments of the two countries agreed in November 2001 to start a new project, titled 'Use of Reclaimed Water in the Jordan Valley' (RWP), in the middle and southern part of the Valley which will build on the infrastructure and achievements of the Brackish Water Project (BWP), jointly implemented since 1997 by JVA and GTZ.
- 3 With an increasing competition for usage of freshwater in municipalities, agriculture and industry the Jordanian water policy considers wastewater as an important component of Jordan's water resources and calls for appropriate treatment of wastewater according to health and environmental standards, priority use for unrestricted irrigation, improved farming practices, extension to farmers, as well as environmental monitoring and public health control.
- 4 The volume of reclaimed water available in the Amman-Zarqa basin is expected to grow from approximately 61 MCM/year in 2000 to almost 180 MCM/year by 2025. Over 90 % of this originates from the Khirbet As-Samra facilities and is only partly in line with international and Jordanian standards. At present, most of the treated effluent is mixed with other water and distributed to about 3,400 farms in the middle and southern Jordan Valley with increasing problems regarding salinity, heavy metals and marketing of crops irrigated with reclaimed water.
- 5 At present a wide range of Jordanian governmental and non-governmental organisations are involved in wastewater management, use of reclaimed water as well as related environmental and health activities. Existing institutional problems are mainly related to the multitude of institutions involved with any possible inherent weaknesses, insufficiently defined responsibilities, as well as insufficient coordination between the institutions.
- 6 Jordanian experiences in the past are that vegetables irrigated with reclaimed water occasionally faced difficulties in being accepted on local Jordanian and export markets. Unless an independent controlling system of agricultural products is implemented, this situation is unlikely to change, in particular with regard to the emerging European market.
- 7 The project purpose of RWP is defined as:

"Farmers in the Jordan Valley use reclaimed water for irrigation in accordance with environmental and public health regulations"
- 8 Beneficiaries of the project are all farmers with irrigated plots in the middle and southern part of Jordan Valley (JVA Middle and Karameh Directorates), where

the economically most feasible options for agricultural reuse are found. These farmers expect the regular supply of sound and sufficient irrigation water. They also expect regular information on the water quality and its nutrient contents in order to adapt the fertiliser quantities applied to the crops.

- 9 Transparency concerning water and agricultural produce quality is a very important feature, especially with regard to health hazard for farm workers and customers. The project supports activities answering these expectations.
- 10 An essential issue of the project concept is the creation of a working group that shall bring together responsible people from relevant institutions from MoWI, JVA, WAJ, MoA, MoH, GCEP as well as the private sector (traders, farmers, processors etc.). The working group will be responsible for coordination of environmental and health monitoring and analysis, dissemination of information, and awareness creation on a high level.
- 11 In particular the following results are expected from the project implementation:

Successful farming practices with reclaimed water are elaborated and made available to farmers and extension services

Impact of reclaimed water on soils and groundwater is regularly assessed on representative sites

Organisations and stakeholders involved in the use of reclaimed water coordinate responsibilities and activities with regard to water quality, health and environment

Quality of crops irrigated with reclaimed water is monitored with regard to human health and market acceptance

- 12 The new project RWP is planned to start in January 2003 with an initial phase of 4 years until December 2006 making full use of the achievements as well as of the physical and personnel infrastructure of the Brackish Water Project (BWP). The activities of BWP will continue until June 2003 so that sufficient overlap is guaranteed and major synergy effects can be exploited.
- 13 For the German side it is recommended to take over the available experts from BWP as well as some of the locally employed technical staff. Taking into consideration the complex works related to the use of reclaimed water we suggest a wastewater specialist join the project team as an additional German contribution.
- 14 After successful implementation of the first project phase a second phase of additional 2 years may be envisaged starting in 2006. This phase would concentrate on further advisory services and follow-up for the consolidation and continuous updating of the achieved results.
- 15 The overall responsibility of project implementation should be linked to **JVA**. This is recommended taking into account the existing experience and infrastructure of BWP and its strong relations with the farmers in the Jordan Valley as beneficiaries of the project. Within JVA the project coordination has to be assigned to a high level in hierarchy with the required responsibilities and abilities in order to assure a smooth and effective project implementation.

- 16 It is suggested to constitute a steering committee representing the main stake holders including MoWI which will provide advice and support during the project implementation. It is deemed necessary that all involved stakeholders take active roles in the steering committee as the project requires intensive coordination among several ministries and institutions, which calls for a strong and respected position within the Jordanian governmental setting.
- 17 During the implementation process additional important roles have to be taken by other organisations. Major contributions in the following fields are considered as crucial:
- WAJ: monitoring of effluent quality, revision of Jordanian Standards, establishment of water quality warning system
- MoH: environmental monitoring, awareness campaigns, public health, revision of Jordanian Standards, quality assurance for agricultural produce
- MoA: agricultural extension, quality assurance for agricultural produce, certification system
- GCEP: awareness campaigns, environmental monitoring, revision of Jordanian Standards
- RSS: analysis of soil, water and agricultural produce
- JEPA: quality assurance for agricultural produce, certification system
- WERSC: establishment and coordination of working groups
- 18 The necessity of sincere Jordanian ownership for the project is strongly underlined by the appraisal team.
- 19 A planning workshop for the project shall be held with the concerned stakeholders in early 2003 in order to fine tune results and activities and to define the contributions from the particular stakeholders.

2 PROJECT RATIONALE, TOR, AND WORKING APPROACH

2.1 Reasons for new project

The water sector is the focal area of cooperation between Jordan and Germany. Following the *Joint Approach of Jordanian-German Cooperation in the Water Sector and related Environmental Aspects* (BMZ/MoWI 2001) the development cooperation between the two countries in the water sector aims at helping to ensure an integrated water resources management that is sustainable in economic, ecological and social terms. Concerning the water use in agriculture it aims at an increased use of treated wastewater (reclaimed water) and brackish water as substitutes for fresh water, especially in the Jordan Valley.

In order to make optimal use of synergies, German development cooperation is aiming to strengthen the collaboration between financial and technical cooperation and other German institutions as well as with other donors. Therefore networking of water sector projects will be further intensified.

Recognising the importance of the use of reclaimed water (RW) in agriculture the governments of the two countries agreed to start a new project titled '*Use of Reclaimed Water in the Jordan Valley*' (RWP) in the middle and southern part of the Valley which will build on the infrastructure and achievements of the *Brackish Water Project* (BWP), jointly implemented by JVA and GTZ since 1997. During the governmental consultations in November 2001 it was decided to commission an appraisal mission for the planning of the new project.

2.2 TOR and working approach

The appraisal works took place in February and March 2002 by:

Dr. Anton Mauderli, Agronomist and Irrigation Expert	(25.02. – 04.03.)
Mr. Otto Schreiner, Agricultural Economist, Team Leader	(18.02. – 04.03.)

The appraisal team based its work on the GTZ guidelines for project appraisal and specific terms of reference. The TOR covered the following fields:

- Familiarisation with the Jordanian-German activities in the water sector and relevant documents
- Discussions with the BWP team, Jordanian and German Governmental organisations, international donors, and implementing agencies
- Brief assessment of the project's potential
- Field visits
- Assessment of status quo of RW use in Jordan
- Preparing of a conceptual proposal for RW project
- Recommendations for implementation of the project

3 PROBLEM ANALYSIS

3.1 Jordanian water sector

3.1.1 Present situation in the water sector

The Jordanian - German sites describe the present situation in the water sector as follows (BMZ/MoWI 2001):

- With annual renewable water resources of about 160 m³ per capita in 2000, Jordan is one of the most water-stressed countries in the world (the water poverty line is 500 m³). The renewable water resources are projected to fall to 90 m³/capita/year in 2025.
- Since the 1980s, water consumption has exceeded renewable water resources and the groundwater table has therefore fallen considerably in a number of basins already. Increasing withdrawals from existing renewable resources is therefore no longer an option.
- The competition of needs between drinking water supply and irrigation for agriculture is becoming increasingly tense. Around two thirds of the available water resources are used for agricultural purposes. However, this sector contributes only 3% of the GDP. The competition of usage between drinking water, agriculture and industry is likely to intensify.
- Drinking water supply coverage is high, above 90 %. At the same time, water losses caused by technical and administrative shortcomings are around 50 %. In urban areas, around 90 % of the households are served by existing central wastewater disposal systems; in rural areas the figure is just 50 %.
- Because of the general shortage of water the management of the water sector has traditionally been supply driven. However, there is an increasing awareness of the need for more demand-side management including water conservation.
- Continuous legal, financial, staffing and institutional improvements are necessary for the economic and technical efficiency of the organisations involved.

3.1.2 Jordan's water policy

The government's water policy is laid down in several strategy and policy papers:

The *National Water Strategy* (MoWI, 1997) stresses the need for improved resource management with particular emphasis on the sustainability of present and future uses. Special care shall be given to protection against pollution, quality degradation and depletion of resources. Water pricing shall be based on covering at least the cost of operation and maintenance of the infrastructure by the beneficiaries. Water tariffs shall be considered as tools to promote cost recovery of water projects.

The *Irrigation Water Policy* (MoWI, 1998) states that regular supply of irrigation water is essential for agriculture as it contributes to the production of food, provides job opportunities in direct and indirect agricultural employment and supporting services. Furthermore irrigation has to protect the environment and should prevent desertification. The policy is concerned with the introduction of advanced irrigation systems, on-farm water management, water quality, public and private involvement, water pricing, regulations and controls.

In the *Wastewater Management Policy* (MoWI, 1998) considers wastewater as an important component of Jordan's water resources. Due to the concentration of the urban population in the highlands the major quantity of treated wastewater is discharged into various water courses and flows to the Jordan Valley where it is used for irrigation.

3.2 Use of reclaimed water in Jordan

3.2.1 Status of reclaimed water use

As the Greater Amman Municipality and other cities of Jordan are growing rapidly, the volume of reclaimed water available in the Amman-Zarqa basin is expected to grow from approximately 61 MCM/year in 2000 to almost 180 MCM/year by 2025. Over 90 % of this originates from the Khirbet As-Samra (KAS) facilities. At present, most of the treated effluent is mixed with other water and distributed to about 3,400 farms in the middle and southern Jordan Valley. Increasingly farmers have problems with the management of salinity and some heavy metals as well as with the marketing of crops irrigated with reclaimed water.

The characteristics of wastewater in Jordan are different from other countries. The average salinity of municipal water supply is 580 ppm of TDS (0.9 dS/m) and the average domestic water consumption is low (around 70 l/capita/day). This results in a high salinity of wastewater, especially when treated in waste stabilisation ponds (85 % of the total generated wastewater), where part of the water is lost through evaporation, thus increasing salinity levels in the effluents. In addition, high organic loads impose operational problems when the treatment plants become biologically overloaded.

Given the low level of industrial discharges to sewage treatment plants, wastewater in Jordan is relatively low in toxic pollutants such as heavy metals and toxic organic compounds. It is estimated that about 10 % of the biological load originates from industrial discharges. Most of Amman's treated wastewater is discharged in the Zarqa river and reaches the King Talal Reservoir (KTR) where it is blended with surface water and used for irrigation in the middle and southern Jordan Valley.

The *Water Sector Review of the Hashemite Kingdom of Jordan* (World Bank, 1997) recommended the formulation of a wastewater treatment and reuse strategy in order to safeguard irrigation water quality and quantity. Thus major key issues have been addressed in the *Wastewater Management Policy* (MoWI 1998):

- Wastewater is considered as a perennial water source and shall form an integral part of renewable water resources and the national water budget. The use of reclaimed water in irrigation shall be given the highest priority.
- Treatment of wastewater shall be targeted towards producing an effluent fit for reuse in irrigation in accordance with WHO and FAO guidelines as a minimum. Reuse of treated wastewater for other purposes shall be subject to appropriate (national) specifications.
- Effluent quality shall meet public health standards for end users. Wastewater from industries with significant pollution should be treated separately to standards allowing its reuse.

- Priority shall be given to agricultural reuse of treated effluent for unrestricted irrigation. Blending of treated wastewater shall be made to improve quality when possible. Crops to be irrigated by the treated effluent or blend thereof with fresh water resources shall be selected to suit the irrigation water, soil type and chemistry, and the economics of the reuse options.
- Crop nutrient requirements shall be determined taking into consideration the prevailing effluent quality. Overuse of nutrients shall be avoided and accumulation of heavy metals and salinity shall be monitored, managed and mitigated. Sludge from the treatment process, which is currently stored in special places, shall be used as fertiliser and soil conditioner after processing. Care shall be taken to meet the regulations of public health and environment protection.
- Farmers shall be encouraged to use modern and efficient irrigation technologies. Protection of farm workers and of crops against pollution with reclaimed water shall be ensured and legislation and institutional arrangements for the development and management of wastewater shall be periodically reviewed and modified, if necessary.
- Extensive and comprehensive monitoring programmes shall be developed. Influent to and effluent from the plants shall be monitored to ensure public health objectives and environmental protection of soils as well as surface and groundwater.
- Applied research on relevant wastewater management topics shall be adopted and promoted by the Government.

3.2.2 Institutions involved (stakeholders)

At present the following Jordanian governmental and non-governmental organisations are involved in wastewater management, use of reclaimed water as well as related environmental and health activities:

- Ministry of Water and Irrigation (MoWI)
- Jordan Valley Authority (JVA)
- Water Authority of Jordan (WAJ)
- Ministry of Agriculture (MoA)
- National Centre for Agricultural Research and Technology Transfer (NCARTT)
- Ministry of Health (MoH)
- Water and Environment Research and Study Center (WERSC)
- General Corporation for the Environment Protection (GCEP)
- Royal Scientific Society (RSS)
- Jordanian Institute for Standards and Metrology (JISM)
- Jordan Valley Farmers Union (JVFU)
- Jordan Exporters and Producers Association for Fruit and Vegetables (JEPA)

Furthermore several donors and organisations are involved in planning and implementation wastewater related projects:

- German Financial Cooperation (KfW)
- German Technical Cooperation (GTZ)
- European Union

- United States Agency for International Development (USAID)
- World Bank
- Canadian International Development Agency (CIDA)

3.3 Critical issues of reclaimed water use in the Jordan Valley

3.3.1 Importance of agricultural production

The Jordan Valley is Jordan's most fertile and productive agricultural area. Winter temperatures in the valley average 15 - 22° C between November and March, but rise to more than 40° C in the summer. The average rainfall is 380 mm in the north, but less than 100 mm per year in the south. Consequently, production of food and other agricultural commodities is hardly possible without irrigation.

Therefore the construction of the East Ghor Canal in the early 1960s was the turning point in the modern history of the Jordan Valley. The canal quickly transformed the area from subsistence cereals farming to large scale irrigated production of high-value, marketable fruits and vegetables.

Today the Jordan Valley covers about 36,000 ha of potentially irrigable land, offering best prospects for irrigated farming especially for winter crops produced at least two to three months ahead of other parts of the Middle East.

3.3.2 Problems of agricultural production with reclaimed water

The main source of reclaimed water used for irrigation in the middle and southern Jordan Valley originates from Khirbet As-Samra (KAS) wastewater treatment plant, which was designed in the early 1980s. Due to the fast urban development the actual inflow was beyond design capacity already in the early 1990s. Presently a new plant with increased capacity and advanced treatment processes is planned and expected to be operational by 2005.

Effluent characteristics of the KAS plant are only partly in line with international standards (WHO) and with Jordanian Standard JS 893/95. Specific technical aspects of and deviations from these standards are discussed hereafter.

Total Dissolved Solids (TDS)

Recorded TDS from the KAS plant (average 1240 mg/l) do not permit unrestricted use for sensitive crops. The latter would suffer from yield-decrease in case of non-blended use. Na is brought into the system through municipal water supply, since fresh water (pumped from aquifers in the up-lands) contains Na-salts. Other elements (N, P, Ca, and S) could basically be beneficial for agricultural production.

With regard to blending of effluents with fresh water in the Jordan Valley, so far only minor negative impacts have been reported. The risk hazard remains unclear as long as data regarding quality of the water supplied in the irrigation system as well as the blending ratio are not available to the public and the water users. The hazard however can be expected to further decrease after the extension of the KAS plant will come into operation.

Biological Oxygen demand (BOD₅) / Chemical Oxygen Demand (COD)

Both these criteria exceed Jordanian Standard JS 893/95 when the water is released from the KAS plant into Zarqa-River. However, due to the aeration process taking place during the 40 km open flow to KTR, the quality of the water is said to improve approximately to the level where it can be used for irrigation of vegetables to be cooked, fruit and forestry trees and for industrial products. After appropriate blending with water from KAC the blend usually can meet the requirements for restricted agricultural use.

Total Suspended Solids (TSS)

TSS is definitely on the high side when the water is released from the KAS plant; it is unlikely to significantly decrease before it reaches KTR. Still the quality aspect would classify this water to suit restricted agricultural use. There should be no problems, provided surface irrigation methods are being applied, though in the case of drip-irrigation there would remain an increased hazard for clogging of drippers and filters. This risk prevails, even under the assumption that the water will be blended before being fed into the pressurised irrigation system.

Pathogens / Control through chlorinating

In general the Jordanian Standard JS 893/95 is in line with the WHO/FAO standards. However the effluent quality records performed by the plant's laboratory do not include hygienic parameters, like coliforms, Helminths eggs, nematodes etc. These parameters are being determined by the Central Laboratory of WAJ as the responsible control institution; the management of the plant is notified in case of deviations from the standards. In addition, RSS (on behalf of JVA) has occasionally been checking pathogens in the blended water from KTR as well as in selected places along KAC. In its tentative assessment RSS emphasises the need to carry out periodically microbial and chemical tests as to assure the quality of the irrigation water and to monitor its variations over time.

Control of pathogens through chlorinating is hardly an option for the time being, due to the high TSS-content. Cl-ions would rather adhere to the suspended particles, than taking care of the pathogens. Only the application of extremely high Cl-doses could eventually have an influence upon the pathogens. Therefore chlorinating as a control-method for pathogens has practically been abandoned.

Agricultural workers are definitely exposed to water of an unknown health hazard. However, health centres are presently not in the position to isolate hazards induced by the prevailing sanitary conditions in the housing areas from those occurring in the fields due to irrigation practices.

Nitrogen (N)

Although the NH₄-content is far too high when effluents are released from the KAS plant, this is acceptable for agricultural use, or it might even reveal beneficial in most cases. As a cation, NH₄ might adhere to soil particles in cases where crops are not in need of this nutrient.

On the other hand the NO₃-content is extremely variable in the effluent of the KAS plant (0.1 – 90 mg/l; average 62 mg/l). This variation might be due to the inadequate control of retention time within the ponds. The high NO₃-content is unlikely to de-

crease on its way to KTR due to the favourable aeration conditions in the wadi. In periods of low N-demand by the crop (e.g. winter-months), the excessive NO_3 will be leached into the groundwater (see subsection 3.3.3). Occasionally crops might also take up excessive N even without physiological demand. In this case the ripening process of fruits could be retarded, fruit quality could be decreased, and/or excessive vegetative growth could occur.

Trace elements and heavy metals

So far the content of trace elements in TWW in Jordan is relatively low. For the time being little impact upon agricultural production has to be expected. However the tendency shows clearly an upward trend. On the other hand, these elements tend to concentrate in the sludge, a fact which might have impacts on the environmental level in the future (see subsection 3.3.3).

Sprinkler irrigation

According to JS 893/195 it is prohibited to use sprinkling for irrigation with reclaimed water. International experts support this regulation. Although heavy metal components are of minor importance within effluents of the Amman area, prohibition of sprinkling appears reasonable as to avoid leaf contamination, due to pathogens.

Vegetable production

According to JS 893/195 it is prohibited to use effluents for irrigation of vegetables that can be eaten raw. Although this restriction might appear to be rather stringent compared to practises elsewhere, it is suggested that present and future projects in Jordan do comply with these criteria. Jordanian experiences in the past are that vegetables face difficulties in being accepted on local Jordanian and export markets. Unless an independent controlling-system of agricultural products is implemented, this situation is unlikely to change in a foreseeable future.

3.3.3 Environmental and health issues

Salinity / Alkalinity

Alkali-hazard represents definitely an environmental issue, since in most cases an eventual alkalisation process is non reversible. Alkalinity represents a further salinity development stage, which may result from previous, inadequate salinity management or from subsequent lack of water due to insufficient leaching fraction. Subsequent adding of Na^+ -ions into the topsoil tends to replace the Ca^{++} -ions in the complex. Due to extremely high electron-positive character of the Na^+ -ions, the latter tend to deflocculation of the soil aggregates; therefore only small pores remain, containing hygroscopic/non-available water. As a consequence, water can hardly penetrate into the soil, and the reminding soil water is no longer released to the crop.

NO_3 -import to groundwater

When NO_3 is not in demand by the crop it could be washed into the subsoil and subsequently into the underlying aquifers. It can be expected that the hazard will come under control as soon as the new KAS plant comes into operation in year 2005.

Emerging contaminants

Some relatively new concerns are the 'emerging' contaminants, including synthetic organic compounds, various pharmaceutical products, such as veterinary and human

antibiotics, and hormones. To a large extent such constituents remain in the effluents released from WWTP. However, so far no direct hazard is being expected with regard to irrigated crop production.

However such constituents are of major concern in the drinking water supply. Thus, a certain hazard does exist insofar as such constituents might be washed through the soil profile in course of normal irrigation operations and subsequently be released into the groundwater serving for drinking purposes.

Sludge disposal

At present sludge from the wastewater treatment plants is transported and deposited in various sanitary landfill areas. No details regarding environmental effects are available. Within the scope of extension of the KAS plant, a mechanical sludge-dewatering plant will be installed. Aspects of controlled sludge disposal including use for soil conditioning have to become objectives of studies and of high-level policy decisions. At present no use of treated sludge is permitted in Jordan.

Market acceptance

A growing concern among consumers of local and export markets can be stated regarding health aspects and quality of fruits and vegetables irrigated with reclaimed water, although no specific data or reports are available which prove these fears.

With the Jordan-EU association agreement signed in 2002 the particular European specifications will become binding for Jordanian agricultural exports to Europe starting from January 2003. By this time exporters have to meet the specific requirements, which calls for an adequate monitoring and certification system to be set up in Jordan in cooperation between the private sector and the concerned public organisations.

3.3.4 Institutional and legal problems

Institutional problems are mainly related to the multitude of institutions involved with not always clearly defined responsibilities as well as occasionally lacking coordination between the institutions. Main problems are:

- Institutional weakness of certain institutions (insufficiently trained staff, low salaries compared to the private sector, low motivation of staff, lack of management capacity, insufficient financial resources)
- Water and wastewater policies are formulated, but insufficiently implemented
- Responsibilities of the involved institutions being poorly defined
- Coordination between the institutions has to be improved (e.g. water quality monitoring)
- Insufficient public transparency concerning irrigation water quality
- Lack of appropriate monitoring- / trigger-off-system / controlling- system for irrigation water quality
- Certification system for agricultural products non existent
- Extension services for water management and adapted agricultural production systems are insufficient

- Decision makers lack information on monitoring results and problems related to low water and produce quality
- Low enforcement capacity concerning regulations and standards

3.4 Analysis of beneficiaries

Beneficiaries of the project are the persons working in and depending on the agricultural sector in the middle and southern Jordan Valley. The total number of directly employed persons in agriculture in this area was estimated to be around 38,000 persons (1996/97). The figure is broken down as follows:

Farmers	5,500 (almost all Jordanian)
Family labour	5,300 (18 % non Jordanians)
Permanent hired labour	7,300 (82 % non-Jordanians)
Seasonal labourers	20,000 (86 % non-Jordanians)

The average revenue per farm is approximately 12,700 JOD, the area average per farm is approximately 340 JOD/du (JVA/GTZ, 1998). The highest farm gross margins are generally obtained by citrus and vegetable farms. Field crops gross margin is considerably lower. Surprisingly, banana farms have a lower gross margin than other major farm types in the southern Jordan Valley mainly due to limited irrigation water availability and high costs for other inputs.

Despite the various land reform programmes in the past, absentee landlords are very common in the valley: the records presented by the Directorate of Planning & Special Projects (JVA), indicate only 30% of the farm units being farmed directly by the owners. Many farms are operated by a manager on behalf of the owner with the help of seasonal labour.

Farmers are worried regarding irrigation water quality, however they have no information regarding specific detrimental components and/or the blending ratio with fresh water. Reliability of irrigation water supply is uncertain, in particular during summer months. Farmers pay water fees according to readings taken at flow-meters (JD 0.015/m³).

Taking into consideration the complexity of sustainable irrigation with reclaimed water and the dependence of most farmers on external irrigation water supply their self help potential in this regard is low.

Only a few farms in the valley are managed by women. However women play an important role in farm work, especially for harvesting. But so far no gender specific issues have been identified concerning the use of reclaimed water.

4 OBJECTIVES ANALYSIS

4.1 Overall goal and project purpose

The **overall goal** of the new project is defined as:

" Water resources are used in an efficient and sustainable way"

The new project builds on the results of the ongoing Jordanian-German Project *Use of Brackish Water Project (BWP)* and fully supports the implementation of the water strategy of the Jordanian Government and particularly the *Wastewater Management Policy*.

The **project purpose** is defined as:

"Farmers in the Jordan Valley use reclaimed water for irrigation in accordance with environmental and public health regulations"

The pertaining indicators are:

- *From 2003 to 2006 an additional 50 % of monitored farm units apply appropriate management practices, thus considering the nutrient content of reclaimed water and reducing fertiliser applications accordingly.*
- *Concentrations of micro-biological parameters (pathogens etc.) on crops exposed to reclaimed water on monitored farm units meet Jordanian health standards by 2006 or are at least reduced by 40 % between 2003 and 2006.*

4.2 Assessment of objectives

4.2.1 Principles of Jordanian-German development cooperation

The project objectives correspond with the focal area of German - Jordanian cooperation and meet perfectly the principles of German development cooperation as well as the strategic intentions of the Jordanian Government. The project is focussing on sustainable use of the natural resources of soil and water in the Jordan Valley and supplying sufficient irrigation water equally to all users. German development cooperation bases its assistance in the water sector on the principles of ecological, economic and social sustainability.

4.2.2 Expectations of the beneficiaries

Beneficiaries of the project are all farmers with irrigated plots in the middle and southern part of Jordan Valley, which is the intervention area of the project. These farmers expect the regular supply of sound and sufficient irrigation water. They also expect regular information on the water quality and its nutrient contents in order to adapt the fertiliser quantities applied to the crops. Transparency concerning water and agricultural produce quality is a very important feature, especially with regard to health hazard for farm workers and customers. The project supports activities answering these expectations.

4.3 Relevant activities of the Jordanian Government and other donors

Within the framework of the *Water Resource Policy Support Project* (MoWI/USAID, 2001) detailed investigations on pre-feasibility level were conducted on potential reuse options for treated wastewater in the Amman-Zarqa basin. From the investigations 7 priority options were identified and detailed: 6 on use of reclaimed water in agriculture and 1 on industrial reuse.

The economically most feasible options for agricultural reuse were found to be in the middle and southern Jordan Valley (JVA Middle and Karameh Directorates). Because of the already existing infrastructure for irrigation water distribution the net revenues in these areas are expected to be the highest of all studied alternatives. Besides the already mentioned synergy effects with the *Brackish Water Project* this fact strongly supports the decision to concentrate the efforts of the new project *Use of Reclaimed Water in the Jordan Valley* on these particular areas.

In this context it is worth mentioning that the option with the next highest economic feasibility is the agricultural reuse in the northern Jordan Valley, where German Financial Cooperation (KfW) is currently preparing a detailed study for integration of reclaimed water in the irrigation system.

Other donor activities in this field include a CIDA supported project on centralized wastewater treatment which is currently carried out in the middle Jordan Valley. Domestic wastewater from the communities of the Valley is transported by trucks to a pilot plant near Deir Alla for treatment. The effluent as well as the sludge is supposed to be used on site for irrigation and fertilization of fodder crops, trees, and ornamental plants. Because of its concept and size, this project has an important approach for the disposal of wastewater from the local villages, but will be of limited influence for irrigated agriculture in the Jordan Valley on a larger scale.

5 PROJECT CONCEPT

The new project is planned to start in January 2003 making full use of the achievements as well as of the physical and personnel infrastructure of the Brackish Water Project (BWP). The activities of BWP will continue until June 2003 so that sufficient overlap is guaranteed and major synergy effects can be exploited.

An essential component of the Jordanian-German approach is networking of projects in the water sector in order to improve significance of the projects. Following the results of the BMZ evaluation of 2001 this appears possible only if coordination between donors can be improved and the professional presence of the German side is secured.

In this context we draw also the attention to the necessity of sincere Jordanian ownership for the project, which was stated in the BMZ evaluation (BMZ, 2001) and is strongly underlined by the appraisal team. In particular this refers to the contributions of infrastructure and personnel which will be defined in the bilateral project agreement.

5.1 Definition of the project

In order to achieve the project's purpose the following results are expected:

1 Successful farming practices with reclaimed water are elaborated and made available to farmers and extension services

Main activities

- *Screen national and international experiences on use of reclaimed water and establish liaison with related institutions*
- *Determine appropriate crops for reclaimed water use with regard to water quality, soil conditions, irrigation practices*
- *Determine fertiliser requirements at the farm level with respect to dissolved nutrients in irrigation water*
- *Identify suitable irrigation equipment and techniques for application of reclaimed water*
- *Compile successful farming practices with reclaimed water*
- *Disseminate successful farming practices through field days, media and via existing extension services*

2 Impact of reclaimed water on soils and groundwater is regularly assessed on representative sites

Main activities

- *Identify representative sites for soil and groundwater monitoring*
- *Monitor soils (salinity, nutrients, heavy metals) and groundwater quality*
- *Analyse and interpret soil and groundwater monitoring results*

- *Evaluate soil and groundwater data in cooperation with concerned environmental organisations*

3 Organisations and stakeholders involved in the use of reclaimed water coordinate responsibilities and activities with regard to water quality, health and environment

Main activities

- *Identify and organise working groups of Jordanian stakeholders and research centres on the use of reclaimed water*
- *Prepare institutional and technical outline of information and warning system for reclaimed water quality in the Jordan Valley*
- *Support awareness campaigns of environmental and health organisations addressing farmers on use of reclaimed water and handling of agricultural produce*
- *Review Jordanian standards related to reclaimed water use in cooperation with working group and recommend adaptations*

4 Quality of crops irrigated with reclaimed water is monitored with regard to human health and market acceptance

Main activities

- *Review and continuously follow-up national and international standards and regulations on health related parameters in agricultural produce*
- *Evaluate institutional set-up of existing health related monitoring programme and identify additional monitoring requirements in cooperation with concerned organisations (MoH, MoA, Exporters Association, etc.)*
- *Select and implement particular monitoring activities with regard to health related parameters*
- *Evaluate crop quality data in cooperation with concerned health and marketing organisations*
- *Prepare institutional and technical recommendations for establishment and enforcement of a quality assurance system for crops irrigated with reclaimed water*

5.2 Definition of indicators

The achievement of the afore-mentioned results will be assessed by the following objectively verifiable indicators:

for Result 1

- *Guidelines for use of reclaimed water (crop selection, fertiliser application, irrigation techniques and equipment) are disseminated to key farmers during 2 field days in each growing season starting in 9/2003*

- *Staff of extension services (JVA, MoA, private sector) are trained in application of successful farming practices (4 workshops with at least 15 participants between 2003 and 2006)*

for Result 2

- *Annual reports on soil and groundwater monitoring are evaluated by the inter-disciplinary working group (water, agriculture, health, environment) starting in 5/2004*

for Result 3

- *Institutional and technical setup of a water quality information and warning system is approved by 6/2004 for immediate implementation by WAJ and JVA*
- *Two awareness campaigns jointly conducted with environmental and health organisations in 2004 and 2005 have addressed more than 50 % of the farmers in the project area*
- *Approved recommendations for quality standard are submitted by the interdisciplinary working group to MoWI and the Jordanian standards committee in 4/2004 and 4/2006*

for Result 4

- *International regulations are incorporated by MoH into quality monitoring system by 12/2003*
- *Organisational proposal of the inter-disciplinary working group for the quality assurance system is submitted to MoWI, MoH and MoA by 5/2004 for implementation before 6/2005*

5.3 Definition of assumptions

Assumptions answer the question "What external factors are not influenced by the project, but may affect its implementation and long term sustainability?" On the level of the project purpose the following assumption is defined:

- *Treatment plants discharging to the Jordan Valley maintain at least the average effluent quality of 1998 to 2002*

It shall be noted that a planning workshop will be held in order to redefine in a participative way with the partners the project purpose, results and activities, indicators, and assumptions for project implementation.

6 PROJECT IMPLEMENTATION

6.1 Implementation phases

The project is planned to start in January 2003 with an initial phase of 4 years until December 2006. In order to make maximum use of synergy effects it is recommended to take over the experienced and qualified staff from BWP which will terminate in June 2003. From the German side it is in particular envisaged to take over 1 agricultural engineer and 1 water resources engineer, who also acts as team leader, as well as locally employed technical staff. Taking into consideration the complex works related to the use of reclaimed water we suggest a wastewater specialist join the project team as an additional German contribution.

An essential issue of the project concept is the creation of a working group that shall bring together responsible people from relevant institutions from MoWI, JVA, WAJ, MoA, MoH, GCEP as well as the private sector (traders, farmers, processors etc.). The working group will be responsible for coordination of environmental and health monitoring and analysis, dissemination of information, and awareness creation on a high level. This working group should establish its own internal rules and meet at least quarterly in order to discuss relevant issues.

After successful implementation of the first project phase a second phase of additional 2 years may be envisaged starting in 2006. This phase would concentrate on further advisory services and follow-up for the consolidation and continuous updating of the achieved results.

6.2 Project organisation

According to the wide range of activities the project will have to cooperate with a variety of organisations. The main institutions involved have been listed in chapter 3.2.2.

The overall responsibility of project implementation should be linked to **JVA**. This is recommended taking into account the existing experience and infrastructure of BWP and its strong relations with the farmers in the Jordan Valley as beneficiaries of the project. Within JVA the project coordination has to be assigned to a high level in hierarchy with the required responsibilities and abilities in order to assure a smooth and effective project implementation.

It is suggested to constitute a steering committee representing the main stake holders including MoWI which will provide advice and support during the project implementation. It is deemed necessary that all involved stakeholders take active roles in the steering committee as the project requires intensive coordination among several ministries and institutions, which calls for a strong and respected position within the Jordanian governmental setting.

During the implementation process additional important roles have to be taken by other organisations. Major contributions in the following fields are considered as crucial:

WAJ:	monitoring of effluent quality, revision of Jordanian Standards, establishment of water quality warning system
MoH:	environmental monitoring, awareness campaigns, public health, revision of Jordanian Standards, quality assurance for agricultural produce
MoA:	agricultural extension, quality assurance for agricultural produce, certification system
GCEP:	awareness campaigns, environmental monitoring, revision of Jordanian Standards
RSS:	analysis of soil, water and agricultural produce
JEPA:	quality assurance for agricultural produce, certification system
WERSC:	establishment and coordination of working groups

6.3 Possibilities for cooperation with German Financial Cooperation

KfW is planning an extended study in order to define its activities in the northern part of the Jordan Valley. These activities are also related to the use of RW. The appraisal team recommends the coordination of activities between KfW and GTZ in order to assure efficient use of scarce resources.

6.4 Monitoring and evaluation

It is suggested that a project review be undertaken at the beginning of 2006 in order to facilitate planning updates.

6.5 Further technical and economic planning

A planning workshop for the project shall be held with the concerned stakeholders in early 2003 in order to fine tune results and activities and to define the contributions from the particular stakeholders.

References

BMZ (2001): Country Evaluation Jordan: Management of Resources in Rural Areas. Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung, Bonn

BMZ/MoWI (2001): Joint Approach of Jordanian-German Cooperation in the Water Sector and related Environmental Aspects. Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung, Bonn / Ministry of Water and Irrigation, Amman

JVA/GTZ (1998): Study on Strategical Aspects of Irrigation Water Management in the Jordan Valley. Jordan Valley Authority / German Technical Cooperation, Amman

MoWI (1997): National Water Strategy. Ministry of Water and Irrigation, Amman

MoWI (1998a): Wastewater Management Policy. Ministry of Water and Irrigation, Amman

MoWI (1998b): Irrigation Water Policy. Ministry of Water and Irrigation, Amman

MoWI/USAID (2001): Plan for Managing Water Reuse in the Amman-Zarqa Basin and the Jordan Valley. Water Resource Policy Support Project, Water Reuse Component. Ministry of Water and Irrigation, Amman / United States Agency for International Development, Amman

World Bank (1997): Water Sector Review of the Hashemite Kingdom of Jordan. World Bank, Washington

Annexes

- Project Planning Matrix (Draft as of 9 July 2002)
- TOR Mr. Otto Schreiner
- TOR Dr. Anton Mauderli