

THE INTEGRATED ENVIRONMENTAL MANAGEMENT OF THE ZARQA RIVER

A PROPOSAL FOR RESTORATION OF THE ZARQA RIVER



FINAL REPORT
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Executive Summary

Pollution and abstraction of water are causing severe degradation of the Zarqa River, putting the environment in the river basin, which is the economic heartland of Jordan, in serious jeopardy. In a complex and viscous circle of interconnectedness, these impacts are damaging human well-being and social and economic development in the area. Biodiversity is being lost and heavy contamination of water in the river is a cause of disease in humans and livestock. As a result, the river cannot supply safe drinking water. However, it is extensively pumped for irrigated agriculture.

Pollution of the river is the result of discharge of domestic and industrial wastewaters from urban areas. These wastewaters are principally treated or untreated sewage. In addition, solid waste disposal sites are located within the catchment area. Their leachates reach surface and groundwater resources causing local pollution and threatening to contaminate the aquifers.

The resulting environmental impacts along the Zarqa Basin include the following:

1. The deterioration of the groundwater quality in Zarqa basin due to infiltration of wastewater to a level that is unsuitable for irrigation.
2. The increase in polluted swamps along the Zarqa river course leading to the increase of insects and disease transmitting vectors.
3. The presence of Ammonia and low levels of dissolved oxygen in the effluents has killed many aquatic life forms in the Zarqa River including amphibians.
4. The high level of nutrients in the water has resulted in the increase of algal blooms and pollution.
5. The severe deterioration of the water quality in King Talal Reservoir to a level that threatens the viability of irrigated agriculture in some locations.
6. The increase in soil salinity in the Zarqa basin and the deterioration of agricultural productivity.
7. Lost potential for investment in the basin and lost assets for poverty alleviation, as well as low tourism potential.

A new wastewater treatment plant is under construction and expected to begin operating in early 2007. Water quality and pollution loads in the basin are therefore set to improve. There is consequently a new and emerging window of opportunity for investment in restoration of the Zarqa River. Such action will create benefits for the ecosystems associated with the river, for the well-being of the people of the basin and for the economy.

Restoration of the river is possible. Application of an integrated approach to restoration of the river will not only make it possible to restore the benefits people obtain from the river, but it will also provide a framework for sustainable management of the basin in future. Action is needed urgently, however, as some of the effects of the pollution of the Zarqa River (such as the deterioration of the health of humans and the loss of biodiversity) can be irreversible. A critical success factor will be the commitment of the Government of Jordan, especially the Ministry of Environment, to cleaning up the basin. In addition, the cost of the rehabilitation and clean-up of the Zarqa River Basin will be lower today than any point in the future, thus saving money in the future.

Current Actions

The deteriorating state of the Zarqa River Basin has become a national priority at the highest levels in the Government. As part of the response action, the Ministry of Environment (MoEnv) - in association with the Ministry of Water and Irrigation (MoWI) and the Zarqa Chamber of Industry - has developed a feasibility study for the establishment of a Centralized Industrial Wastewater Treatment Plant (CIWWTP). Furthermore, the Prime Ministry entrusted the MoEnv with the responsibility of convening stakeholders and developing an integrated approach for reversing the degradation of the Zarqa River. At workshops organised by the Ministry in October and November 2005, stakeholders concluded that:

"The extreme deterioration in the natural and aesthetic constituents of the environment at Zarqa River basin, as well as the adverse consequences on the social and economic aspects of the inhabitants' lives are threatening the loss of one of Jordan's most important natural and cultural landmarks, and leading to decreased opportunities to save and rehabilitate the area in an attempt to achieve national development goals".

As a result, the Ministry of Environment has placed the rehabilitation and integrated environmental management of the Zarqa River Basin at the top of its priorities in its workplan for 2006-2007.

Strategy for Restoration of the Zarqa River

This document presents a strategy for restoration of the Zarqa River. The overall goal of this strategy is:

Restoration of the Zarqa River and reversal of the impacts of severe environmental degradation on the well-being and economic development of the people of the Zarqa basin and Jordan.

The strategy builds on the principles of integrated water resources management (IWRM), using lessons and experience gathered from river basins around the world. It combines development of effective governance, application of economic tools, knowledge management and capacity building, civil society engagement and implementation of restoration and sustainable management. There are four main components to the strategy for the project. These are:

- A. Knowledge, information and communication
- B. Governance
- C. Social and economic development
- D. Resource management and demonstration

Each component has been designed to achieve a specific objective. These are:

1. Build public support for river restoration through communication of the urgency and benefits of action to people living in the basin and decision makers, and provision of the knowledge and information needed to enable action and monitor impacts.
2. Governance of river restoration and water resources that empowers civil society through institutions capable of coordinating decision making between water users, managers and policy makers.

3. Integration of the economic costs and benefits of river restoration, and assessments of social impacts, into planning and investment decisions in the Zarqa basin, enabling application of incentives for basin management and new livelihood and economic opportunities through reversal of environmental degradation.
4. Integrated planning of water resources management in the Zarqa basin and implementation of river restoration.

Implementation of restoration is grouped into four types of actions: flow restoration, improved urban water infrastructure, sustainable agricultural water use, and ecosystem restoration.

Actions Proposed

Restoration of the river is envisioned to be a long-term endeavor, requiring a decade or more of commitment to rebuilding the functions of the river and its ecosystems. Phase 1 will last 3 years. Impacts on the ground will occur almost immediately, through a set of urgent demonstration actions that will start soon after the launch of the restoration program. These will serve to build the profile of the program and to demonstrate 'quick wins' from investment in river restoration that will be highly visible to the people of the basin. In addition, Phase 1 of the program is designed to enable development of an integrated plan for restoration and management of the basin, supported by capacity building, stakeholder dialogue over governance arrangements, and required assessments and analysis. Pilot restoration projects will be initiated. Thus, at the conclusion of Phase 1 of the project, there will be visible results on the ground from river restoration, an integrated plan for basin-wide implementation of restoration, backed by stronger governance and capacity for implementation.

The integrated plan will identify and prioritise actions needed to implement river restoration and to deliver benefits at a basin-wide scale under Phase 2, in Years 4-6. Under Phase 3, river restoration will be scaled up to the basin and consolidated.

Budget

The budget for Phase 1 is shown in the Table below. The total cost is estimated to be \$9.4 million.

Phase 1 Y1-3 Component	USD
A1. Information	1,565,000
A2/A3. Capacity Building	950,000
A4. Monitoring	430,000
A5. Communications	550,000
B. Governance	235,000
C. Economics	350,000
D1. Planning	1,880,000
D2. Flows	1,010,000
D3. Urban	500,000
D4. Agriculture	450,000
D5. Ecosystems	1,500,000
Total	9,420,000

1.0 INTRODUCTION AND PROBLEM STATEMENT

The environment in the Zarqa Basin, the economic heartland of Jordan, is at risk. In a complex and viscous circle of interconnectedness, many developmental impacts are degrading the environmental and social conditions in the area. For decades, the Zarqa River has been heavily polluted by untreated domestic and industrial wastewaters, in addition to solid wastes. Moreover, surface waters in the river are extensively pumped for agricultural purposes, with pumping almost spanning over its entire length.

The current level of pollution of the river has numerous negative impacts on the ecosystems it supports, in addition to the human population surrounding it. These impacts include the loss of biodiversity and the spread of disease among humans and livestock. As a result, the river is not being exploited for drinking water. However, it is extensively pumped for agricultural purposes as shown in Figure 1.

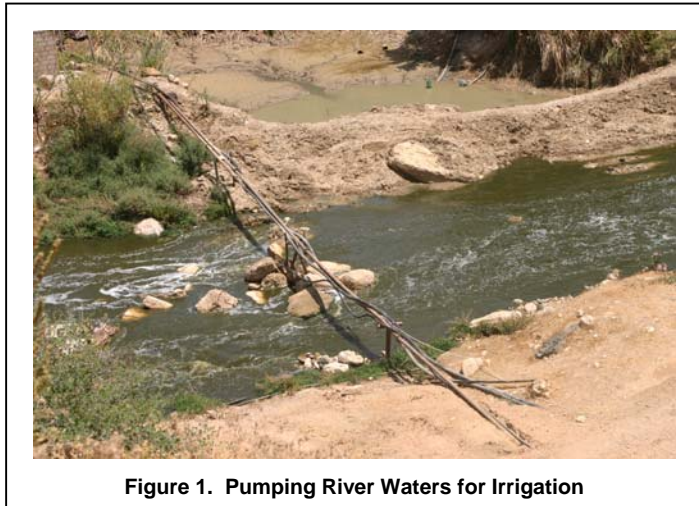


Figure 1. Pumping River Waters for Irrigation

Moreover, and for a long time, the river has been heavily polluted by domestic and industrial wastewaters. The urban and industrial wastewaters are generally treated or untreated sewage. In addition, solid waste disposal sites are located within the catchment area. Their leachates reach surface and groundwater resources causing local pollution and threatening to contaminate the aquifers.

Air pollution is high in close vicinities of industrial areas. Natural resources are increasingly exploited for development activities, and use plans do not take into consideration environmental impacts, and the loss of the scarce vegetation cover is ever increasing. Linked to increasing poverty and degraded livelihood conditions, the environmental impacts are magnified.

This situation has undermined the quality of life of residential communities in the area. It has also negatively impacted the competitiveness of the business environment. The close interface between residential and industrial activities in the area has also created tensions between residential communities, government and industry regarding future development in the area.

The following sections give a description of the various pollution sources and magnitude.

1.1 Industrial Wastewater

The Zarqa River basin is home to more than 90% of the small to medium scale industries in Jordan. Industries in Zarqa cover a wide range of sectors, including food sector, chemical, construction, textiles, leather, pulp and paper, medical sector and the main oil refinery.

Most of these industries are small-medium sized industries, although some of the largest industries in Jordan also operates in Zarqa. Some industries dispose of their

untreated wastewater into the sanitary network. Although wastewater must meet the quality requirements of Jordanian Standard Specifications (JSS) 202 for the discharge of industrial and commercial wastewater to the sanitary network, some industries do violate national standards and discharge polluted wastewater into the sanitary network. Other industries dispose of their untreated wastewater in adjacent wadis, often by using tanker trucks, as shown in Figure 2. This way of discarding industrial wastewater has resulted in severe pollution to the surface and groundwater resources in the basin.

To ensure compliance with national standards and adequate environmental performance, the Ministry of Environment conducts environmental monitoring and inspection for industries in Zarqa. The wastewater quality is monitored through certified laboratories in the Water Authority and the Royal Scientific Society (RSS). Monitoring records are documented and used for environmental compliance and enforcement by the Ministry of Environment. It should be mentioned, that there is no on site testing conducted. The Environmental Protection Law no 1 for 2003 provides the MoEnv with the legal support to close down factories that do not comply with the national standards. During July 2004 the MoEnv has used the law to temporarily close down several violating industries until they comply with the national regulations in terms of environmental performance. However, the law has not been imposed satisfactorily thus far

In addition to water quality issues caused by industries, heavy over pumping of groundwater wells in the basin area has resulted in the reduction of the natural base flow of the Zarqa River. This negative effect was compounded with the decrease in rainfall due to the natural drought cycles in the past decade.

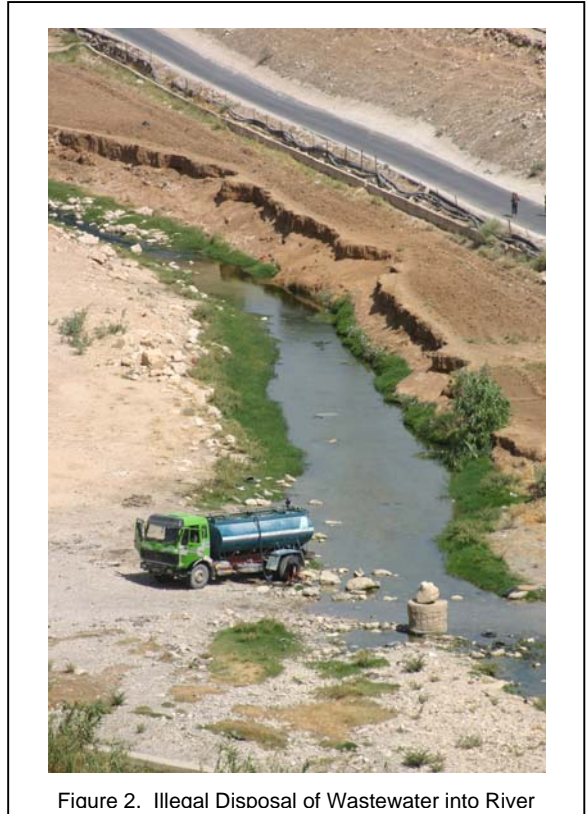


Figure 2. Illegal Disposal of Wastewater into River

1.2 Domestic Wastewater

The major source for domestic wastewater is Al-Samra Wastewater Treatment Plant (AsWWTP). Originally built in 1985, the AsWWTP was designed to treat water through trains of stabilization ponds. The original design capacity was 68,000 m³/day for a detention time of 42 days. The actual load in 2004 was 236,000 m³/day with a detention time of less than 40 hours.

The original design of the plant was to treat 68,000 m³/day, which is less than half the present inflow of 150,000 m³/day. This means that the plant is currently operating at more than twice its capacity

Because some of the industries in the basin area discard of their industrial wastewater through the sewer network, trace elements and heavy metals levels are in violation of the Jordanian standards, namely (Co, Cr, Cu, Pb, Ni, Zn). Recent analysis in 2005 for 8 soil samples along Zarqa River, indicated that the concentration of the heavy metals was higher near AsWWTP and was reduced along the river length due to the precipitation along the stream bed and dilution with stream water. The study concludes that "although current metal concentrations are low to moderate, floodplain surface soils in this area should be regarded as a potential source for future heavy metal pollution downstream."

The resulting environmental impacts along the Zarqa Basin include the following:

1. The deterioration of the groundwater quality in Zarqa basin due to infiltration of wastewater from **KSTP** to a level that is unsuitable for irrigation.
2. The increase in polluted swamps as shown in Figure 3 along the Zarqa river course leading to the increase of insects and disease transmitting vectors.
3. The presence of Ammonia and low levels of dissolved oxygen in the effluents of the KSTP has killed many aquatic life forms in the Zarqa River including amphibians.
4. The high level of nutrients in the water has resulted in the increase of algal blooms and pollution.
5. The severe deterioration of the water quality in King Talal Reservoir downstream from the KSTP - due to the above-mentioned causes - to a level that threatens unrestricted irrigation.
6. The increase in soil salinity in the Zarqa basin and the deterioration of agricultural productivity.
7. Lost potential for investment in the basin and lost assets for poverty alleviation, as well as low tourism potential.

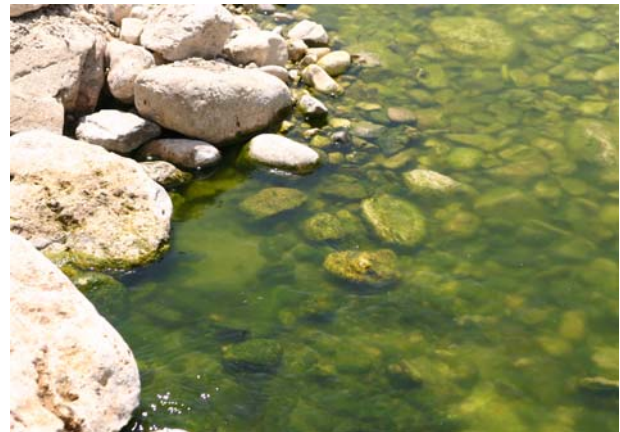


Figure 3. Polluted Swamps

A new wastewater treatment plant is under construction and expected to start operating by the beginning of 2007. The new plant is a mechanical one, and should completely take over the old treatment plant. However, the designed capacity for the new plant is 267,000 m³/day and the actual load for 2004 was 236,000 m³/day. This means that the maximum capacity would be reached very soon. Another point to be careful about is that the plant is for domestic wastewater and its ability to handle the industrial wastewater is not clear.

2.0 THE CHALLENGES

The main challenges in the Zarqa River Basin can be summarized as follows:

- The current degradation of the environmental situation within the basin area has undermined the quality of life for residential communities in the area.
- Since the river is being pumped for irrigation, the pollutants potentially could become incorporated into the food chain and adversely affect consumers.
- The food and water security of the poor are being compromised by the current environmental degradation taking place in the basin which exacerbates the current socio-economic situation.
- Poor management of water in the basin means that the allocation of water is not in line with the immediate and pressing needs of the economy and society.
- The situation has also negatively impacted the competitiveness of the business environment, and resulted in tensions between residential communities, government and the industry regarding future development in this area.
- Instead of having an aesthetic value and contributing to the recreational value of the area, the river in its current state is an eyesore as well as a source of foul smells.

Although the environmental conditions in the river basin are deteriorating, it is possible to rehabilitate the river. The implementation of an integrated approach will not only make it possible to restore the benefits people in the basin formerly obtained from the river, but it will also provide a framework within which the river can be managed properly in the future. Action is needed urgently, however, as some of the effects of the pollution of the Zarqa River (such as the deterioration of the health of humans and the loss of biodiversity) can be irreversible. A critical success factor in action taken to restore the river is the commitment on behalf of the Government of Jordan through the relevant governmental entities, especially the Ministry of Environment. In addition, the cost of the rehabilitation and clean-up of the Zarqa River Basin will be lower today than any point in the future, thus saving money in the future.

3.0 DESCRIPTION OF THE ZARQA RIVER BASIN

Jordan is not richly endowed with rivers. The Jordan River used to discharge around 1400 MCM/year into the Dead Sea before the development of the water resources in its catchment. Even this river is a very small compared with international rivers like the Nile or Euphrates, because its total annual discharge amounts to only 1.5% of the former and 4.3% of the latter. Other surface water resources in Jordan are found in the Yarmouk and Zerka rivers and in wadis like Karak, Mujib, Hasa, Yabis and El-

Arab, in addition to flood flow wadis in the different parts of the country as shown in Figure 4. Serious pollution and depletion of water resources in the Zarqa River is thus a severe threat to a scarce natural resource that is vital to national economic development and the welfare of Jordanians.

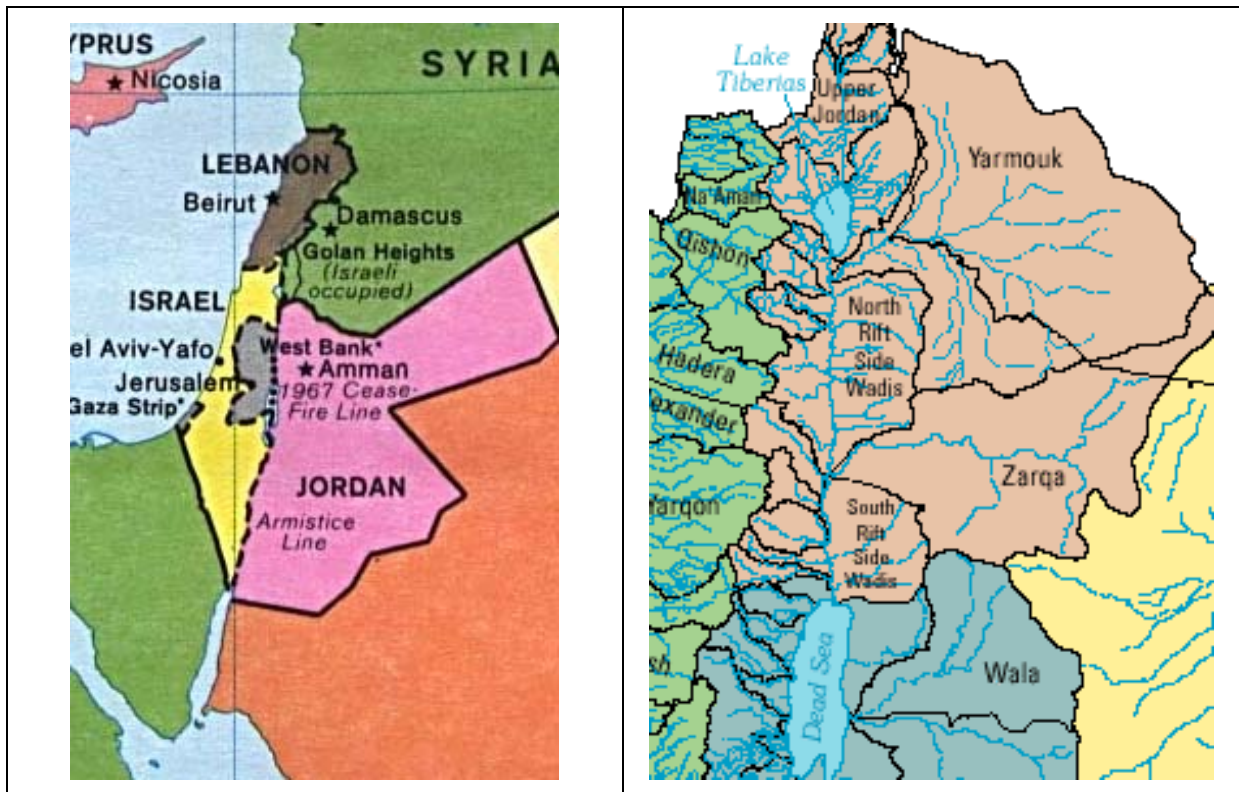


Figure 4. Jordan River System

The Zarqa River shown in Figure 5 is the third largest in Jordan. Its catchment area extends from the foothills of Jabel Druz to the Jordan River. The river consists of two main branches; Wadi Dhuleil, which drains the eastern part of the catchment area, and Seil-Zarqa, which drains the western part. Both meet at Sukhna to form the Zarqa River. Naturally, the eastern branch drains only flood flows as a result of precipitation, whereas the western branch drains flood and base flows. The most densely populated area in Jordan which is the catchment area of Zarqa River comprises around 65% of the country's population and more than 80% of its industries.

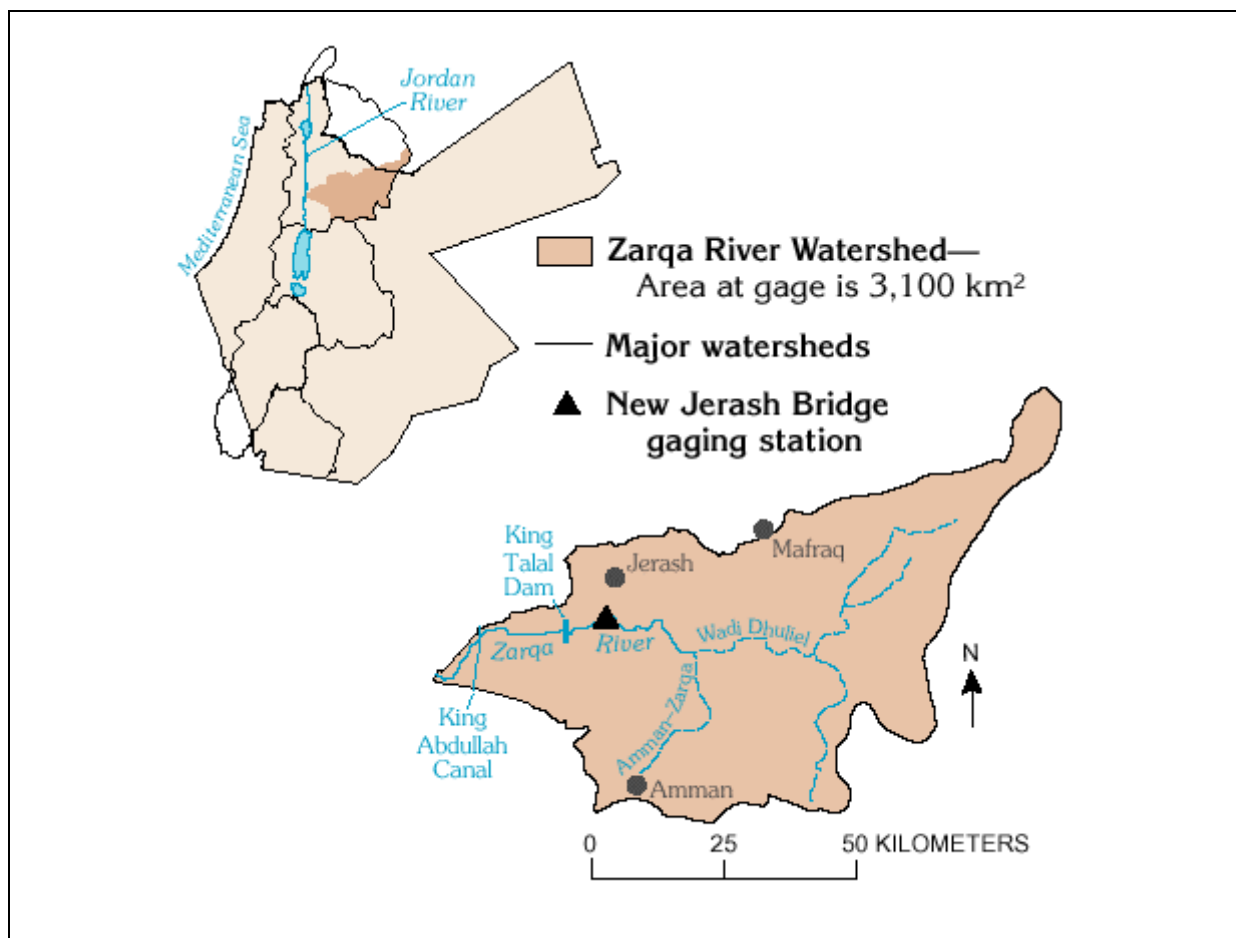


Figure 5. Zarqa River and Basin

The area of the Zarqa River Basin has an area of about 3,900 km². Mean annual rainfall for the watershed is about 300 mm, and the mean annual stream flow is about 63 million cubic meters (MCM). The Zarqa River is perennial with typical monthly flows of 2 to 3 MCM during summer and 5 to more than 8 MCM during winter. The Zarqa River is controlled by the King Talal Dam, which provides a storage capacity of 86 MCM. Connected through a canal and pipes to the King Abdullah Canal, the River provides irrigation for a further 8,400 hectares of land. Withdrawals for water supply from aquifers in the upper Amman-Zarqa groundwater basin have reduced the natural base-flow of the Zarqa River. The flow characteristics have been further modified by the discharge to the river of treated domestic and industrial wastewater that compose nearly all of summer flow and substantially degrade the water quality.

Major inflows into the river include springs, wastewater seepage (mostly from Al-Samra wastewater treatment plant (WWTP), discharge of effluent from Al-Samra WWTP as well as seepage and discharge of effluent from nearby industries, some of which is not or only partially treated. The waters of the river are extensively used for municipal water supply, irrigation and industrial needs.

Socio-economically, the Amman-Zarqa area is the most densely populated area in Jordan. It includes about 65% of the total population of Jordan and more than 90% of the small-medium scale industries in the country. With the high population growth and high demand for natural resources, especially water; the Basin is subject to

increased exploitation of its natural resources to an irreversible state unless a strategic management plan is implemented in the coming decades.

4.0 CURRENT RESPONSE ACTIONS

The deteriorated environmental conditions in the Zarqa River Basin have become a national priority at the highest levels in the Government. As part of the response action, the Ministry of Environment (MoEnv) - in association with the Ministry of Water and Irrigation (MoWI) and the Zarqa Chamber of Industry - has developed a feasibility study for the establishment of a Centralized Industrial Wastewater Treatment Plant (CIWWTP) in Zarqa to provide a comprehensive system for industrial wastewater treatment and to reduce the costs of establishing individual plants in factories. The establishment of the CIWWTP will relieve pressure on the KSTP and enhance the quality performance of the KSWTP especially after the capacity expansion project for KSWWTP to be implemented by the MoWI.

The KSWWTP expansion and updating plan which is currently around US \$170 million public-private partnership based on the Build, Operate and Transfer (BOT) system. The plan will help the KSWTP to increase its capacity to treat high amounts of wastewater with a particularly high organic load.

The proposed expansion of the KSWTP will not allow for the proper treatment of industrial wastewater since it will not remove industrial pollutants such as heavy metals and high levels of dissolved solids (TDS). The industrial effluents contribute to about 10% of the total salinity reaching the KSWTP. Given the evaporation rate of the existing pond system at KSWTP, the cumulative effect of the industrial wastewater is magnified. The only solution to this problem is the release of pressure from industrial wastewater by constructing the CIWWTP.

Furthermore, the Prime Ministry has recently formulated a committee representing all stakeholders to set up a plan to solve all problems related to Zarqa River. The committee came up with different interventions. Unfortunately, the suggested solutions did not deal with the issue in an integrated manner. The Prime Ministry entrusted the MoEnv with the responsibility of conducting a national workshop comprising all stakeholders to deal with the issue in a more integrated manner while studying also the suggested solutions by the previous committee.

As a result, the Ministry of Environment has placed the rehabilitation and integrated environmental management of the Zarqa River Basin at the top of its priorities in its workplan for 2006-2007. Accordingly, MoEnv is putting high levels of efforts in developing a strategic management package for the Amman-Zarqa basin, using the catchment area, or watershed as the management unit. The approach of the catchment strategic planning is innovative to Jordan and will be applied as a model for other similar situations in this project.

To gather momentum for a joint effort in developing an integrated response against the environmental challenges in the Amman Zarqa Basin, a Committee was formed comprising representatives from MoEnv, MoWI, Greater Amman Municipality, Zarqa Governorate, Zarqa Municipality, Rusaifa Municipality, Hashmiya Municipality, Zarqa Chamber of Industry, Hashemite University, Royal Scientific Society, and IUCN. The main objective of forming such Committee was to develop a logical framework for setting a national strategy for rehabilitation of Zarqa River through a systematic integrated scientific and participatory approach.

As part of its activities, the committee has organized two workshops involving the above-mentioned committee members. The workshops were held at the Ministry of Environment on 2 October 2005 and 24 November 2005, during which the overall problem of Zarqa River was analyzed using the Logical Framework analysis as follows:

"The extreme deterioration in the natural and aesthetic constituents of the environment at Zarqa River basin, as well as the adverse consequences on the social and economic aspects of the inhabitants' lives are threatening the loss of one of Jordan's most important natural and cultural landmarks, and leading to decreased opportunities to save and rehabilitate the area in an attempt to achieve national development goals".

The overall problem in the basin can be divided into four dimensions:

- 1- The development and economic aspects
- 2- The institutional, technical and geographic aspects
- 3- The impacts on natural environment
- 4- The social impacts

To come up with a comprehensive solution that addresses all the above components it is important to follow a comprehensive approach. Therefore, it is vital that Integrated River Basin Management be the solution for the future management of the Zarqa River, and is an important step towards its rehabilitation. IRBM has been successfully implemented in various countries around the world. One example of such a success story is the Murray-Darling Basin Initiative in Australia.

The key elements to a successful IRBM initiative are:

- A long-term vision for the river basin, agreed to by all the major stakeholders.
- Integration of policies, decisions and costs across sectoral interests such as industry, agriculture, urban development, including thorough poverty reduction strategies.
- Strategic decision-making at the river basin scale, which guides actions at sub-basin or local levels.
- Effective timing, taking advantage of opportunities that arise while working within a strategic framework.
- Active participation by all relevant stakeholders in well-informed and transparent planning and decision-making.
- Adequate investment by governments, the private sector and civil society organizations in capacity for river basin planning and participation processes.
- A solid foundation knowledge of the river basin and the natural and socio-economic forces that influence it.
- Enforcement and implementation of all relevant legislation.

5.0 STRATEGY FOR RESTORATION OF THE ZARQA RIVER

5.1 Project Goal

The Zarqa River is heavily polluted and highly degraded. Many of the benefits that rivers bring to people have been lost or are severely damaged. Major new investments in infrastructure needed for waste water treatment and pollution control are being made. Water quality in the basin is therefore set to improve, beginning in 2007. This is a vital first step in improving the aquatic environment in the Zarqa basin, but much more is needed to recreate a healthy river. Water needs to be returned to the river to restore flows and river ecosystems need to be rebuilt. As the health of the river returns, the benefits that the river and these ecosystems provide will be available again to people living in the basin.

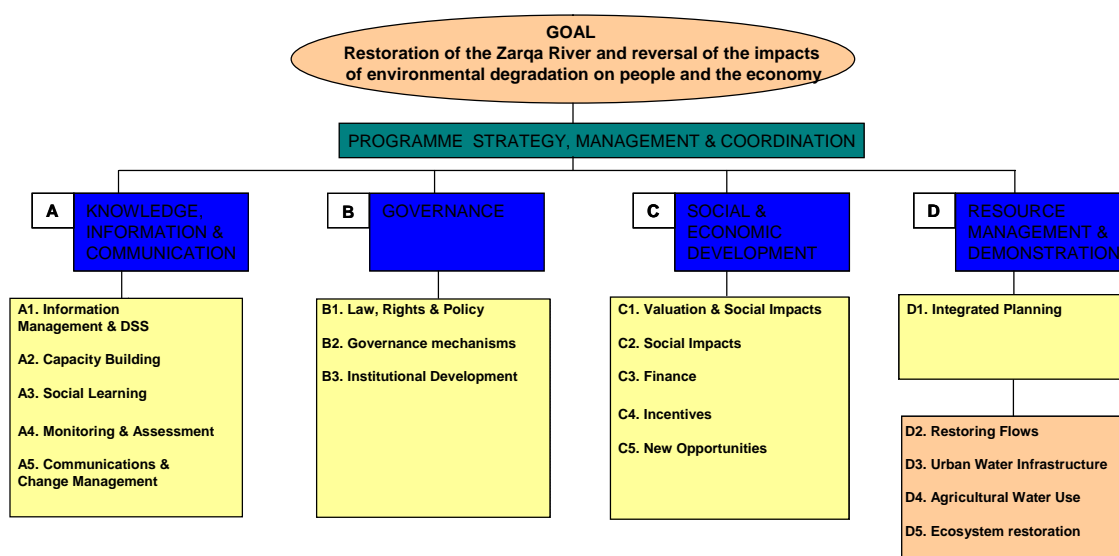
The overall goal of the project is therefore:

Restoration of the Zarqa River and reversal of the impacts of severe environmental degradation on the well-being and economic development of the people of the Zarqa basin and Jordan.

The strategy developed to support this goal builds on the principles of integrated water resources management, using lessons and experience gathered from river basins around the world. It combines development of effective governance, application of economic tools, knowledge management and capacity building, civil society engagement and implementation of restoration and sustainable management. There are four components to the strategy for the project, which are summarised on Figure 6. These are:

- A. Knowledge, information and communication
- B. Governance
- C. Social and economic development
- D. Resource management and demonstration

Figure 6: Components and sub-components of the strategic framework for restoration of the Zarqa River



5.2 Knowledge, Information and Communication

Restoration of the Zarqa River will demand commitment and concerted action by the people of the basin, civil society organisations and government. This demands that stakeholders are informed about the urgency of action needed, that they have the skills and capacities required to contribute and that they have access to the knowledge and information needed for decision making.

The Specific Objective of Component A is:

Build public support for river restoration through communication of the urgency and benefits of action to people living in the basin and decision makers, and provision of the knowledge and information needed to enable action and monitor impacts.

Progress is planned through activities grouped into five results areas. These will enable and strengthen the effectiveness of action taken under the other components of the project strategy. The five results areas are:

- A1. Information management and decision support
- A2. Capacity building
- A3. Social learning
- A4. Monitoring and assessment
- A5. Communications and change management

5.2.1 Information Management And Decision Support

Information and data are key resources for planning and decision making in river basin management. Existing data and information need to be combined with outputs from new assessments and monitoring and organised into a database that ensures they are accessible. Data and models can then be assembled into a decision-support system (DSS) for use in analysing and guiding decisions. For example, a decision support system might ensure access by planners to data and analytical models needed to understand how changes in water quality impact economic activities downstream.

The main output from this result area is a decision-support system for use in integrated planning of the Zarqa River basin.

5.2.2 Capacity Building

Restoration of the Zarqa River will demand new technical capacities and skills in both institutions and stakeholders. Institutions will need new capacity in, for example, developing and operating an environmental monitoring programme, or in participating in and facilitating stakeholder dialogues. Stakeholders themselves may need training in techniques for water management or civil society groups may need support to effectively participate in negotiation of decisions. Capacity building will be a critical platform for success of the river restoration programme.

The main output will be establishment of capacity for key institutions and stakeholder in, for example, river monitoring, integrated management and flow restoration.

5.2.3 Social Learning

Capacity building will be reinforced by a social learning strategy. This will aim to incorporate cycles of planning, acting and reviewing into all components of the

programme, as a basis for learning from and sharing experience gained through action undertaken. This will enable adaptive management of the programme and implementation.

The main output from this result area will be integration of a strategy for social learning and adaptive management across the programme.

5.2.4 Monitoring And Assessment

Monitoring of hydrological, ecological, social and economic impacts will enable tracking of progress in river restoration and its benefits. Monitoring data and products will also be critical inputs to adaptive management.

The main output will be development and implementation of monitoring strategies for the programme.

5.2.5 Communications And Change Management

Effective communications are vital to the development and success of the programme. Action on communication is needed from the very beginning to build widespread recognition that river restoration in the Zarqa basin is an urgent task. The communication strategy will be the platform for application of lessons in change management developed from other river basin projects worldwide. This approach uses communication combined with empowering people to take action and demonstrating 'quick wins' to reinforce the success of the programme.

The main output will be strengthening of change processes and a high public profile for the Zarqa River restoration programme and its benefits.

5.3 Governance

Changes needed in the management of the Zarqa basin and water resources to enable river restoration will cut across sectors and demand the support and cooperation of a range of stakeholder groups. Action is needed by individuals as well as by state and civil society institutions, working at scales that stretch from individual land holdings to the whole basin. Cooperation and coordination will thus be key. However, in such a water-stressed environment, competition for use of water resources is high. As a consequence, success in river restoration will be strengthened by dialogue over water management and participation in decision making through negotiation. This must be backed by credible enforcement of law on water and environmental management. Policy and the legal and institutional framework for management of the basin should therefore be used to facilitate trust in the processes of change and the participation of multiple stakeholders in decisions. Application of this approach will make outcomes from river restoration more durable.

The Specific Objective of Component B is therefore:

Governance of river restoration and water resources that empowers civil society through institutions capable of coordinating decision making between water users, managers and policy makers.

The governance component of the river restoration strategy has 3 results areas. These will build the credibility of the river restoration programme and encourage the active participation of key stakeholders and institutions in planning and implementing basin management. The 3 results areas are:

B1. Law, policy and rights

B2. Governance mechanisms

B3. Institutional development

5.3.1 Law, Policy And Rights

Governance of water in the Zarqa basin will have to accommodate river restoration and sustainable management of water resources. Much of the necessary policy and legal and institutional framework may already be in place. The existing governance context for water resources and environmental protection will therefore be reviewed and the need for changes to accommodate the goals of river restoration assessed. The effectiveness of implementation of existing policy and law needs to be reviewed, with particular emphasis on enforcement, to enable development of a strategy for regulatory enforcement in the basin.

The main output from this result area will be a strategy for implementation and further development of policy and law needed to support river restoration, including regulatory enforcement.

5.3.2 Governance Mechanisms

In common with many countries around the world, responsibility for governance of water in Jordan is split between several institutions in government. River restoration will require coordination of policy and action among these agencies, to ensure consistency in policy and decisions. Coordination in government will be strengthened by establishment of a special coordination unit in the Ministry of Environment. In addition, many economic sectors and civil society organisations have interests in water and how it is managed. The relationships between all of these entities and their interests and responsibilities need to be understood to ensure that all key stakeholders are involved in dialogue over water governance in the basin. A dialogue over river restoration and water governance will be undertaken through establishment of national, basin-wide and water-user level forums. The aim of these dialogues will be to agree a set of guiding principles for water governance in the Zarqa basin, including mechanisms for participation of civil society in decision making.

The main output will be a 'river charter', which codifies the principles for governance of river restoration and sustainable management of the Zarqa basin.

5.3.3 Institutional Development

The 'river charter' will have to be adopted into government policy and by civil society organisations. Institutional arrangements needed to implement the river charter will have to be adapted or established. For example, new institutional arrangements may be needed to support representation of water users in planning processes for river restoration, or in the negotiation of new policy instruments used to regulate or incentivise management of the river.

The main output from this result area will be agreement of the institutional and policy framework needed for operational implementation of the 'river charter' to support multi-stakeholder participation in river restoration.

5.4 Social and Economic Development

Degradation of rivers is often the result of economic decision making that ignores the value of benefits from rivers or the costs of remediation of damage. Thus, dumping of pollutants in rivers may occur because it is seen as free by polluters, or because

the value of economic returns to industry or national wealth is assumed to outweigh the resulting loss of both social and economic benefits from rivers. Experience from around the world has shown that this assumption is frequently wrong. Decision making can be improved by incorporating economic values for river ecosystems and understanding of social impacts into planning of investment and resource development. Valuation of the costs and benefits of healthy river ecosystems and assessment of the social impacts river degradation can thus be very powerful tools for promoting investment in river restoration and motivating sustainable management of river basins.

The Specific Objectives of Component C are therefore:

Integration of the economic costs and benefits of river restoration, and assessments of social impacts, into planning and investment decisions in the Zarqa basin, enabling application of incentives for basin management and new livelihood and economic opportunities through reversal of environmental degradation.

There are 5 results areas in this component of the river restoration strategy. These are intended to provide information on relationships between river restoration and economic and social development. This information will provide a platform for innovation of new financing approaches for investment in river restoration and new incentives for management choices that will protect and benefit the river. It will also contribute to identification of new opportunities for strengthening of livelihoods and economic development associated with the recreation of benefits from the river. The 5 results areas are:

- C1. Economic valuation
- C2. Social impacts
- C3. Sustainable finance
- C4. Incentives
- C5. New opportunities

5.4.1 Economic Valuation

Scenarios for the future of the Zarqa River can be developed that encompass continuing degradation and alternate choices for the extent or pace of restoration. Comparison of the costs and benefits of these scenarios for the people and economy of the Zarqa River basin will enable the benefits of a healthy river to be accounted for in planning and economic decisions.

The main output will be decision making and investment guidelines for management of the river, based on comparison of the economic costs and benefits of future scenarios for the river.

5.4.2 Social Impacts

Social impacts under alternate scenarios for the future of the river will be assessed. This will include assessment of impacts on livelihood assets and poverty in the basin.

The main output will be a framework for comparing the social impacts of river degradation and future river restoration.

5.4.3 Sustainable Finance

Economic valuation and assessment of social impacts will enable estimation of returns from investment in restoration in terms of both social and economic benefits. Appropriate models for financing restoration over the long-term can then be developed. Alternate financing models could include, or combine, donor finance, government expenditure, establishment of a trust fund, user fees or other mechanisms for paying for ecosystem services.

The main output will be a plan for sustainable financing of the restoration of the Zarqa River.

5.4.4 Incentives

Knowledge of the economic and social benefits (and costs) of river restoration will enable the design of new policy instruments for influencing the behaviour and choices made by water users and land managers in the basin. Better decisions might be motivated by, for example, regulation, peer pressure or in-kind benefits from adoption of sustainable management. Financial incentives might also be used, including for example subsidies, tax relief or payments for services.

The main output will be agreement among stakeholders on incentive schemes for river restoration, enabling them to be piloted and then implemented as part of restoration actions.

5.4.5 New Opportunities

Economic and social impact assessments will highlight how restoration of the river can create new opportunities for people living near the river to enjoy improved, more sustainable livelihoods and to develop new enterprises. For example, river restoration will improve access to safe water and sanitation and lower environmental health risks associated with contamination of food supplies. There may be new opportunities for agricultural marketing and market development resulting from irrigation with safe water, or business opportunities related to recreation amenities and tourism along the river.

The main output from this result area will be the generation of social and economic benefits from piloting and implementation of new livelihood or enterprise activities under restoration actions.

5.5 Resource Management & Demonstration

Components A to C of the project strategy focus on development of an enabling environment for restoration of the Zarqa River. Implementation of river restoration takes place under Component D. Action needed for river restoration will be determined through an integrated planning process. Within this, urgent demonstration actions and pilot projects will be identified. The planning process will incorporate stakeholder participation and adoption of outputs from the other components of the strategy, namely arrangements for communications, capacity building, monitoring, governance and use of economic and social assessments in decision making. The final plan for restoration of the Zarqa River will specify agreed actions. These actions will then be implemented using an adaptive management framework and scaled up throughout the river over the long-term.

The Specific Objective of Component D is thus:

Integrated planning of water resources management in the Zarqa basin and implementation of river restoration.

There are 5 results areas. These will enable progress from planning through to implementation of restoration actions and recreation of a healthy river over the long term. The 5 results areas are:

- D1. Integrated planning
- D2. Restoring flows
- D3. Improved urban water infrastructure
- D4. Sustainable agricultural water use
- D5. Ecosystem restoration

5.5.1 Integrated Planning

Integrated planning for water resources management in the Zarqa basin will entail identification and prioritisation of actions needed to restore the river and associated ecosystems, while enabling sustainable use of land and water resources to support the well-being of people in the basin. There are diverse groups of stakeholders in the basin with diverse interests and objectives. Thus, the plan for river restoration and sustainable water management will have to accommodate multiple objectives. Ownership of the plan will have to be shared among government, civil society and sectoral stakeholders, and therefore the planning process must accommodate active participation by these stakeholders. Development of the plan will be supported by other components in of the project strategy, including for example decision support, governance arrangements for river restoration agreed under the 'river charter', financing and incentive mechanisms, and capacity building and monitoring.

The main output will be an integrated plan for water resources management and restoration of the Zarqa River.

5.5.2 Restoring Flows

The benefits of improvements in water quality for river restoration will be multiplied by restoration of flows. New capacity for urban waste water treatment will improve water quality, but restoring flows demands that channels are rehabilitated and water is returned to the river. Removing debris and weeds from the river channel will ease the flow of water through the river. Allocating more water to the river, however, requires that choices are made about how water is used. Some opportunities for restoring flow may arise from, for example, more efficient management of water in agriculture. However, allocating water to the river is likely to require negotiation among water users and incentives for changes in the way water is used. Implementation of flow restoration will be initiated through urgent demonstration actions early in the project and then pilot projects. Actions needed to enable flow restoration will be included in the water management and river restoration plan.

The main outputs in this result area will be demonstration of flow restoration through urgent actions and pilot projects and implementation of flow restoration actions under the integrated management plan.

5.5.3 Improved Urban Water Infrastructure

Control of pollution in urban areas will require continuing improvement, because of growth in urban populations, the need to improve treatment of industrial waste water and the need to prevent contamination caused by flood events.

The main outputs of this result area will be implementation of urban runoff and flood control improvements and enhancement of pollution control through urgent actions, pilot projects and actions under the integrated management plan.

5.5.4 Sustainable Agricultural Water Use

Restoration of the river will be of great benefit to agriculture, by improving the quality of irrigation water and therefore improving the quality of soils, crop productivity and the safety and quality of produce. River restoration should therefore provide new economic opportunities and stronger livelihoods for farmers. Further benefits will result, however, if farmers can use water more efficiently. Pumping of groundwater and abstraction of water from the river could then be reduced, enabling re-allocation of water, including to support ecosystems and the benefits they provide to people.

The main outputs will be demonstration and implementation of sustainable agricultural water use.

5.5.5 Ecosystem Restoration

Restoration of the Zarqa River will demand rehabilitation of the lost and degraded ecosystems associated with the river. These include wetlands and riparian vegetation. These can be restored to create new recreation amenities and tourism opportunities that can be enjoyed by people living in the basin and provide new economic opportunities. They will also help to rebuild the health of the river.

The main outputs of this result are will be restoration of ecosystems and recreation of natural amenities along the river, through urgent demonstrations, pilot projects and implementation of the integrated management plan.

6.0 ACTION PROPOSED

6.1 Project Tasks

Tasks needed to address the strategic goals and objectives of the proposed Zarqa River restoration strategy were assessed. These are tabulated in Annex I for components of the strategic framework in Figure7. Phasing of the project activities within each component is indicated.

Restoration of the river is envisioned to be a long-term endeavor, requiring a decade or more of commitment to rebuilding the functions of the river and its ecosystems. However, the restoration program has been designed as a series of steps, with a first phase lasting 3 years, as shown in Figure 8. The steps in the program begin to deliver impacts on the ground almost immediately. Very early after the launch of the program, a set of urgent demonstration actions will be identified and implemented. These will serve to build the profile of the program and to demonstrated 'quick wins' from investment in river restoration that will be highly visible to the people of the basin. In addition, Phase 1 of the program is designed to enable development of an integrated plan for restoration and management of the basin, supported by capacity building, stakeholder dialogue over governance arrangements, and required assessments and analysis. Pilot projects will be initiated on the basis of interim outputs from the planning process, to generate experience and lessons from river

restoration on the basin, and to continually reinforce the progress and benefits delivered by the program. Thus, at the conclusion of Phase 1 of the project, there will be visible results on the ground from river restoration, an integrated plan for basin-wide implementation of restoration, backed by stronger governance and capacity for implementation. Benefits from river restoration for people and the economy will be visible and monitored. A social learning and adaptive management process will be in place to ensure that lessons learned from the action undertaken are understood and used to strengthen the effectiveness of implementation of the integrated plan, beginning under Phase 2.

The integrated plan will identify and prioritise actions needed to implement river restoration and to deliver benefits at a basin-wide scale. Thus, under Phase 2, the plan will be operationalised, requiring the scale of works to be increased substantially. However, justification for the investment needed will be solidly based on the analytical framework that will underpin the plan. Action on the ground under Phase 2 will continue to be supported by communications, capacity building, monitoring and social learning. This will ensure that the lessons from the program continue to be learnt, and that the cultural change in how the river is used and valued is continually reinforced. As the scale of impacts grows under Phase 2, benefits for livelihoods will continue to expand, supported by emerging economic opportunities associated with a healthier environment. These opportunities are likely to arise in a range of economic sectors, including agriculture, recreation and tourism.

Under Phase 3, from Year 7 onwards, consolidation of river restoration will begin. This will entail continued implementation of on-ground restoration, but with increasing reinforcement from a growing culture of sustainable resource use among communities experiencing the benefits living with a healthy river.

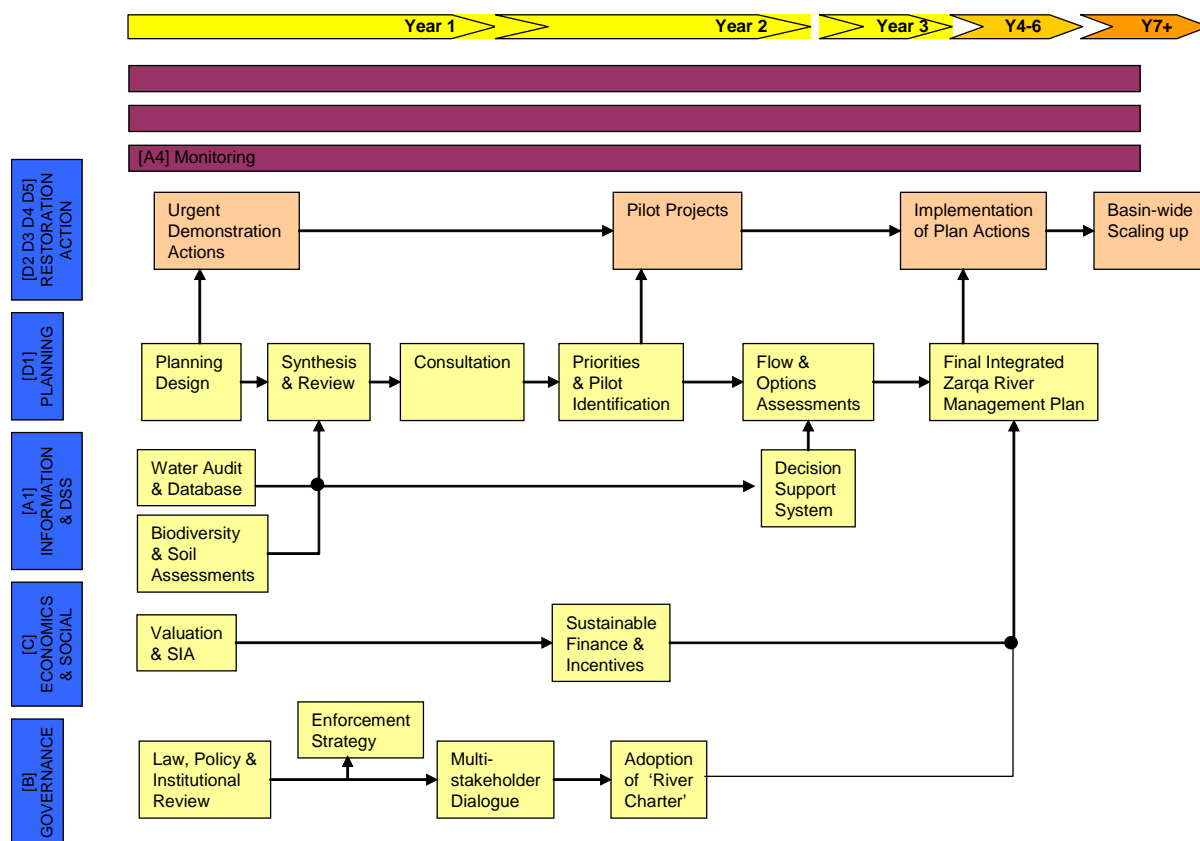


Figure 7 : Links between components and tasks of the Zarqa River restoration project. On-ground implementation is shown in orange; enabling activities in yellow and cross-cutting support in purple.

6.2 Timeframe

Phase 1 of the program has been designed for Years 1-3. Phase 2 will last until Year 6. Phase 3 will begin in Year 7. Because of the severity of damage to the river, the total time needed for restoration of the river is likely to be 10-20 years.

7.0 ESTIMATED BUDGET

The budget for Phase 1 is shown in Table 1, below. The total cost is estimated to be \$9.4 million.

Costs for Phases 2 and 3 will be determined in detail through the integrated planning process. The cost for Phase 2 is likely to be in the order of \$30 million. However, as discussed in Section 5.4.3, the plan will include development of a sustainable finance mechanism for restoration of the river. Based on IUCN experience from elsewhere in the world, this could include a combination of approaches including establishment of a trust fund, government and donor contributions, payments for environmental services or other mechanisms.

Table 1. Estimated budget for Phase 1 of Zarqa River restoration.

Phase 1 Y1-3 Component	USD
A1. Information	1,565,000
A2/A3. Capacity Building	950,000
A4. Monitoring	430,000
A5. Communications	550,000
B. Governance	235,000
C. Economics	350,000
D1. Planning	1,880,000
D2. Flows	1,010,000
D3. Urban	500,000
D4. Agriculture	450,000
D5. Ecosystems	1,500,000
Total	9,420,000

8.0 MANAGEMENT ARRANGEMENTS

Coordination of the strategy for restoration of the Zarqa River by the Ministry of the Environment will be supported by the IUCN-WESCANA. In addition to the core expertise in water resources management present in the WESCANA office, IUCN is able to bring the benefits of its experience of river basin management projects from around the world. Since 2001, IUCN has been leading the Water and Nature Initiative (WANI). This program has worked in partnership with governments, NGOs and communities in over 25 countries worldwide to successfully implement integrated management of water resources and the protection and restoration of aquatic ecosystems. WANI projects have created benefits for both nature and poverty reduction where it has worked, by effectively combining sustainable management of ecosystems with creation of benefits for human and economic development from strengthened provision of ecosystem services. WANI approaches integrate legal, institutional, stakeholder empowerment, economic and technical aspects of water management. Outputs from WANI include learning and capacity building tools that will be a valuable resource for Zarqa river projects.

ANNEX I: ZARQA RIVER RESTORATION – PROJECT TASKS

Component A1: Information and Decision Support

Component	Phase 1: Y1-Y3 Tasks	Timeframe
A1. Information and decision support	A1.1.1 Water audit for the basin: review of available information, current water availability, current and future water demand, threats to water resources	Months 1-9
	A1.1.3 Establish (electronic) knowledge library and database for Zarqa basin	Months 1-9
	A1.1.4 Assess DSS needs and modelling requirements	Months 6-9
	A1.1.5 Biodiversity assessment for Zarqa basin	Months 12-24
	A1.1.6 Assessment of heavy metal soil contamination	Months 12-24
	A1.1.6 Adaptation or development on basin models: hydrology, WQ & pollution, land-use, bio-economic	Months 9-24
	A1.1.7 Assembly and testing of DSS	Months 12-24

Components A2/A3: Capacity Building [A2] and Social Learning

Component	Phase 1: Y1-Y3 Tasks	Timeframe	Phase 2: Y4-Y6 Tasks	Timeframe	Phase 3: Y7+ Tasks	Timeframe
A2. Capacity Building A3. Social Learning	A2.1.1 Capacity building needs assessment and priority setting	Months 1-3	A2.2.1 Ongoing training and workshops including technical training		A2.3.1 Ongoing training and workshops including technical training	
	A3.1.1 Development of strategy for social learning and adaptive management	Months 1-3				
	A2.1.2 Workshops and training in monitoring of WQ and water use for technicians and stakeholders	Months 2-6				
	A2.1.3 Workshops and training on public participation for government and civil society	Months 6-12				
	A2.1.4 Workshops and training in IWRM and planning	Months 6-12				
	A2.1.5 Other priority capacity building	Months 6-12				
	A2.1.6 Training and workshops in pilot project implementation, including technical training	Months 6-36				
	A2.1.7 Training in use of DSS for users	Months 21-27				

Component A4: Monitoring

Package	Phase 1: Y1-Y3 Tasks	Timeframe	Phase 2: Y4-Y6 Tasks	Timeframe	Phase 3: Y7+ Tasks	Timeframe
A4. Monitoring	A4.1.1 Develop monitoring strategy for river restoration programme, including hydrology, ecology, social and economic impacts, including livelihoods and poverty	Months 1-3	A4.2.1 Implementation of basin monitoring: hydrology, ecology, social and economic	Ongoing	A4.3.1 Implementation of basin monitoring: hydrology, ecology, social and economic	Ongoing
	A4.1.2 Establish monitoring baselines: hydrology, ecology, social, economic, including livelihoods and poverty	Months 3-6				
	A4.1.3 Develop and implement WQ monitoring programme, including testing lab and training	Months 1-12				
	A4.1.4 Implementation of basin monitoring: hydrology, ecology, social and economic	Month 6 onwards				

Component A5: Communications

Component	Phase 1: Y1-Y3 Tasks	Timeframe	Phase 2: Y4-Y6 Tasks	Timeframe	Phase 3: Y7+ Tasks	Timeframe
A5. Communications	A5.1.1 Communications strategy and vision	Months 1-3	A5.2.1 Communications support for technical pilots and implementation	Month 18 onwards	A5.3.1 Communications support for technical pilots and implementation	Month 18 onwards
	A5.1.2 Urgent communications actions	Months 2-6				
	A5.1.3 Communication for change management: vision, empowerment, success	Month 6 onwards				
	A5.1.4 Establishment of visitor centres at restoration sites	Month 6 onwards				
	A5.1.5 Communications support for Planning	Month 1 onwards				
	A5.1.6 Communications support for technical pilots and implementation	Month 18 onwards				

Component B: Governance

Component	Phase 1: Y1-Y3 Tasks	Timeframe
B. Governance and civil society	B.1.1 Establishment for MoE unit for institutional coordination	Months 1-6
	B.1.2 Law and policy review and assessment of future needs	Months 2-6
	B.1.3 Institutional mapping and stakeholder power analysis	Months 2-6
	B.1.4 Development of regulatory enforcement strategy	Months 6-9
	B.1.5 Dialogue on Zarqa restoration: establishment of national, basin and water user forums: criteria for river charter; identification of conflicts and strategies for resolution	Months 6-12
	B.1.6 Dialogue on Zarqa river charter	Months 12-15
	B.1.7 Adoption of river charter into policy and by civil society organisations	Months 15-18
	B.1.8 Participation of stakeholder forums in planning and decision making	Month 18 onwards

Component C: Social and Economic Development

Component	Phase 1: Y1-Y3 Tasks	Timeframe	Phase 2: Y4-Y6 Tasks	Timeframe
C. Economics and social impacts	C.1.1 Financial assessment for river restoration	(pre)	C.2.1 Incentive schemes for river restoration piloted and implemented	Month 37 onward
	C.1.2 Scenario development: degradation vs. restoration scenarios	Months 1-3		
	C.1.3 Valuation of costs and benefits of degradation vs restoration, with stakeholder disaggregation and equity assessments	Months 3-12		
	C.1.4 Social impact assessment of degradation & restoration, including livelihoods and poverty assessment	Months 3-12		
	C.1.5 Design of sustainable financing mechanism	Months 12-18		
	C.1.6 Design of potential incentive schemes	Months 12-18		
	C.1.7 Incentive schemes negotiated under planning components	Months 18-24		
	C.1.8 Sustainable finance mechanism negotiated with government and donors and incorporated into planning component	Months 24-30		
	C.1.9 Ecosystem costs and benefits incorporated into investment accounting for water resource development, infrastructure and EIA	Months 12 onwards		

Component D1: Integrated Planning

Component	Phase 1: Y1-Y3 Tasks	Timeframe
D1. Integrated planning	D1.1.1 Design the planning process, identify key stakeholders and include plans for consultation and participation	Months 3-6
	D1.1.2 Identification of urgent demonstration actions eg. channel clearing, restoration, revegetation, point source pollution control, for quick wins	Months 3-6
	D1.1.3 Inventory of data and information	from A4
	D1.1.4 Public consultation on goals, objectives and possible actions	Months 6-12
	D1.1.5 Prepare a draft plan for solid and hazardous waste management	Months 3-12
	D1.1.6 Prepare a draft plan for emergency responses to pollution events	Months 3-12
	D1.1.7 Strategic review and needs assessment for sustainable agricultural water use	Months 3-12
	D1.1.8 Strategic review and needs assessment for urban water and infrastructure development in the basin: incorporating urban waste water audit (assess existing WWTP, sewer systems and lifting plants)	Months 3-12
	D1.1.9 Strategic review and needs assessment for land-use zoning and vegetation restoration in the basin	Months 3-12
	D1.1.10 Strategic review of water abstraction and options for restoring flows	Months 3-12
	D1.1.11 Assessment of environmental health risks in the basin	Months 3-12
	D1.1.12 Prioritisation of actions and identification of pilot actions through public consultation	Months 12-18
	D1.1.13 Environmental flow assessment for Zarqa river	Months 12-24
	D1.1.14 Assessment of hydrological, ecological, social and economic implications of options for action on river restoration (using DSS where applicable)	Months 18-27
	D1.1.15 Finalisation and adoption of integrated plan for river restoration, incorporating actions, river charter, capacity building, information management, monitoring and adaptive management	Months 24-30

Component D2: Restoring Flows

Component	Phase 1: Y1-Y3 Tasks	Timeframe	Phase 2: Y4-Y6 Tasks	Timeframe	Phase 3: Y7+ Tasks	Timeframe
D2. Restoring Flows	D2.1.1 Urgent demonstration actions - eg. channel restoration	Month 3 onwards	D2.2.1 Implementation of Plan actions and adaptive management	Months 36-72	D2.3.1 Scaling up and adaptive management	Year 7 onwards
	D2.1.2 Pilot projects eg. channel clearing and restoration (including procurement of equipment)	Months 18-42				

Example Actions

Urgent demonstrations (under D2.1.1):

- River clean up campaigns, at high profile sites in 4 governorates.

Pilot projects (under D2.1.2):

- Solid waste management and disposal
- Clearing of channels and bed restoration
- Demonstration of environmental flows in sub-basins in 4 governorates

Plan implementation (under D2.2.1)

- Implementation of solid waste management facilities and basin-wide policing of dumping
- Negotiation of flow allocation between users and environmental flow implementation at basin level
- Channel clearing and bed restoration at increasing scale

Component D3: Improved Urban Water Infrastructure

Component	Phase 1: Y1-Y3 Tasks	Timeframe	Phase 2: Y4-6 Tasks	Timeframe	Phase 3: Y7+ Tasks	Timeframe
D3. Urban water infrastructure development	D3.1.1 Urgent demonstration actions - eg. point source pollution control	Month 3 onwards	D3.2.1 Implementation of Plan actions and adaptive management	Months 36-72	D3.3.1 Scaling up and adaptive management	Year 7 onwards
	D3.1.1 Pilot projects eg. urban runoff and flood control improvements, point source pollution control (including monitoring and public awareness)	Months 18-42				

Example Actions

Urgent demonstrations (under D3.1.1):

- Control of effluent at high-profile pollution hot spots.
- Trials of anti-dumping measures for sewage tankers

Pilot projects (under D3.1.2):

- Mapping of point-source pollution sites and public reporting on control measures, to build peer pressure and social demands for action
- Private-sector implementation of effluent control at industrial sites

Plan implementation (under D3.2.1)

- Upgrades to waste water treatment (eg. for industrial pollution)
- Upgrades to sewerage and urban sanitation infrastructure
- Basin-wide policing and incentives for anti-dumping measures for sewage tankers

Component D4: Sustainable Agricultural Water Use

Component	Phase 1: Y1-Y3 Tasks	Timeframe	Phase 2: Y4-Y6 Tasks	Timeframe	Phase 3: Y7+ Tasks	Timeframe
D4. Sustainable Agricultural Water Use	D4.1.1 Urgent demonstration actions - eg. clean water use on farm	Month 3 onwards	D4.2.1 Implementation of Plan actions and adaptive management	Months 36-72	D4.3.1 Scaling up and adaptive management	Year 7 onwards
	D4.1.2 Pilot projects eg. on farm demonstrations of irrigation management for increased water use efficiency, crop selection	Months 18-42				

Example Actions

Urgent demonstrations (under D4.1.1):

- On-farm awareness raising of the benefits of river restoration for farmers
- Enforcement of the groundwater by-law

Pilot projects (under D4.1.2):

- Trials of on-farm rain-water harvesting
- On-farm demonstrations of alternate cropping systems and irrigation management technologies, with farmer visits
- Improvements to safe water supply and sanitation in rural communities

Plan implementation (under D4.2.1)

- Promotion, training and incentives for improved irrigation management or technologies
- Promotion, training and incentives for adoption of alternate cropping systems
- Changes in on-farm water management linked to promotion of agricultural marketing
- River restoration integrated into livelihood programmes linking environment and health, food safety, social capital and safe water supply and sanitation.

Component D5: Ecosystem Restoration

Component	Phase 1: Y1-Y3 Tasks	Timeframe	Phase 2: Y4-Y6 Tasks	Timeframe	Phase 3: Y7+ Tasks	Timeframe
D5. Ecosystem Restoration	D5.1.1 Urgent demonstration actions - eg. revegetation and creation of riverside parks	Month 3 onwards	D5.2.1 Implementation of Plan actions and adaptive management	Months 36-72	D5.3.1 Scaling up and adaptive management	Year 7 onwards
	D5.1.2 Pilot projects eg. river bank restoration, revegetation, installation of parks and recreation space	Months 18-42				

Example Actions

Urgent demonstrations (under D4.1.1):

- River bank restoration and stabilisation at high profile sites in 4 governorates
- Tree planting and development of riverside parks

Pilot projects (under D4.1.2):

- Restoration of small sub-basins and integration with livelihood strengthening relating to for example, health, water supply and sanitation, recreation and agricultural marketing
- High profile restoration and revegetation of reach of main river at location with high visibility.

Plan implementation (under D4.2.1)

- Waste removal and reconstruction of river banks
- Revegetation of river banks and wetlands
- Rehabilitation of wetlands
- Development of for example recreation and tourism activities associated with wetlands