Integrated Water Resources Management in the Lower Jordan Rift Valley

Sustainable Management of Available Water Resources with Innovative Technologies

SMART

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SMART – MOVE

D 4.5

Social, economic and environmental assessment and comparison of water plans

Task 4.5.1:

Selection of social, environmental & economic indicators (KIT-HYD: annex 2)

Task 4.5.2:

Assessment of the social dimension of key measures and IWRM strategies

Task 4.5.3:

Economic assessment based on water allocation modeling (KIT-HYD:annex 2)

Task 4.5.4:

Economic Assessment for upgraded water plans

Task 4.5.5:

Environmental assessments based on quantifiable indicators

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Comparison of IWRM strategies and water plans

Task 4.5.7:

Outline of suggested water development plans

Authors

Bernd Rusteberg[1], AbdelRahman Tamimi[4], Muath Abu Sadah[2], Florian Walter[1], Jacob Bensabat[3], Joseph Guttman[5],Amer Salman[6], Emad Al-Karablieh[6], Paulina Alfaro[7], Julian Xanke[7], Jochen Klinger[7],Nico Goldscheider[7],

[1)]Rusteberg Water Consulting UG (RWC)
[2)]Hydro-Engineering Consultancy (HEC)
[3)]Environmental Water Resources Engineering (EWRE)
[4)]Palestinian Hydrology Group (PHG)
[5)]Israeli Water Company MEKOROT (MEK)
[6)]Arab Technologists for Economical and Environmental Consultation (ATEEC)
[7)]Karlsruhe Institute of Technology – Institute of Hydrogeology
(KIT-HYD; Task 4.2.3 see Annex 1)

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1. Introduction

The present deliverable 4.5 bases on the results achieved under D4.4 with regards to water sector supply reliability and water resources system resilience under different hydrological scenarios, taking also extended dry periods in account. Different models were applied in order to study the positive impact of IWRM measures for activating additional sources of water on the selected representative resilience indicators. D45 identifies and assesses further indicators to cope with the social dimension, water cost of IWRM measures and related benefits as well as environmental aspects. For case study areas in the Palestinian Territories and in Jordan recommendation for IWRM implementation and sustainable water resources development will be provided.

2. Objectives

Project deliverable 4.5 aims on the social, economic and environmental assessment and comparison of alternative IWRM measures and strategies to upgrade the water resources systems in the case study areas. This includes the following specific research objectives:

- Selection of representative social, environmental and economic indicators
- Assessment of the social dimension of key measures and IWRM strategies
- Economic assessment of alternative interventions in Jordan, based on water allocation modeling
- Economic Assessment for upgraded water plans at catchment cluster West
- Environmental assessments based on quantifiable indicators in the Jordanian case study area
- Comparison of IWRM strategies and water plans
- Outline of suggested water development plans

3. Representative Indicators

In order to compare and evaluate the water resources planning alternatives, based on an environmental assessment, a set of suitable indicators need to be selected and quantified. Recommendations on sustainability and environmentally oriented IWRM indicators can be found in abundance in the literature. However, the selection of adequate environmental indicators should rely on the specific needs for environmental protection in the Lower Jordan Valley, taking the national water and environmental policies into consideration.

For the assessment of the economic, social and environmental performance and impacts of alternative IWRM measures (interventions) and strategies towards the improvement of the water resources system water development plans representative indicators will be selected in close cooperation with the regional stakeholders and development banks, taking the National water sector policies into consideration. The selection of IWRM related indicators highly depends on the national socioeconomic and environmental and the institutional capacity context .For the purpose of this study indicators were assessed by local experts Panels . that evaluate they fulfil the IWRM Criteria .Social , economic ,Environmental and Institutional .In order to select the most representative and significant indicators and selection matrix has been formulated in the Frame of DPSIR ((Driving Forces, Pressures, States, Impacts and Responses) for the purpose of this study the focus will be on impact and Rresponse indicators .

Since Indicators are powerful decision-making tools, the application of indicators of water use and management can undoubtedly contribute to a better allocation of this limited resource (Kang and Lee, 2011). Nevertheless, for their formulation, it should not only be considered as a technological issue but also should include the environmental, social, institutional, and economic aspects related to sustainability (Spangenberg, 2004).

In The frame of SMART –MOVE the methodology to identify the representative indicators, in depth literature review has been employed, in particular the World Bank (WB), Global Water Partnership document and relevant beer reviewed Journals. In addition, a panel of Experts have been organised to Identify and Evaluate the Indicators.

As mentioned above for the purpose of this study, the selected indicators were the ones related to the water allocation and management from the perspective of the possible Impact. (Impact indicators: Describe the impacts on the social and economic functions on the environment, and Response Indicators (Refer to responses by groups and individuals in society, as well as government attempts to prevent, compensate, ameliorate or adapt to the impact of the changes in the state of the environment. Some societal responses may be regarded to reduce or eliminate negative driving forces; other responses may aim at raising the efficiency of products and process).

By the consultation with the Expert stakeholders panel (Farmers, decision makers, NGOs, Experts and Private sector) has identified the most significant indicators as the following:

Social indicators (, contribution to poverty reduction, livelihood sustainability, improving access to the quality water. water allocation for farmers – social conflict, willingness to pay)

Economic Indicators (% of income increase per farmer Number of job Created, % of increased cultivated land, affordability of water cost)

Environmental indicators (climate change adaptation capacity, sustainability of natural resources)
Water scarcity increases as we go from northern towards South in JV. Deir Alla is considered the main production zone for vegetables production in Jordan (DOS,2015), is suffering from the limited and misdistribution of irrigation water, in addition to poor management in agriculture production, where it mainly depends on surface irrigation water resources represented by: King Talal Dam, and ground water represented by Tube wells. The main objective of this study is to evaluate the irrigation water use from an economic point view, and the efficient water use in Deir-Alla regarding different water sources, by studying the impact of implementing different water policy actions carried out by the WAJ and WUA such as: Reduction of cultivated areas of spring season crops' as a way and mean in order to save more water to be supplied for municipal purposes. Moreover, the study will demonstrate the optimal cropping pattern, water supply schedule, and water demand functions for the current water resources without any policy intervention. Crop water requirement (MWI), planted areas of crop in the period between 2015-2016, irrigation water supply (MWI, 2015, JVA, 2009-2015), and water sources (MWI,2015). In addition to unpublished data in various divisions and directorates in JVA.

4. Social Dimension of upgraded Water Resources Systems and Water Plans

The assessment of the social dimension, including the quantification of representative social indicators such as social acceptance or family welfare, is an important prerequisite for the successful IWRM-implementation towards sustainable social development, which significantly contributes to the political stability of the region. In this task, the social indicators, identified under task 4.5.1will be assessed for alternative water plans and specific measures by different procedures, including questionnaires.
The evaluation of the social indicators was based on the field survey and the survey form filled by experts , the evaluation has been done to serve both the qualitative and quantitative Judgment
The qualitative evaluation were categorised as not significant, slight significant ,moderate significant and high significant
In order to evaluate the social indicators mixed method has been used, 115 questionnaire have been distributed in the study area were only 70 were valid for analysis. The questionnaires included cluster of questions related to the social part of the study and the target people have been asked to give score. (1 : the lowest and 10 the highest .the total maximum score for each indicator 700 after that the % of given score has been calculated (X/7oo)

*100 for the impact indicator of each proposed strategy , after analyzing the collected data by the statistical methods , the scores has been categorized as the following:

Score (%)	Category
Less than 10	No social impact or negative
10-40	Slight positive impact
41-70	Moderate positive impact
71-100	High positive impact

Table 4.1:. Social Indicators Evaluation

Social Indicator/strategy	Strategy A: excess spring discharge for controlled GW recharge	Strategy B: Additional controlled GW recharge by retained flood water	Strategy C: Additional water for direct irrigation by implementation of deep wells	Strategy D: Add total production of treated effluent (TE) from Jericho WWTP for direct irrigation	Strategy E: Add TE of WWTP El-Bireh to the valley for direct irrigation	Strategy F1: Import of additional brackish water from Feshka springs to the valley for irrigation purposes (10 MCM/a)	Import water
Contribution to poverty reduction	**30**	**44**	**73**	**64**	**46**	**67**	**80**
livelihood sustainability	**22**	**65**	**54**	**22**	**31**	**75**	**79**
improving access to the quality water	**44**	**13**	**45**	**NA**	**NA**	**NA**	**88**
water allocation for farmers – reduction social conflict	**31**	**77**	**72**	**54**	**73**	**62**	**73**
Average social indicators	31.7	49.7	61	46	50	54	80

(*) The benefits include (domestic, agriculture, development and job creation)

The above table shows the following main results:

- None of the strategies has negative social impact.
- The overall evaluation of the social indicators showed that the import of water will contribute to improve the entire social conditions of the society in Palestinian side .that because the availability of water will improve the livelihood conditions and will remarkably reduce the tensions of water between different sectors and will meet the demand of the people for drinking , agriculture and developmental purposes.
- The availability of treated waste water will secure additional water for agriculture , however due to the cultural and religion values the responds of the people still hesitant to give clear answer , which raise the need for intensive public awareness.
- The additıonal water (whatever the resource) will reduce the social tensions and will impact positively the livelihood conditions and the entire stability at country and regional level.

5. Economic Assessment for upgraded Water Plans in Catchment Cluster West

During the last 10 years The Palestinian government considered the Jordan valley areas as an integrated development priority , the main drivers of the decision was the potentiality of the area to be a agriculture, tourism and agro industrial and development zone . The sustainable use of the area will contribute into the national plan to contribute in Sustainable development goals in Particular SD1, SD6, SD13.SD16 , However one of the major challenge the availability of water and the socioeconomic and benefits environmental of the different water development options , the following diagram illustrates the linkage between water resources availability and regional Development .

Socioeconomic and financial analysis was conducted based on valid input for cost estimates and benefits (social , environmental and economic) it is noted that the available hydrological (from WEAP and models) data are sufficient for the preparation of the feasibility study on storm water harvesting and ground water sustainable management . proposed Strategies (deliverable 2.1.1) cover efficient utilization of water resources , including waste water and brackish water treatment means, raft rules for water allocation and distribution , draft organisations of water management system and methods for maintenance of facilities , Executing bodies (Water Users associations) ,targets, Implementation Schedule , priorities of the Plan and management need to be examined as major pillars to IWRM implementation .

The average cultivated land size per farmer's household is estimated approximately 10 hectar over the study area , according the latest agricultural statistics (MOA,2016) data and socioeconomic baseline (PHG,2016) It is then estimated that a beneficiary farmer can increase the cultivated area by 15 % , which lead to increase the household income around 12-17 % (based on the cost of water from different resources and the type of crop)

Investments in hydro-infrastructure and technological interventions may contribute to an improved system resilience against hydrological extreme events and better environmental protection, reducing losses in water distribution, providing additional water storage or production facilities or increasing the water quality of the source by the treatment of waste water or brackish water resources.

As proven in SMART I and II, the use of decentralized wastewater technologies can contribute to the alleviation of the risks of groundwater pollution and to the improvement of the existing situation in a targeted region. The economic data developed in Task 3.3.2: "Economic efficiency of different scenarios of groundwater protection" will be used to complete the economic assessment for upgraded water plans.

In this task, costs and benefits of the upgraded water resources system and its management will be quantified together with further economic indicators, identified under task 4.5.1, including clear statements for the required investments for water plan implementation. In addition to the above mentioned indicators , the implementation of the proposed options for additional water will contribute Significantly the efforts of Palestinian Authority to reduce .The poverty reduction will be secured by the revenue of additional cultivated land and jobs , approximately (8764) job will be created . and the survey showed that the social conflict on water will be reduced since the average of responds of the surveyed people (62.4%) declared that the conflict will be reduced , In particular the implantation of scenario B and scenario G .

Table 5.1: Major economic Indicators at 5% discount for different measures

Indicator	Measures					
	excess spring discharge for controlled GW recharge	Additional controlled GW recharge by retained flood water	Additional water for direct irrigation by implementation of deep wells	production of treated effluent (TE) from Jericho WWTP for direct irrigation	TE of WWTP El-Bireh to the valley for direct irrigation	IMPORT Water
Net Present Value (NPV) (Million US$)	**214**	**420**	**1278**	**101**	**84.3**	**1897**
Internal Rate of return (IRR) (%)	**8**	**11**	**12**	**9**	**7**	**14**
COST /BENEFIT B/C (*)	**3.4**	**3.39**	**4.2**	**1.1**	**1.06**	**3.74**

(*) benefits include agricultural, social and development benefits

Table 5.2: Average Incremental Cost (US$/m3)

Average Increm. Cost	**IWRM-Measures as part of Integrated Strategies**						
	GW-recharge with spring water surpluses	Flood Water Retention to enhance GW recharge	Deep wells in the area for direct irrigation	Treated effluent reuse from Jericho WWTP for direct irrig.	Treated effluent import from El-Bireh	Deep Wells at Feshka and transfer to Ramallah East	Brackish water import from Feshka springs *(extra cost for desalination*
AIC (US$/m³)	**0.07**	**0.27**	**0.41**	**0.49**	**0.45**	**0.87**	**0.35 (0.39)**

The field survey showed that the willingness to pay the cost of water are high and the affordability of the people also 90% of farmers are able to pay (due to the cultivation of cash crops as date)

The detailed economic analysis in agricultural sector indicates that the best revenue of one cubic meter ($\$/m^3$) will be secured by cultivating dates using treated waste water and beans during winter using the fresh water.

The Palestinian authority always concerns about the operation and maintenance costs. However, the calculated operation costs for proposed strategies were in the acceptable rates, the highest O &M cost rates will be The highest 18 % for treatment and transport waste water and the lowest was 0.05% of deep wells management . The remained strategies O & M costs are between 7-10% , the main components have been considered for O &M were(energy, human resources, administration and quality monitoring).

These results highlight the fact that the option of treatment of waste water (locally and imported) for dates and the fresh water for beans (locally and imported fresh water are the best options for additional water.

Table 5.3: Revenue of cubic meter per crop (US$/m3)

Cropping		**Gross Margin US$/Dunum**	**Profit US$/Dunum**	**Water Requirement m^3**	**Gross Mar./Water Req. US$m³**	**Profit/Water Req. US$/m³**
Green House Vegetables						
Tomato (GH)	Tear round	5,689	3,947	800	7.11	4.93
Cucumber (GH)	Winter	2,631	2,073	500	5.26	4.15
Beans (GH)	Winter	4,334	3,801	350	12.38	10.86
Paprika (GH)	autumn	5,381	3,693	600	8.97	6.15
Outdoors Vegetables						
Industrial Cucumber	Spring	879	723	450	1.95	1.61
Potatoes	autumn	467	305	550	0.85	1.94
Eggplant	Spring	840	582	450	1.87	1.94
Cucumber	autumn	367	302	500	0.73	1.94
dates		4000	3400	1000	4	3.4

This result does not underestimate the other options since the socioeconomic benefits are accumulated to contribute into national economy and prosperity of the region as illustrated below.

The socioeconomic indicators of the study areas indicates the high poverty rate (27%) and the unemplyment around (21%), accordingly any development projects in the area will have a remarkable impact on the socioeconmic indicators .

The PHG socioeconomic baseline survey and the evaluation of Japan International cooperation evaluation of Jericho waste water treatment plant indicates that the additional water to meet the agricultural demand will reduce the poverty rate by 7% and the unemployment around 8% which will enhance the Palestinians efforts to meet the SDGs .

As described in Table (4) the additional water options will secure additional income range from 0.875 to 14.5 million US$. per year the range of contribution will be based on which additional water option has been implemented.

Table 5.4: The overall socioeconomic impact of the additional water of different options

Indicator	Strategy					
	Do nothing	Strategy A	Strategy B	Strategy C&D	Strategy E&F	Strategy G
Additional water supply (million m^3)	0	6	94	38	68	252
% of water allocated for agriculture	0	100	100	100	100	100
Additional water allocated for agriculture (Mm^3)	0	6	94	38	68	100.8
Average consumption (m^3/donum /year)	700	700	700	700	700	700
Potential land can be cultivated (donum)	0	857.14	13428.5	5428.6	9714.3	14400
Additional potential job will be created (working person /donum /season)	0	171.4	2685.7	1085.7	1942.8	2880
Additional income US$ 1000/Year	0	857.1	13.428.5	5.428.6	9.714.3	14.400.0

6. Comparison of alternative Water Plans

Palestinian Case Study

The following matrix of Indicators indicates that , the implementation of the additional water strategy (local resources development and imported water) will have high positive impact on the study area , national and regional levels. (Annex 1)

As described in the above sections the implementation the strategies as one package (with time frame) and if the fund will be secured the impact would be very significant , by using **.**The conventional WPI-approach showed that availability, access and time were 22.49 per cent, 55.25 per cent, and 6.82 per cent respectively. The corresponding WPI value was 51.63 per cent. However, based on a holistic WPI-approach, the values of R, A, C, U and E were found to be 22.5 per cent, 52.8 per cent, 36.0 per cent, 69.0 per cent and 40.8 per cent respectively. The corresponding WPI was 44.2 per cent when equal weighing (0.2) was used. The WPI for the West Bank was lowest compared to neighboring countries. Moreover, the WPI decreases slightly as population increases rapidly. Finally, increases of 100 MCM/year and/or GDP shift upward the WPI to 51.3 which means , the four parameters water availability,accessibility ,capacity and use will be significant improvement.

Table 6.1: Performance Matrix (for details see annex 1)

summary of Performance Matrix (1)						
Supply-Demand Indicators)						
indicato	strategy					
indicator /option	Do nothing	A	B	C+D	E+F	G
Total water supply (Mcm)	0	8.4	118.2	57.37	146.8	407.1
Unmet Demand (Mcm)	0	565.19	595.29	574.96	437.37	139.9
Demand Coverage (%)	48.6	48.6	54,3	57.9	63.2	89.3
Reliability (%)	0	0	0	0	0	65
Social indicators (2)						
Potantial job created		171	2685	1085	1943	2880
Poverty reduction		significant	significant	significant	significant	significant
Livlihood sustainability		significant	significant	significant	very significant	very significant
Reduction of conflict (farmers pereceptions %)		31	77	63	68	73
Economic indicators (3)						
Benefit/ cost ratio		3.4	3.39	4.2	1.08	3.74
Revenue of additional cultivated land Million US$)		0.8	1.3	5.4	9.7	14
Revenue of created jobs (Million US$)		0.855	13.4	5.7	9.7	14.4
Political indicators (4)						
Willingness to implement the option (stakeholders)		high	high	high	high	high
notes						
(1) the detailed calculation in Annex1						
(2) methodology of survey in the text						
(3) more dtailes about the major economic indicators in the report						
(4) the survey covered all major stakeholders (annex2)						

The Performance Matrix indicates the following results for MWDM:

- Single strategy will not meet the demand of the Palestinians; however, the implantation of all strategies will create an accumulated additional water supply will cover 85% of the demand centres (supply /demand) .see annex 1.
- The implementation of multi strategy will create positive significant impact on poverty, job creation , the entire livelihood .

- Meeting the demand of the agricultural sector will reduce remarkably the social conflict on water allocation and abstraction of ground water among the farmers in particular the farmers of dates.
- The strategy G (import water) will help to large extend to meet the demand and will increase the trust and cooperation among the three countries.
- The indicative analysis indicates that introducing high value added activities would bring much higher financial benefits than only securing additional water through the implementation of the strategies.

Jordanian Case Study

The conservation actions involve a water pricing policy, while yet, policy actions are the only way to sustain and provide the needed water supply for all economic sectors, by these actions either applied nor developed Jordan can maintain water resources in the long run. It has become necessary to optimize water allocation in the agricultural sector by increasing the efficient use of water with a high economic return of irrigation water, especially in the agricultural area that depends only on the irrigation water from different sources, excluding rainfall. One of these conventional resources is the treated wastewater where about 125 MCM is used in agriculture (DOS,2015).

The main objective of this study is to evaluate the irrigation water use from an economic point view, and the efficient water use in Deir-Alla regarding different water sources, by studying the impact of implementing different water policy actions carried out by the WAJ and WUA such as: Reduction of cultivated areas of spring season crops' as a way and mean in order to save more water to be supplied for municipal purposes. Moreover, the study will demonstrate the optimal cropping pattern, water supply schedule, and water demand functions for the current water resources without any policy intervention.

As mentioned, agriculture in the study area is using two different water qualities from different water sources.Figu shows the optimal water allocation of ground water, it shows that the peak of ground water use took place during the period between April to October, which is considered (summer season). This water quality is mostly used for Vegetables production, farmers in the study area using excessive amount of ground water to irrigate vegetables, they pump water without taking any consideration to water table whether it is below or above the safe yield.

Where in Figure 6., it shows the optimal water allocation from KTD , it is clear that irrigation water supply starts to increase from February until it reaches the peak on August, then it start to decrease. Actually, this water source is mostly used for spring season, which is under the control of Jordan Valley Authority (JVA)., the only legible mandate in the Jordan Valley, which is supplying farms with water according to water order/request that is mostly needed when temperature starts to increase in April to finish the autumn season and starts the spring season.

Derivation of water demand functions and their anticipated price elasticity for the two water resources (Young,2005).Demand price elasticity was derived from the demand functions. All over the cases, price elasticity was the same except in the case of the existing water supply of ground water (Tube wells) price elasticity (-0.06), which means starting the price 0.02 MUS$ on increasing of 1 % in the price of ground water will decrease the quantity demanded by 0.06% indicating that demand is slightly inelastic.The inelastic demand for water reflects a weak response on behalf of farmers in case of increasing the prices of irrigation water from tube wells; hence, prices policy could not be used to control the irrigation water used from tube wells

Table 6.2 shows that the main for ground water source (Tube wells): to manage water use, prices of one m3 should exceed 1.43 US$ to regulate ground water extraction and use in agricultural production. However, for King Talal dam prices of water used should exceeds 0.43 US$/m3 to influence water demand and improve water use efficiency.

Table 6.2: Water and area allocation, water share per ha and water profitability according to the actual prices of water.

Indicators	Shadow Prices
Tube Wells (US$/m3)	0.088
King Talal Dam (US$/m3)	0.15
Water per hectare	
Tube Wells (m3/ha)	8,570
King Talal dam (m3/ha)	7,330
Profitability of water	
Tube wells (US$/m3)	1.214
King Talal dam (US$/m3)	0.414

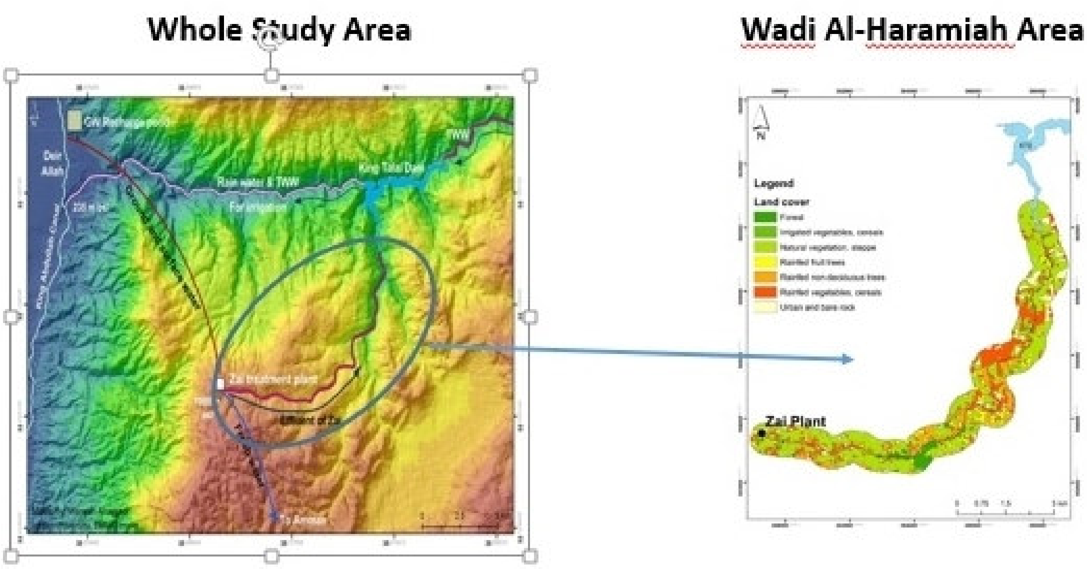
Figure 6.1: Optimal water schedule during the year for irrigation water from tube wells.

Figure 6.2: Optimal water schedule during the year for irrigation water from King Talal dam.

Environmental and economic assessment of MAR implementation in Jordan (ZAI-TP, KTD and Jordan Valley)

Using the GIS system to estimate the areas that has been affected in the study area shows the decrease and degradation of the forest shown in Figure 6.2 and Table 6.2. The activities are assumed to be any natural vegetation, irrigated, Rainfed or urban replaced the forest in the study area. The total affected area is estimated to 1636 ha. This value has been multip-lying by the value of forest degradation over 30 years and 100 years (World Bank 2005), to get the accumulated losses of the forests in the study area which they were JD 18.04 Million over thirty years' horizon and about JD 138.4 Million over one-hundred years' horizon.

Figure 6.3: Schematic Diagram of study area.



The value of damages or losses of forest is very high since the loss one hectare in a specific year is continuing to be as a loss for the coming years. Though the policies and actions should be taken to decrease the degradation of the forest expressly that a part of the degradation is not because of the climate change but as results of human interventions, namely by reducing water pollution that comes from Zai Treatment plant which has been affect the Wadi AlHaramiah area negatively over a long time horizon.

Table 6.3: Area for each land cover in Wadi Al-Haramiah and value of accumulated losses in Million Jordanian Dinars

Class	**Area in Ha**	**%**	**Acc. Loss in Forests over 30 years**	**Acc. Loss in Forests over 100 years**
Forest (evergreen & deciduous trees)	78.92	4.60	0	0
Irrigated vegetables, cereals	25.30	1.48	0.28	2.14
Natural vegetation, steppe	825.46	48.12	9.10	69.80
Rainfed fruit trees	204.74	11.94	2.26	17.31
Rainfed non-deciduous trees	193.28	11.27	2.13	16.34
Rainfed vegetables, cereals	272.33	15.88	3.00	23.03
Urban and bare rock	115.36	6.72	1.27	9.75
Total Area / Value of Losses	1,715.38	100.00	18.04	138.37

Social, Economic and Environmental Assessment of Alternative IWRM Measures

Decision makers in the water sector are continuously faced with increasing difficulties to cover the water demand due to an increasing water scarcity and a poor water management. Often, decisions are based on how to increase the supply of water in quantitative and qualitative terms or the better management of existing supply. Benefit cost analysis and cost effectiveness tools are used for helping planners and decision makers to identify the most suitable and effective approaches and strategies for addressing various water management related problems. MAR should be able to provide higher yields in previously lean months. More specific economic benefits from artificial recharge are often associated with agriculture. Benefits commonly discussed include the potential for an increase in the total area under irrigation due to the increased availability of water, or a rise in crop yields per hectare associated with improvements in land productivity. A detailed economic cost benefits analysis in addition to an optimal water allocation in agriculture were conducted. The water value added will be estimated for additional water gained form optimal allocation of water.

Apart from technical considerations one main question to be addressed is the question if the project is going to be effective. There is only limited information for an economic benefit assessment and costs are often limited to construction costs only. Costs related to (pre- feasibility study, O&M and monitoring, water abstraction after artificial recharge needs to be included though. MAR schemes will only be cost-effective, if regular maintenance is taking place as these increases the life time of the scheme significantly.

The most obvious costs are the construction costs and these are often considered solely in a cost-effectiveness analysis. From available Jordanian data it is obvious that there is a nearly linear increase in costs with the increase in storage capacity of the storage pond, but that there is an initial construction costs of about 2 JD per 1 m^3 storage capacity. Accordingly, pond construction costs per m^3 decrease from about 2 JD/m^3 for 5 mcm to <1 JD/m^3 for large dam of > 10mcm storage capacity. For Wehdeh dam and Karameh dam about 1.4 US$/$m^3$ storage volume was calculated.

The construction costs involve excavation of the pond, convenience system, pumps, steel pipes and cost of engineering services and consultation services, in addition to 10% contingency costs of the total capital investment costs. These contingency costs may include if polluted water was recharged, dam failure occurred resulting in damage downstream or legal challenges arise.

After implementation, O&M costs as well as monitoring costs are accrued. As a rule of thumb together these are about 10% of the construction costs. These costs should cover, for example, the removal of sediments, the replacement of wear and tear parts, the repair of damages to the dam or infiltration basins, the personnel to inspect the site regularly, the sampling and analysis of groundwater and surface water, the monitoring of groundwater levels and flood gauges and the personnel to asses collected monitoring data. The operational maintenance costs can also include the staff salaries, the drilling of new wells and the installation of water level recorder and rain gauges.

Table 1.4: Rough assumptions of cost-benefits analysis of the MAR in JV

Item	Unit	Value
Storage capacity, fill two time a year	mcm	2.5
Annual yield from MAR	mcm	5.0
Construction Costs	JD Million	5.0
Construction Period	years	2.0
Contingency cost (10% of CAPEX)	%	10%
Total Investment Costs	JD Million	5.5
Operational & Maintenance Costs of CAPEX	%	10
Operational Costs	JD Million	0.275
Abstraction Costs from Wells	JD/m^3	0.15
MAR benefits		
Water Supply for domestic	mcm	2.0
Water Supply for agriculture	mcm	3.0
Water value for domestic purposes	JD/m^3	1.52
Water value for agricultural purposes	JD/m^3	0.75
Total Annual Benefits	JD Million	5.3

In Jordan, the water prices vary depending on the use, the location, the quantity abstracted, the salinity and the licensing conditions. Based on the results of Work package: 2 (2.1.3), we assumed the economical return to be 0.75 JD/m^3 for agricultural use, 1.52 JD/m^3 for domestic. The results of the economic indicators are shown in 6.5. The average incremental costs of MAR are estimated with 0.32 JD/m^3 at 8% discount rate, while the benefit-costs ratio is 3.3, which means the present value of total benefits exceeds the present value total costs by 3.3 folds.

Table 6.5: Result of Economic Feasibility Indicators of MAR

Discount Rate	**8%**	**10%**	**12%**
B/C	3.28	3.07	2.88
NPV (Million JD)	31,338	24,933	20,063
AIC, JD/m^3	**0.32**	**0.34**	**0.37**

From an economical point of view MAR in JV region seems worthwhile; the political and strategic considerations play an important role. Finally, a great limitation to the benefit estimation is the high degree of uncertainty of actual infiltration rate. Current data are not sufficient to underpin the actual volumes recharged. For future estimations of benefits, the high variability of rainfall and runoff has also to be considered.

7. Recommendation towards Sustainable Water Development

For the case study areas in the Palestinian Territories and in Jordan, based on the above results, recommendations for IWRM implementation and sustainable water resources development and management are being provided below.

According to the major project goal, special importance is given to those IWRM measures which significantly will improve system resilience, discussing the water sector supply reliability under extended drought conditions and water resources system robustness against high hydrological variability and extreme events. The need for future water import from external sources of water is discussed in this context, too.

Palestinian Case Study

Since the study area under intensive development , it is recommended that the power sources for future plan (solar energy the best option) should be implemented in order to reduce the O&M cost . the use of solar energy in water pumping and water transfer will reduce the operation cost by 28 % and for Jericho treatment plants around 17% . (Based in Phg Work in the north Jordan Valley)

A proper water allocation between domestic , agriculture and development is recommended to be planned by the central government through monitoring system (as done by SMART-MOVE in Ein sultan spring) of springs and wadies and utilization . in the study area the monitoring system has been in ein alsultan enabled the Municipality to manage water more efficietly , this case can be promoted to the othersprings.

The implementation of strategies will increase the availability of water for domestic purpose , which will lead to increase the volume of treated waste water .The increasing of treated waste water from surrounding villages in the eastern slopes will increase the opportunity to expand the agricultural areas in Particular for dates and cash crops.

The institutionalization the licensing of use of treated waste water procedure and standards need to be reformulated .

The implementation of strategies will create multifunctional economic growth process

Investing in water is important driver to generate rapid socioeconomic return . which will lead to impact at national and regional levels

Investment in water resources development and management can contribute to meeting Sustainable Development goals (SDGs)as a whole both through broad interventions designed to promote sustainable development on an area basis - such as water dams -- and through targeted actions one or more particular goals in specific location , such as a wa-

tershed management , both types of interventions are important to make SDGs a reality . application of IWRM concept will make the achievement more cheaply and sustainable .
The public/community involvement is crucial for a successful and sustainable water resource management. It has been emphasized that natural resources management related policies including water requires the use of knowledge, experience and opinions of local communities who are the key stakeholders in resource conservation. This could be ensured through public/community participation. IWRM should mean ensuring that local communities' voices and interests are heard. This means empowering local communities with the necessary tools to take care of their own welfare by ensuring that their voices are heard, and their interests are adhered to.

The economic development of the project area will rely for the near future on two key activities: agriculture and tourism. Both activities require substantial amounts of water in a way that is to be sustainable and reliable. Moreover, the expected population growth will require not only additional direct supply of water but also the need for additional agricultural output, as much possible from local production. However, the available water resources in the area are scarce and characterized by stiff fluctuations due to period of severe droughts (possibly associated to climate change). Tourism essentially requires water for domestic purposes but in quantities per/capita that are far larger than the average local consumption. Agriculture requires proportionally large amounts of water per unit of cultivated area and or per unit mass of crop yield, due to the very high evapo-transpiration. This makes the water allocation process complex and heavily dependent on uncertainty with regard to the replenishment regime of the local water sources. In addition, one needs to consider issues of sustainability, resilience and flexibility. The analysis carried out in D44 shows that it is possible to optimize the utilization of water by implementing a number of key measures:

- Seasonal and Annual storage in the alluvial aquifer;
- Extensive use of non-conventional sources of water (brackish, treated effluent, and mixing) to replace as much as possible the use of freshwater for irrigation;
- Improving the quality of the treated effluent (for example to tertiary levels) in order to lift most of the restriction on their use for irrigation.

The solutions have the advantage to be applicable and relevant even in case of massive imports additional water to area (from any of the large-scale projects under consideration). This because any additional water imported to area will bear a cost that will be difficult to handle by agriculture, so there is always a need to optimize the utilization of water.

Another important lesson learned is that agriculture must be adapted to the conditions of the area (high evapo-transpiration, high cost of water etc.) and therefore one should prioritize crops that can accommodate non-conventional sources of water (brackish and treated effluent) that will always be available with a high degree of reliability. Fresh water demanding agriculture should be confined only to seasonal crops. While these bear in general less income per irrigated volume of water, they have the huge advantage to be highly resilient. They can be developed in years of abundant precipitation and water availability and the damages subsequent to shortages in water supply are limited only to one season (as opposed to permanent crops). The tools developed in this work-package are particularly suited to developing alternatives in this direction.

Jordanian Case Study

To achieve a sustainable water development, all social, economic and environmental aspect should be taken into considerations. The researchers suggest and recommends the following:

- The researchers suggest to transfer the effluent of Zai-Treatment plant using pipes (instead a direct release into the Wadi) to avoid the pollution and degradation that is happening to the study area.
- To prove the effectiveness of MAR schemes new projects should monitor and quantify accrued costs and benefits before, during and after implementation. The current data do not allow for a detailed analysis. The main missing information is the volume of water reaching the groundwater. The costs comprise capital costs, operational costs as well as social and environmental costs before, during and after the implementation of a MAR scheme.
- The inelastic demand for water reflects a weak response on behalf of farmers in case of increasing the prices of irrigation water from tube wells; hence, prices policy could not be used to control the irrigation water used from tube wells
- Farmers opt for different options to cope with recent change in policy and regulations, some of those options coincide with the intended policies such as reduce water abstraction, land fallowing, investment in water saving technologies, changing of cropping pattern, selecting of less water consumptive crops. Other coping measures are selling excess water below the quota to neighbours, manipulation of water meters, and drilling illegal well near the legal one to irrigate the unlicensed irrigated areas.
- Faced with the difficulties in enforcing water abstraction limits and in view of the negative impacts of over-pumping of these critically valuable groundwater resources, the water

policy in Jordan needed to move towards the introduction of new water management approaches. Recognizing the fact that the reduction of agricultural water use in the highlands is a politically difficult and challenging task, the strategy followed is based on participation of the water users, MWI, and other relevant stakeholders in the exploration of management options and the development of an action plan to implement the options ultimately selected. One of the successful options to overcome groundwater depletion and the associated costs, governments may support managed aquifer recharge (MAR). MAR is the purposeful recharge of water to aquifers for subsequent recovery or environmental benefit, such as rainwater harvesting (RWH), infiltration ponds, or check dams. These are considered in this paper, as they generate water supplies from sources that may otherwise be lost due to runoff

- If the state would go for reducing groundwater pumping to preserve and protect the groundwater resources from depletion. The state's immediate concern is to protect famers' income and their social status. In other words, any measure of irrigation water supply reduction should be achieved without negative socioeconomic impacts on farmers. Based on this principal, farmers are requesting to tie the measures for groundwater pumping reduction with appropriate compensation of surface water from WAJ, or in kind money transfer or support on agricultural marketing to compensate the reduction of cropped area with a higher sale value.
- To increase the water sector supply reliability in the coming short run future, decisions makers have to take into considerations that there will be more frequent drought years and the water supply is expected to be decreased, based on that the policy makers and decision makers should investigate all ways and means to increase water supply, and under the current circumstances finding new water resources using cost effective desalination is the only way to satisfy the increased the future water demand in the region. This means to encourage future demands for additional water, rather than a more appropriate focus on improved efficiency, recycling, and reuse.

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ANNEX 1

MWDM							
Environmental Indicators							
Indicator	**Scenario**	**Do Nothing**	**Scenario A**	**Scenario B**	**Scenario CD**	**Scenario EF**	**Scenario G**
Demand: sum of water demand of the demand centres over the Management Period (20 years) in Mcm)	Auja	212.65	212.65	212.65	212.65	212.65	212.65
	Jericho	709.14	709.14	709.14	709.14	709.14	709.14
	Ramallah	298.22	298.22	298.22	298.22	298.22	298.22
	Total	**1220.01**	**1220**	**1220.01**	**1220.01**	**1220.01**	**1220.01**
Supply Delivered: Sum of supply delivered to Demand Centres from all sources over the Management Period (20 years) in Mcm (Excluding Losses)	Auja	146.16	147.39	169.91	171	174.71	208.76
	Jericho	373.86	378.88	460.64	471.66	532.9	609.15
	Ramallah	131.95	131.95	131.95	158.4	183.41	280.65
	Total	**651.97**	**658.22**	**762.5**	**801.06**	**891.02**	**1098.56**
Improvements in Supply Delivered	*Auja*	*0*	*1.23*	*22.52*	*1.09*	*3.71*	*34.05*
	Jericho	*0*	*5.02*	*81.76*	*11.02*	*61.24*	*76.25*
	Ramalla h	*0*	*0*	*0*	*26.45*	*25.01*	*97.24*
	Total	**0**	**6.25**	**104.28**	**38.56**	**89.96**	**207.54**
Un-met demand The sum of gaps between required and actual supply to Demand Centres over the Management Period (20 years) in Mcm	Auja	66.49	65.26	42.74	41.65	37.93	3.89
	Jericho	335.28	330.27	248.51	237.48	176.25	100
	Ramallah	166.28	166.28	166.28	139.82	114.81	17.57
	Total	**568.05**	**561.81**	**457.53**	**418.95**	**328.99**	**121.46**
Improvements in Un-met Demand	*Auja*	*0*	*-1.23*	*-22.52*	*-1.09*	*-3.72*	*-34.04*
	Jericho	*0*	*-5.01*	*-81.76*	*-11.03*	*-61.23*	*-76.25*
	Ramalla h	*0*	*0*	*0*	*-26.46*	*-25.01*	*-97.24*
	Total	**0**	**-6.24**	**-104.28**	**-38.58**	**-89.96**	**-207.53**
Coverage (%): the average of percentage coverage of water in demand centres (i.e. Supply delivered / supply required)	Auja	74.00%	74.70%	83.60%	84.10%	86.00%	98.40%
	Jericho	61.20%	62.00%	71.70%	73.30%	80.10%	87.90%
	Ramallah	35.40%	35.40%	35.40%	43.90%	49.60%	85.60%
Improvements in Demand coverage	*Auja*	*0.0%*	*0.7%*	*8.9%*	*0.5%*	*1.9%*	*12.4%*
	Jericho	*0.0%*	*0.8%*	*9.7%*	*1.6%*	*6.8%*	*7.8%*
	Ramalla h	*0.0%*	*0.0%*	*0.0%*	*8.5%*	*5.7%*	*36.0%*
Reliability: measures the percentage of months that the deliver supply is met the demand over the Management Period (20 years)	Auja	59.40%	59.80%	70.20%	70.20%	73.80%	96.00%
	Jericho	19.00%	21.30%	28.80%	33.30%	45.40%	71.70%
	Ramallah	0.00%	0.00%	0.00%	0.00%	0.00%	65.00%
Improvements in Reliability	*Auja*	*0.0%*	*0.4%*	*10.4%*	*0.0%*	*3.6%*	*22.2%*
	Jericho	*0.0%*	*2.3%*	*7.5%*	*4.5%*	*12.1%*	*26.3%*
	Ramalla h	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*65.0%*
social Indicators							
Potential job			171	2685	1085	1943	2880
Poverty reduction			significan	significant	significant	significant	significant
Livelihood sustainability			significan	significant	significant	very significant	very sugnificant
water allocation for farmers – reduction social conflict *			31	77	63	68	73
Economic indicators							
Benefit/cost ratio			3.4	3.39	4.2	1.08	3.74
Revenue of additional land million US$/year			0.8	1.3	5.4	9.7	14
revenue from created jobs million US$/year			0.855	13.425	5.425	9.715	14.4
political Indicators							
willingness to implent * (the willingness measured by the national strategy of PWA and MOA			high	high	high	high	depends on the development of Political cooperstion and negotiation

Performance Matrix

MDDM

Environmental Indicators

Indicator	**Scenario**	**Do Nothing**	**Scenario A**	**Scenario B**	**Scenario CD**	**Scenario EF**	**Scenario G**
Demand: sum of water demand of the demand centres over the Management Period (20 years) in Mcm)	Auja	212.65	212.65	212.65	212.65	212.65	212.65
	Jericho	709.14	709.14	709.14	709.14	709.14	709.14
	Ramallah	298.22	298.22	298.22	298.22	298.22	298.22
	Total	**1220.01**	**1220.01**	**1220.01**	**1220.01**	**1220.01**	**1220.01**
Supply Delivered: Sum of supply delivered to Demand Centres from all sources over the Management Period (20 years) in Mcm (Excluding Losses)	Auja	107.64	108.56	125.15	126.75	129.62	207.69
	Jericho	315.23	320.22	387.97	398.69	469.62	591.76
	Ramallah	131.94	131.94	131.94	158.4	183.41	280.65
	Total	**554.81**	**560.72**	**645.06**	**683.84**	**782.65**	**1080.1**
Improvements in Supply Delivered	*Auja*	*0*	*0.92*	*16.59*	*1.6*	*2.87*	*78.07*
	Jericho	*0*	*4.99*	*67.75*	*10.72*	*70.93*	*122.14*
	Ramallah	*0*	*0*	*0*	*26.46*	*25.01*	*97.24*
	Total	**0**	**5.91**	**84.34**	**38.78**	**98.81**	**297.45**
Un-met demand The sum of gaps between required and actual supply to Demand Centres over the Management Period (20 years) in Mcm	Auja	105	104.08	87.5	85.9	83.03	4.95
	Jericho	393.91	388.93	321.18	310.45	239.53	117.38
	Ramallah	166.28	166.28	166.28	139.82	114.81	17.57
	Total	**665.19**	**659.29**	**574.96**	**536.17**	**437.37**	**139.9**
Improvements in Un-met Demand	*Auja*	*0*	*-0.92*	*-16.58*	*-1.6*	*-2.87*	*-78.08*
	Jericho	*0*	*-4.98*	*-67.75*	*-10.73*	*-70.92*	*-122.15*
	Ramallah	*0*	*0*	*0*	*-26.46*	*-25.01*	*-97.24*
	Total	**0**	**-5.9**	**-84.33**	**-38.79**	**-98.8**	**-297.47**
Coverage (%): the average of percentage coverage of water in demand centres (i.e. Supply delivered / supply required)	Auja	56.90%	57.40%	64.80%	65.60%	67.20%	98.00%
	Jericho	53.50%	54.30%	62.70%	64.40%	72.80%	85.80%
	Ramallah	35.40%	35.40%	35.40%	43.90%	49.60%	85.60%
Improvements in Demand coverage	*Auja*	*0.0%*	*0.5%*	*7.4%*	*0.8%*	*1.6%*	*30.8%*
	Jericho	*0.0%*	*0.8%*	*8.4%*	*1.7%*	*8.4%*	*13.0%*
	Ramallah	*0.0%*	*0.0%*	*0.0%*	*8.5%*	*5.7%*	*36.0%*
Reliability: measures the percentage of months that the deliver supply is met the demand over the Management Period (20 years)	Auja	36.70%	36.70%	40.40%	40.40%	42.10%	92.90%
	Jericho	12.50%	15.60%	18.30%	23.30%	34.80%	63.10%
	Ramallah	0.00%	0.00%	0.00%	0.00%	0.00%	65.00%
Improvements in Reliability	*Auja*	*0.0%*	*0.0%*	*3.7%*	*0.0%*	*1.7%*	*50.8%*
	Jericho	*0.0%*	*3.1%*	*2.7%*	*5.0%*	*11.5%*	*28.3%*
	Ramallah	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*65.0%*
social Indicators							
Potantial job			171	2685	1085	1943	2880
Poverty reduction			significant	significant	significant	significant	significant
Livelihood sustainability			significant	significant	significant	very significant	very significant
water allocation for farmers – reduction social conflict *			31	77	63	68	73
Economic indicators							
Benefit/cost ratio			3.4	3.39	4.2	1.08	3.74
Revenue of additional land million US$/year			0.8	1.3	5.4	9.7	14
revenue from created jobs million US$/year			0.855	13.425	5.425	9.715	14.4
political Indicators							
willingness to implent * (the willingness measured by the national strategy of PWA and MOA			high	high	high	high	depends on the development of Political cooperstion and negotiation

The colors used to represent the level of improvement per strategy

Indicate the value of indicator under do-nothing scenario

Represent the value of improvement as a result of strategy

The transitional coloures indicat the level of change from red to green (from do nothing to level of improvement)

ANNEX 2

Key Stakeholders:

National Water Council (NWC), Palestinian Water Authority (PWA), West Bank Water Department (WBWD), Coastal Municipal Water Utility (CMWU), Ministry of Agriculture (MoA), Environmental Quality Authority (EQA), Ministry of Local Government (MoLG), Ministry of Public Work and Housing (MoPWH), Ministry of Planning and Development (MoPAD), Ministry of Health (MoH), Ministry of Finance (MoF), Israeli Civil Administration (ICA), Joint Water Committee (JWC), Israeli National Water Company (*Mekerot*), and the Israel Water Commissioner.4

Primary Local Stakeholders:

Municipal Water Departments, Village Councils, Joint Service Councils (JSC), Jerusalem Water Undertaking (JWU), and the Water and Sanitation Services Authority (WSSA).

Secondary Stakeholders:

Donors, international NGOs (INGOs), local NGOs, unions, and educational institutions