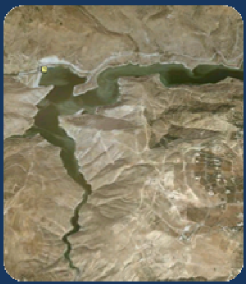
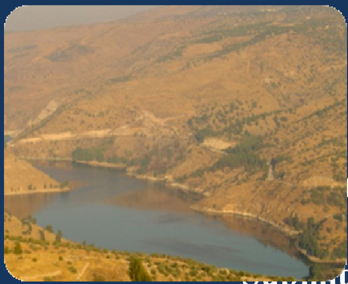
Micro-Level Assessment of potential direct and indirect impacts of climate change on socio-economic factors

In the Zarqa River Basin

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1 General Description

1.1 Introduction

In Jordan more than 80 % of the country's area is arid and receives less than 200 mm annual rainfall. The climate varies from dry sub-humid Mediterranean in the northwest of the country with rainfall of about 600 mm to desert conditions with less than50 mm in Wadi Araba in the south (An Environmental Profile of Jordan, 2006).

The competition between different water users in different sectors as domestic water, tourist sector, industry, public parks and agriculture is rapidly increased. In the year 2007 agriculture consumes about 64%(check number) of the available water resources while 30% is for domestic use. Industry consumes about 5% of the available water resources (Royal Commission on Water, 2009).
These competitors for fresh water use have different economic, social and political relevance. The domestic and agriculture sectors require more water in the future as a consequence of increasing population.

The Zarqa basin is considered the most important basin in Jordan because it hosts about 70% of the industrial activities and about 50% of the population of the country reside on it. A large wastewater treatment plant is situated in the basin, the effluent of this plant discharges to the main river contributing to about 50% of its annual yield (University of Jordan, 2006).

The basin now is facing many environmental problems such as land degradation and desertification, salination of ground water and deforestation processes. The expectation of climatic changes and its effect on the eco-system and the water resources is imposing another dimension to the future scenario of the basin. The frequent occurrence of drought and weather externalities has become a known phenomenon in this region.

This study focuses on the competitiveness of water use in agriculture and other sectors and use of water of different quality. Also this study will evaluate and assess the different scenarios of water availability and quality – as a consequence of climate change in the region - depending on economic and social aspects.
To simulate the complexity of the system, a base line scenario was built using the Water Resources Model (WRM). Scenario has been tested to reflect the expectation of the impact of climate change in the future.

1.2 The study area: Zarqa River Basin

The Zarqa River is the second largest river in Jordan after Yarmouk River. The river basin drains an area of 4120 square kilometers where about 95% of its area is within Jordan and only 5% is in Syria. The basin extends from the Syrian city of Salkhad in Jebal al-Arab with an elevation of 1460 m to south of Amman and then westward to discharges its water at its confluence with River Jordan at an elevation of -350 m.

The basin represents a transitional area between the semi arid highlands in the west to the arid desert in the east. The basin is subdivided into two main catchments; Wadi Dhuliel sub-basin representing the arid conditions and flat land and Seil al-Zarqa sub-basin which represent the most populated mountainous area. The main agricultural area in this basin is from Northwest of Jordan and stretching from the Wastewater treatment plant As Samra down the river Zarqa to Jordan Valley including Deir Alla.

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 (ministry of Environemnet, 2006).These zones cover different water qualities. The water quality of King Talal Dam fluctuates all over the year; the best quality occurs when the floodwater in the dam is dominant and the worst quality occurs when the effluent of the wastewater treatment plant is dominant.
Therefore it will be three main areas for the study:

1. Highlands of the ZRB that use fresh water (Groundwater).
2. The ZRB which represents the area between As-Samra Treatment Plant and KTD. In this area the quality of water before King Talal Dam is better than that after the treatment plant, because of that it could be divided into two different sub-regions.
3. Lower ZRB which represents the Jordan Valley.

1.3 Objectives

The overall objective of this study is to evaluate the impact of different scenarios of the water resources availability and quality as a result of Climate Change on the Zarqa River Basin an in-depth socio economic analysis.

The specific objectives are as follows:

1. To analyse and measure the effect of different water qualities in farm organisation, families' living standard and sustainability of farming systems under different conditions of water availability and water quality
2. To simulate and measure the future impact of different scenarios of water availability and quality on farm organisation and income as well as living standard of farm families.
3. To discuss the competitiveness of water use in comparison to between different sectors.

1.4 Methodology

1. Describing the socio-economic status without any change in Climate by analyzing Factors (Driving forces) that are affecting the socio-economic status like population growth, income level & other economics activities. This has been done in the agriculture sector depending on water quality for irrigation.
2. Measuring the impact of water quantity and quality on Agricultural income at different levels (farm Income, Gross Income), labor, productivity and profitability of water, the change in cropping pattern and restriction of planted areas.
3. Evaluate the impact of different scenarios of water availability and quality as a result of climate change on agriculture sectors and consequence on the availability of water in other sectors like domestic and industrial sectors.

1.4.1 Modeling Approach

In this study a Water Allocation Model (WAM) will be used as a decision support system to study the impact of changing water quantity of different qualities on socio-economics of the Agriculture, Municipal and Industrial sectors of ZRB. WAM has two main goals, first, to provide district and national level planners with a decision support tool for planning agricultural activities under various water amounts, qualities, and prices as a result of climate change scenarios; and second to provide with a soundly based analysis of agricultural water demand and it optimal allocation of water, cropping pattern and agricultural income.

WAM is an optimizing model and will deal mainly with irrigated agriculture sector. It uses data on available land, water requirements per unit land area for different crops, and net revenues per unit of land area generated by the growing of those crops. WAM is characterized by the following: (1) application of WAM to actual data suggests that the model closely approximates the actual response of farmers to water prices. (2) WAM results can serve planners as an approximation. (3) A departure of actual behaviour from the optima generated by WAM can serve as a signal to planners that further study should be done. (4) WAM provides a quantitative post-optimal sensitivity analysis that can be used to analyze uncertainty, stability of plans and risks. (5) WAM can serve as a decision-support device suggesting to planners what crop patterns are likely to prove optimal under various conditions and relating these to different water policies.

WAM is formulated at the regional level. Its objective function is the net agricultural income of the district, which is maximized by selecting the optimal mix of water-consuming activities (Vegetables, fruits and field crops). The constraints in WAM involve two factors: water, land area, labor, fertilizers and marketing capacity of all crops. The user can impose constraints on the availability of water by quality and by season and on land quality represented by it class level. As an example, for lower ZRB, the categories of activities subject to land-area constraints are all activities; crops of the same group (vegetables, fruit trees and field crops); crops irrigated by the same water quality and crops grown during the same season.

1.4.2 Scenarios of the study:

Two main scenarios expected to be analyzed in this study as follows:
Business as Usual (BAU): The purpose of this scenario is to identify what course of action would be taken in the absence of climate change adaptation, and how climate change is likely to affect development activities. It seeks to answer the question: "What development activities would be pursued by the Government of Jordan (MoEnv) at the Zarqa River Basin in the absence of climate change? How would the targeted human systems develop without adaptation?" Without adaptation, how would development activities be affected by climate change?
Adaptation scenario: The purpose of this scenario is to identify the course of action that will have to be taken to respond to the adverse impacts of climate change, so as to achieve sustainable results. It seeks to answer the question: "How

should the development objective be achieved, taking into account the impacts of climate change, and what immediate and urgent measures are necessary to respond to such impacts?" determine what will the future water availability and quality impact the overall economical conditions of the basin. Determine how the use of alternative water supplies with different qualities will affect cropping pattern and types and may be marketing. Determine how will the industrial sector be forced to adopt different measures to deal with water availability which will impact the eventually impact the consumer. Under this main scenario three sub-scenarios will be analyzed as follows:

1. Decreasing fresh water quantity.
2. Increasing TWW quantity.
3. Degradation of fresh water quality.

1.4.3 Design of survey and collection of information

The study is based on secondary and primary data. Secondary data were obtained from different governmental services and non-governmental institutions and services. Likewise a discussion with governmental and non-governmental officers in the study area has been carried out. Nevertheless the secondary data were obtained from other studies have done for the study area.

Since the time is limited Primary data were obtained through Rapid Rural Appraisal (RRA), meeting with key persons and short surveys on the level of farms, families and households. The experience of researchers and the rate of inflation were be considered in estimating and determining the present values

2 Socioeconomic Status of Zarqa River Basin

This part deals with the socio-economic issues of the family and farm in different zones in Zarqa Basin. The first section describes the availability of the resources in Zarqa Basine, such as labour, land, water and capital. The second section deals with the resulting living standard of the concerned rural population through the analysis of social and economic criteria including parameters such as education and health, economic criteria focused on income and cash availability.

2.1 Resource analysis

The resource analysis is important for understanding the decision-making process because it gives information about the availability, quality and differences of using resources in different zones. This section deals with human, water, land and capital resources of farm-household-family in the study area.

2.1.1 Land resource

Agricultural land occupies more than 24% of the total land area in Zarqa River basin. Natural forests occurring in the mountainous part are composed of oak, pine, juniper, wild olive and cypress. Agricultural activities and their associated weeds have supplanted the indigenous flora communities. Agriculture is scattered with the basin from rainfed orchards, olive and field crops to irrigated agriculture on the river banks and the Jordan valley. Private Irrigated area using groundwater as a source of irrigation water can be found in scattered places in the middle and the eastern part of the basin. The rainfed land represents about 10% of total area (e.g. orchards, olive and field crops) and irrigated area represents 12% on the river banks and the Jordan Valley. Pasture activities represents 17% .
Land capacities of farms in the study area were between 36-58 dun and the lowest was in area before King Talal Dam. The highest percent of farmers using greenhouses were in Jordan Valley.

In the past vegetables and fruit were the main products in the area between treatment plant and King Tallal Dam but now the pattern of plants changed. In the area after treatment plant the main product is clover and in before king Tallal dam it is fruit trees, especially olives. The reason for these changes is the quality of water, which became worse. Due to the bad quality of treated wastewater, irrigation was limited to fodder and trees, it was not allowed to plant vegetables in these areas according to the Jordanian standards for the use of wastewater in irrigation (Environmental Health Directorate, 1999).

2.1.1.1 Industrial sector

ZRB is the most industrialized area in Jordan. About 60% to 70% of industrial activities are located in the basin. Sixty one industries were identified and localised in the ZRB. In terms of water use, the most important industries include: the Jordan petroleum refinery, Al-Hussein thermal power plant, the Jordan paper & cardboard MFG (paper and carton processing), the Jordan paper ice & aerated water co., the national industry of Ghreise (cement product) and the yeast industries co. Other industrial sub-sectors concern the textile and leather production, food Industries, distilleries, drugs and chemical industries, intermediate petrochemicals, engineering industries, iron and steel manufacturing.

2.1.1.2 Touristic sector

At national level, the tourist sector contribute to more than 10% of the Gross Domestic Product and about 2.5% of total active population is working in this sector (Taha et al., 2004). At basin level, the tourist activities are mainly concentrated around Amman city. In the context of the Jordanian Water Master Plan, the touristic water use assessment was based on the number of bed-places and occupancy rate in tourist accommodation.

2.1.2 Water Resources

The main source of water for the agricultural area between As-Smara and King Talal Dam is the effluent from As-Samra treatment plant. The mixed water from the King-Talal Dam is the main source for Jordan Valley. In total, about 100 MCM/yr of surface water are presently developed for irrigation, municipal and industrial use in the whole Basin. Groundwater is considered to be the major source of water in ZRB. The majority of the groundwater abstraction occurs in the highlands (121 MCM) 46% of which was used for irrigation, 48% for domestic, 4.1% for industrial and 1.4% for pastoral use. Currently, there are over 800 wells in ZRB used for different purposes of domestic, agricultural, tourist and industrial uses. Large number of which are privately owned.

The safe yield of ZRB aquifer is about 87.5 MCM which makes about 32% of the country's renewable groundwater resources (USAID/ARD, 2001).
Other groundwater resources in the ZRB include the springs and the brackish water. There are about 150 springs in ZRB, the flow of which ranges between 0.1 MCM to larger than 1 MCM. Desalination plants are constructed at some of these springs, the effluent of which is used for domestic purposes such as Kayrawan spring which supplies part of Jarash. The main springs within ZRB that have considerable flow are: Kayrawan ; Hazzir ; Wadi Sir.

There are 4 wastewater treatment plants (WWTP) serving most of the major urban areas in the ZRB. The effluents of Al-Baq'a, Jarash, Abu-Nuseir, and As-Samra treatment plants are discharged to the Zarqa River where it flows to the reuse sites or to the KTD (MWI, 2004).

The agricultural water demand represents about 230 MCM (51% of total water demand in the basin) (MWI, 2004). Agricultural water demand in ZRB is concentrated in two areas which are Zarqa river watershed and the high lands. It is important to note that a high percentage (46%) of the groundwater abstraction in ZRB happens at the highlands and is used for irrigation (USAID/ARD, 2001).

Municipal water demand makes the second in volume of the water users in ZRB. Within ZRB, 252 domestic demand centres was identified in the National Water Master Plan some of which are large parts of big cities like Amman and Zarqa which represents hundreds of thousands of people. The average per capita per day domestic water consumption over the whole basin is estimated to be about 110 l/c/d, however there is some disparity across the basin. The present water demand amount to 150 MCM/y, of witch about 50% are for Amman governorate Amman city is actually supplied with domestic water from the three main groundwater basins occurring in the highland aquifer systems and partly from Zai Water Treatment Plant, which utilizes the Yarmouk River water through King Abdullah Canal (MWI, 2004).

The total industrial water demand amount 7.5 MCM for the year 2005, representing around 1.7% of total water demand in ZRB. It should be noted that the estimated industrial water demand refers to the self yield water, mainly abstracted locally from industrial wells. The largest industrial consumers within the basin use more than 100,000 m^3/yr. Part of industrial water use is computed in the municipal water demand – small and medium industries which are connected to public water supply network. Most of these industries consume small amounts of water less than 300 m^3/yr or less (MWI, 2004, Meditate, 2006).

The touristic sector in ZRB absorbs about 0.5 % of the total present water demand (2 MCM/yr). The per capita water use in this sector was estimated at an average of 2 l/c/d in Amman governorate (Taha et al., 2004).

2.1.2.1 The Quality of Water in the Basin

The over abstraction of groundwater has resulted in water quality deterioration of some wells. Pollution of surface water is from domestic and industrial effluents as well as solid wastes.

Water quality is the lowest in the effluent near the As-Samra treatment plant and improves due to natural causes during its flow down to King-Talal Dam where it is mixed with fresh water. This mixed water constitutes the water of the second best quality in the study area, topped only by the quality of pure fresh water from groundwater in the study area.

Now the quantities of irrigation water per dun between As-samra and King Talal Dam increased as compared with the past (before 20 years). This means the water was more available in this area and the farmers could use more water but with low quality. In other zones in basin the quantity of water (mixed water or fresh water) decreased as compared with the past. This means in the zones of treated wastewater the water is more available comparing with the past.

About 70% of the irrigation systems are high-tech mainly micro irrigation. Also, water distribution to irrigation projects are mainly through pressurized pipe systems. The low quality of water reflected the using of irrigation systems; where in treated wastewater zones the using of drip irrigation system is low comparing with other zones in the basin. This is due to the fact that this kind of technology needs good quality water otherwise the dripper becomes clogged. Additional reason was the availability of water, which was high in low quality water zones.

2.1.3 Human resource analysis

The analysis of human resources focuses first on demographic criteria such as sex and age. Both factors determine the capacity and availability of labour for the farm and off-farm activities. The family allocates labour among the household, farm and off-farm activities.

2.1.3.1 Demography

The ZRB is shared among 5 administrative governorates: Amman, Al Balqa'a, Az Zarqa, Al Mafraq and Jarash. ZRB is the most populated basin in Jordan, the population was estimated about 3.2 million in 2005, representing about 58% of the total Jordan's population. (Department of Statistics (DOS), 2005).

Four main indicators are discussed in this part for describing the human resources in the study area: family size, sex and age of the head and members of family, and the level of education of the head of family.

For analytical purposes, the labour capacity of family members was standardized according to age classes. A full man-equivalent (ME) was assigned to members at an age between 14 and 16 years, 0.5 ME for members above 60 years and 0.2 ME for members below 14 years.

The level of education of head of the family affects decision-making and his age gives an indicator of his potential active participation in labour activities. In the entire study area the head of the family was male; in Jordanian society the head of the family is the father and when he dies the eldest son becomes the head of the family. Women rarely become the head of the family. From the result of the RRA and the discussion with key persons the demographic data has been analyzed. As a result the average age of the head of family is between 46 and 53 years in all zones, and an average 1 ME was attributed to this position.

The family size, an average total population, was between 7.4 and 11.3 members per family (RRA and Key persons). All of these areas were rural and agricultural areas, characterized by large families due to the farmers' need of labour force to aid him in his work. The average age the family members are between 14 and 60 years old. The number of family members who were over 60 years old was low; it was within the average of 0.2 to 0.4 members but not more than 5.5% of the total members of the family. At the same time 60% to 68% of the members of the family in all of the study areas were between 14 to 60 years old. This means the labour capacity of the family was high in the study areas.

2.1.3.2 Family labor and off-farm activities

Family labour is allocated between farm and off-farm activities. The labour capacity and the labour use were analysed in this part. Labour capacity depends on the family size and the age of the members of the family.

The total labour capacity was between 5.4 to 7.7 ME per family in the whole study area. Impacts on the allocation of these labour capacities in household, farm and off-farm activities derive from factors like income, the availability of off-farm employment, the requirements of farming activities and social constraints, such as the willingness of individual family members to participate in specific activities. About half of the families (40% to 65%) had at least one member who worked in an off-farm activity. The off-farm labour was between 0.56 to 1.32 ME per family. The availability of family labour after subtracting the off farm labour from the total labour capacity was between 4.84 ME and 6.98 ME. (RRA, Key persons, previous studies).

The off-farm work is allocated between military, government and private work. The private business provides better opportunities in the Jordan Valley. The reason for this is that the Jordan Valley is a large agricultural area
and provides many related activities such as renting tractors and selling fertilizers and pesticides

2.1.3.3 Hired labour

In the farm, labour can be provided by family members or by hired labour, the hired labour can be both permanent and temporary. The farm requires temporary labour at the time of harvesting, fertilizing or other agricultural processes during specific times during the year. Small farmers use temporary labour because their farms do not need permanent labour. In all of the study area, permanent labour was only performed by males. Temporary labour was performed by males or females but the number of males was higher. The temporary female labour in the study area contributed 18% to 46% to the total temporary labour force.

2.1.4 Capital resources

This part discusses the value of average investment in different zones and the source of capital, credit or cash. Since the quality of water is better in Jordan valley comparing with that near the treatment plant, the highest average investment was in Jordan Valley, the farmers in Jordan Valley used new technology more than in the areas near treatment plant e.g. drip irrigation systems, which do not work with low quality water due to technical problems. The lowest investment was in zones near treatment plant, where farmers planted clover as a main crop and this type of crop does not need much investment. While more than 75% of farmers in Jordan Valley their main investments are in irrigation systems and about 48% are in greenhouses.
In the study area there were many farmers dependent on credit to obtain capital; about 24% to 68% of the farmers received credit but the average value of the credit was not high near As-Samara while it is higher in the Jordan Valley.

2.2 Living standard in Zarqa River Basin

This part discusses the living standard of the family in the study area by using criteria of living standard. Doppler (2002) emphasized the role of living standard as a part of the quality of life and defined the following basic criteria:

- Family income.
- Cash and liquidity.
- Independence from resource owners.
- Food supply and food security.
- Supply of water, housing, sanitary equipment, energy and clothes.
- Health conditions of the family.
- Education and qualification.
- Social security.

The living standards analysis in the study area (Zarqa Basin) will depend on previous mentioned criteria. These criteria include economical and social indicators which reflect the present situation in the study area. Depending on these criteria the expectation of future impact of climate change will be analyzed in this basin.

2.2.1 Family income

Income is one of the economic criteria of the living standard and reflects the ability of the families to satisfy their needs in terms of food, clothes etc., also the possibility to accumulate capital through net revenues. The family income consists of the farm and the off-farm income. The farm income represents the difference between all revenues and all expenses from activities resulting from the own agricultural enterprise (Doppler, 1998).

In Jordan Valley the total cost of farm activities is high due to the level of investments, and the resulting depreciation and maintenance costs, also expenses for plant production are high in this zone, because both use high quantity and good quality of fertilizer and pesticides compared to other zones as shown in Table 2-1. The pattern of crop and using high technology in zones of Jordan valley comparing with other zones (zones of low quality of water) leads to make a difference in the level of income between these zones. The average farm income near treatment plant is low comparing to the other two zones. This indicates that the climate change will affect the living standard of people in this zone highly comparing to other zones.

The lowest farm income per unit of area was in Zones near treatment plant and the farm income per unit of water is very low in this Zone (0.13 JD /m3) compared to other zones (Table 2-2), this indicates that the farmers in this zone could pay the lowest price for water compared to other zones. The necessity to increase the quantity of water is present in other zones. The farm income per unit of capital is between 0.38 and 0.6 JD/JD.

The highest off-farm income in the study area is between 29%-41% of the family income. This indicates that many farmers work in off-farm activities, which reduces the possible risk incurred from agricultural production.

The differences between the family incomes are high in different zones. The reason for this is that the agricultural activities practiced by farmers are different. The investment is very high for the farmers, who planted vegetables in greenhouses where the returns were very high. The others planed in the traditional way and their farm income is low. The conclusion here is that the potential to improve the farm income in zones of high quality water is higher than in the other zones. As a result of using treated wastewater water, the potential to improve the income is limited due to the limited types of crops that are allowed for planting.

Table 2-1: The farm, off-farm and family income in different zones in Zarqa Basin, Jordan 2009/2010

Zones	Near treatment Plant	Before King Talal Dam	Jordan Valley
Total expenses	11424	18242	25067
Rent of the land	1230	4,424	3,190
Labour	2,722	3,192	4,649
Transportation	2,038	930	2,487
Water	121	26	332
Fertilizer and pesticides	630	2300	5200
Seeds and feeding for animals	1130	2,706	2,246
Reduction in stock	496	380	0

Depreciation and maintenance	2,618	3,641	4,288
Others	439	643	2,675
Total revenue	18347	28549	34493
Revenue from plant production	12,620	24136	30826
Revenue from livestock	3,677	1546	584
Rent out resources	2,050	2,867	3,083
Farm income	6923	10307	9426
Off-farm income	2,801	5,286	6,605
Family income	9724	15593	16031

Table 2-2: Farm income per unit of land, unit of water, unit of labour and unit of invested capital, Jordan 2009/2010

Criteria	Unit	Near treatment Plant	Before King Talal Dam	Jordan Valley
Farm income per year	JD/year	6923	10307	9426
Farm income per area	JD/dun	192.3	134.7	162.5
Farm income per quantity of water	JD/m^3	0.13	0.46	0.33
Farm income per invested capital	JD/JD	0.61	0.57	0.38
Family income per year	JD/ year	9724	15593	16031

2.2.2 Cash and liquidity

Liquidity indicates the availability of cash when it is urgently needed, e.g. when the loan has to be repaid. Liquidity analysis deals with the cash availability and requirements on a farm or family in different periods over time (Doppler, 2002).

Time periods can be different based on a weekly or monthly basis the cash situation of the household. Annual cash balances, provide information on the general situation of the family and the liquidity over many years reflects cash problems related to draughts and other general occurrences in the region. While the short-term analysis reflects more the condition of the individual family, long-term cash problems are more typical for a large number of families in the region.

The liquidity reflects how much the farmer can pay for the external resources such as land, water or credit. Also, it is important if the farmer needs to change the pattern of crops when he faces problems.

Liquidity is the cash which farmers have after deducting cash out-flows from the cash in-flows from all activities in the farm and household. Cash out-flows are very high in Zone near the dam and in Jordan Valley, and cash in-flows as well. The average value of liquidity in different zones is high (Table 2-3) but it is the lowest near the treatment plant. The farmer needs cash mainly in March, April and May in Zones of Jordan Valley, where vegetable crops are the main activities, while revenue is produced in May, June and July. Farmers in the Jordan Valley can buy what they need on credit from the shops there for their planting activities such as fertilizers and pesticides. When they sell their products they pay back these loans at no interest rate, so they have cash if the products and the prices are high. The farmers in the Jordan Valley depend on the traders to get what they need for planting. In Zone of olive cultivation, cash is available in September and October. In Zone of clover cultivation, cash is available in all months of the year, because the farmers harvest and sell clover, about ten times per year, from February to November.

The lowest farm cash income per unit of area is in the Zones near treatment plant, the highest is in Jordan Valley zones. This means renting more land in Jordan Valley is more efficient than the Zones of treatment plant. The farm cash income per unit of water is very low in the Zones near treatment plant compared to other Zones. This indicates that the farmers in this Zone could pay the lowest price for water compared to other Zones. The need to increase the quantity of water presents in Zones of Jordan Valley. This means the climate change will affect these zones (Jordan valley zones) highly in case the fresh water decreased.

Table 2-3: The annual cash in-flow and out-flow in different farming systems, Zarqa Basin, Jordan 2009/2010

Zones	Near treatment Plant	Before King Talal Dam	Jordan Valley
Expenses for plant and animal production	8367	13958	18104
Household expenses	5,880	7,100	6500
Other expenses	1,266	1,843	2251

Total cash out flow	15,513	22,901	26,855
Plant production	12620	24136	30826
Livestock	3677	1546	584
Rent of resources and others	2050	2867	3083
Off-farm income	2801	5286	6605
Inflow cash	21148	33835	41098
Cash balance	5635	10934	14242

2.2.3 Food and water supply, housing, and expenditure in the household

These criteria reflect the main needs in the household and reflect the ability of farmers to satisfy these needs. In all of the study area the expenditure for food is between 37%-44% of the total expenses of the household as shown in Table 2-4. The food subsistence in the study area is between 10%-18% of the total value of food for household, it means the families depend on the market to satisfy their food needs. The reason behind that is the aim of farmers is to plant what the markets need, so the orientation to the market in all of the study area is high. At the same time, the diversity of crops in the farm is not enough to cover all the needs of the families. The household expenses are 40% to 60% of the family income in different zones of the study area. The highest percent of the household expenses in the family income are in Zones near treatment plant, they are 60% of family income. This indicates that the expenses in the farm activities are low in these zones, which reflects the low ability to change agricultural activities in case the farmer wants to improve his living standard.

The water quantity for the household (m^3 /per person) in the study area is between 110 m^3 to 175 m^3. In the study area all families had electricity except about 4%. Also in all of the study area 92% or more of families in each zone own their houses.

Table 2-4: Household expenses and food consumption of the family, Zarqa Basin, Jordan 2009/ 2010

Zones	Near treatment Plant	Before King Talal Dam	Jordan Valley
-Total food consumption (JD)	2587	2840	2405
-Food from market (JD)	2328	2442	1972
-Food from farm (JD)	259	398	433

-% Value of food subsistence from total food expenses	10%	14%	18%
-% Value of food consumption from total household expenses	44%	40%	37%
- %Value of other expenses from total expenses in household	56%	60%	63%
Total household expenses (JD)	5880	7100	6500
Total household expenses as percent of family income	60%	46%	41%

2.2.4 Health of the family

Health is a social criterion to provide an impression of how families take care of their members and their financial ability to pay for physician services when needed. It also reflects the availability of health services in each zone. This part discusses how often family members visited the doctor annually within the previous five years when one was sick and what the main diseases in each zone are.

The average number of times in the previous five years that members of the family were sick in the year of the study is between 4 to 5 times per year and about 62% to 87% of these saw the doctor. Many members suffered from fever while in the area near the treatment plant about (24%) suffered from Asthma.

2.2.5 Education and qualifications

Education and qualification are important to add to the knowledge and experience of the decision maker, and in the long term to provide the coming generation with improved knowledge in the society.

In the study area 12%-24% of heads of the families were illiterate. On the other hand, 4%-24% of them studied after school in college or at universities. Most of them (56%-84%) finished at least one phase in the school. The situation in the new generation is better. At least 76% of the families in each zone had a member at school. The average number of members in school is between 2.4- 4.3 per family nevertheless there is about 4%-5% members of the family who studied after school. The situation of education is not only for males but there is also interest in teaching the females in the families. In some zones the percentage of females who studied after finishing school is more than that for male.

2.2.6 Social security

This aspect of the living standard gives an idea about what happens to the member of the family in the future when they become old or sick, or, if they suffer an accident how they can maintain a good quality of life. Two indicators were considered in the discussion of social security. The first one is how many families had health insurance; the second is how many families had social insurance.

About 32% of families in the study area had health insurance and most of them were covered if one of the family members was working in the government or military sector. Social insurance was very low in the study area; it was between 0%- 12%. This kind of insurance is private and covers accidents. At the same time, families with a member working in the government or military sector get pensions when they retire.

3 The efficiency of Resources use

Different methods are available for the partial analysis of the economic efficiency of resource use: such as production coefficients, cost coefficients for resources services, productivity of resources and gross margins (Doppler, 2000).

In this study the gross margin was used and calculated from the average variable costs and the average values of the output of plant and animal production in each zone, taking in consideration that the pattern of crops is different in different zones. The data of cost and return have been estimated depending on a survey has been done in the part of the study area, secondary data from the statistical department, discussions with key persons and on the previous studies and surveys in addition to the experiences of the researchers.

The permanent labour implied fixed costs and, contrary to temporary labour, was not considered. The cost of water was considered as a variable cost because it depends on the quantity of water, which changes depending on the crop.

3.1 Crop competitiveness within the study area

In the zone near treatment plant the main crops were clover and olives, in the zone before King Talal Dam the main crops were olives and citrus, while in the Jordan Valley vegetables and citrus were the main crops. In this part, the gross margin was calculated per unit of land (dun), per unit of cubic meter of water. These calculations will help to compare the efficiency of using the land in different zones, also to give an idea of the efficiency of using different qualities of water in different zones.

3.1.1 Gross margin for Field Crops

3.1.1.1 Gross margin for clover

The variable cost of clover was is relatively low; farmers use small quantities of fertilizer or pesticides as shown in Table 3-1. The gross margin for clover is about 858 JD/ dun, but the gross margin per cubic meter for clover is down to 0.35 JD/ m^3. The reason behind that is the quantity of water per dun of clover is very high. It is the highest quantity in all of the study area. Planting clover in this zone could be the right decision, regarding the availability of water, because in this area the quantity of water is available but the quality is not good which is not necessary for this type of crops.

Table 3-1: Gross margin for clover in the zone near treatment plant, Jordan, 2009-2010

-Value of production (JD/ dun)	1033
Quantity of sales the product (Kg)	15000
Quantity for feeding livestock (Kg)	1210
Total quantity of production	17,210
Average price (JD/kg)	0.06
-Average variable cost (JD/dun)	175
Water (for energy)	20
Fertilizer, seeds and pesticides	42
Labour	52
Transportation	35
Others	10.1
Interest of operation capital (JD/dun)	15.9
-Average gross margin in JD/Dun	858
-Average gross margin in JD/m^3	0. 35

3.1.1.2 Gross margin for wheat, Barley and Sorghum

Field crops in the study area are depending on rainfall. The variable cost for these crops is relatively low, also the productivity is low except the sorghum which is the highest gross margin comparing with wheat and barley as shown in table 3-2. The land use efficiency is high for sorghum and low for other two crops. It indicates that the farmers could pay a high price for renting more land if they plant sorghum as compared to the farmers who plant wheat or barley.

Table 3-2: Gross margin for barley in rainfed area, Zarqa Basin-Jordan 2009/2010

Crop	Barley	Wheat	Sorghum
-Value of production (JD/ dun)	31.4	66.0	880
Quantity of sales production (Kg)	120	150	20000
Quantity of consumption (Kg)	5.5	10	200
Total quantity of production	125.5	160	22000
Average price (JD/kg)	0.25	0.35	0.04
Value of hey (JD/Dun)		10	
-Average variable cost (JD/dun)	16.5	36.8	495
Water (JD/dun)	-	-	20
seeds (JD/dun)	3.5	3.5	20
Fertilizer (JD/dun)	2.0	10	35
Labour (JD/dun)	10	20	25
Machine rental (JD/dun)	-	-	-
Transportation (JD/dun)	-	-	50
Rent of land (JD/Dun)	-	-	300
Interest of operation capital (JD/dun)	1.5	3.3	45
-Average gross margin in JD/Dun	14.9	29.2	385

3.1.1.3 Gross margin for olives

The gross margin for olives per unit of land (see table 3-3) is less than that for clover; while the gross margin per unit of water for olives was about double that for clover, because the variable cost and the quantity of water for olives were lower than that for clover. In Zone before King Talal Dam many of farmers started to plant fruit trees few years earlier and they had changed their planting area from vegetables to olives so these trees were still young and their productivity is still low, but the gross margin per unit of water is high because the quantity of irrigation water in is low and the farmers are depending mainly on the rainfall.

It can be concluded that land use efficiency is higher in the area near treatment plant comparing with the area of before King Tallal Dam, but the water use efficiency is lower. It indicates that the value of water in the area near treatment plant is lower than the area of before the dam but the land is higher as compared to the other zone.

Table 3-3: Gross margin for olives, Zarqa Basin - Jordan 2009/2010

-Value of production (JD/ dun)	165.0
Quantity of sales production (L oil)	50
Quantity of Consumption (L oil)	3.0
Total quantity of production	43
Average price (JD/L)	3.5
-Average variable cost (JD/dun)	106
Water (energy for pumping)	25
Fertilizer (JD/dun)	15
Pesticide (JD/dun)	2.0
Labour (JD/dun)	45
Machine rental (JD/dun)	3.8
Transportation (JD/dun)	8
Share of installation cost (JD/Dun)	7.5
Interest of operation capital (JD/dun)	4.6
-Average gross margin in JD/Dun	69
-Average gross margin in JD/m^3	0.08

3.1.1.4 Gross margin for vegetables

Most of the farmers in Jordan Valley plant vegetables. In these zones, farmers plant many different vegetable crops in the same season to reduce the risk which might occur if they planted only one crop, but the major area in the farm is one or two main crops.

In this part, the gross margin analysis is analysed for crops that are produced large amount in these zones. Many farmers in Jordan Valley zones owned greenhouses and used drip irrigation systems, at the same time they used more and better quality fertilizer and pesticides than other zones in the Zarqa Basin. They also used expensive seeds in planting. The better quality and higher quantity make the cost of these in-puts higher and as a consequence the total variable cost is higher comparing to other crops in other zones. As a result of using good quality and suitable quantities of in-puts, in addition to using technology, the productivity in these zones is high. The cost of transportation in these zones in the Jordan Valley for vegetables is high because there are many farmers depending not only on the Deir-Alla market which is in the same area but also they depend on the main market in Amman which is about 50 km from this area. The reason for that is the quantity of products of vegetables in this area is high as a result of the high number of farmers who plant vegetables in this area.

The main vegetables crops in the study area are potatoes, onions, squash, tomato and cucumber. The gross margin per the area of land in the opened field is between 113-473 JD/dun (table 3-4). The highest value is for squash crop because of the price of this crop is usually higher than the other vegetables crops. In the case of gross margin per cubic meter the highest value is also for squash which is about 0.9 JD/ m^3 and the second value is for tomato which is 0.43 JD/m^3 (table 3.5), while the lowest value is for eggplant and onion which are less than the value of clover. The low value for gross margin per unit of water is acceptable in the zones of treated wastewater but in the zones of fresh scarcity water should be re-evaluated considering the demand of the markets and the expectation of the quality and quantity of fresh water as results of climate change in the future.

Table 3-4: Gross margin for vegetables Zarqa Basin- Jordan 2009/2010

Crop	Potato	Eggplant	Squash	Onion
-Value of production (JD/ dun)	630	608	891	594
Quantity of sales (Kg)	3000	3600	2500	2,700
Quantity of consumption (Kg)	150	200	200	50
Total quantity of production	3150	3800	2700	2750
Average price (JD/kg)	0.2	0.16	0.33	0.22
-Average variable cost (JD/dun)	459.8	495	411,4	345.4
Water (JD/dun)	30	60	55	25
Fertilizer (JD/dun)	50	80	35	35
Pesticide and chemicals (JD/dun)	30	50	65	35
Temporary Labour (JD/dun)	60	80	100	92
Machine rental (JD/dun)	10	10	12.0	30
Transportation (JD/dun)	88	150	92	75
Seeds (JD/dun)	150	20	15	50
Interest of operation capital (JD/dun)	41.8	45	37.4	3.4
-Average gross margin in JD/Dun	170.2	113	479.6	248.6
-Average gross margin in JD/m^3	0.38	0.25	0.96	0.31

Table 3-5 shows the gross margin for tomatoes in open field and under green houses. It is clear that the gross margin in the opened field is very low compared with the gross margin for crops under greenhouses, because of the productivity, which is much higher under green houses. In Zones where greenhouses are used, the cost of fertilizers, seeds and pesticides for tomatoes and cucumbers are high but the productivity is very high. The gross margin per unit of water under the green houses production is high. This indicates that the farmers could pay a higher price for water and a higher price for renting more land compared to the farmers of opened field production, which reflects the high value of land and water. The water use efficiency in the case of tomatoes in greenhouses is 70% more than that in the case of planting cucumbers. It indicates that the farmers can pay higher prices for water if they plant tomatoes in greenhouses instead of planting cucumber in greenhouses.

The other advantage of the planting under the green houses is the prices of products; the farmers can produce when the demand at markets is high and supply is low.

Table 3-5: Gross margin for tomatoes and cucumbers in opened field and under greenhouses, Zarqa Bain Jordan 2009/2010

	Opened field	Green houses	
Crops	Tomato	Tomato	Cucumber
-Value of production (JD/GH)	690	2280	2321
Quantity of sales production (Kg/GH)	4,500	15000	13500
Quantity of consumption (Kg)	120	200	150
Total quantity of production	4600	15200	13650
Average price (JD/kg)	0.15	0.14	0.17
-Average variable cost (JD/GH)	491	764.5	957
Water (JD/GH)	30	35	35
Fertilizer (JD/GH)	50	55	70
Pesticide (JD/GH)	60	70	120
Chemicals (JD/GH)		60	70
Temporary Labour (JD/GH)	150	180	300
Machine rental (JD/GH)	30	35	35
Transportation (JD/GH)	96	120	120
Seeds (JD/GH)	75	140	120
Interest of operation capital (JD/GH)	49.1	69.5	87.0

-Average gross margin in JD/GH	199	1515.5	1364
-Average gross margin in JD/m3	0.47	3.69	2.17

4 The Impact of Climate Change on Resources and Living Standard

This chapter focuses on the analysis of the future impact of different strategies and policies for climate change on the living standard of farm families. A set of scenarios was selected in order to measure the impact on the living standard of farm families and to measure the availability and quality of the water in the regional level. These scenarios were derived from the results of the socio-economic analysis in the study area.

4.1 Development of scenarios

The scenarios relevant for testing were derived from the analyses in the previous chapters. The results indicate that the use of mixed water could be an alternative to the use of fresh water. In addition, growing crops suitable to the quality of water could affect negatively on family income. The expectation of the impact of climate change that the using of treated wastewater increases and the quality of water becomes worse over time. As a consequence of increasing low quality water, the quantity in King-Talal Dam (mixed water) will increase and water will be more available in Jordan Valley but with low quality. Scenarios were derived from these results and their impacts measurement. The testing of different scenarios focused on the micro level by measuring the impact on the living standard and the use of resources in farm-family-household system. The availability of water resources will be determined on the macro level.

The expectation of the impact of climate change indicates that problems related to water supply in zones with freshwater arise from the scarcity of water. The zones of treated and mixed wastewater suffer less from restrictions in water quantity but have to deal with the effects of water pollution. Both problems are likely to increase in the future.

Estimations of impacts from decreasing water qualities have to be based on assumptions on potential effects from polluted water since precise knowledge of interrelationships is not available. Prognoses of impacts from changing water quantities can rely on the knowledge of the applied production methods and allow the testing of two main scenarios for development in the future. The first scenario assumed a decrease in freshwater availability and there is no alternative for replacing fresh water (same quality but less quantity). The second scenario predicted an increase in the availability of mixed and treated wastewater, which might offer an alternative for replacing freshwater in other zones (same quantity but less quality).

4.2 Model structure

In this study a linear programming model is applied to investigate the respective impact on farm, off-farm and family income, and to measure the impact of strategies in different zones. Linear Programming is a method of determining an income maximizing combination of farm enterprises that is feasible with respect to a set of fixed farm constraints (Hazell, 1986).

The impact of climate change is determined by testing different scenarios by comparing the results of the model to the income of the farmers both by using these scenarios and without using them.

The programming model, which has been used in this analysis, can be mathematically presented as follows:

Objective function $$\text{Max } Z = \sum_{j=1}^{n} P_j X_j - C_j X_j \quad (1)$$

The Constraints $$\sum_{j=1}^{n} a_{ij} X_j = bi, \quad \text{all } i=1 \text{ to } m \quad (2)$$

$$X_j \geq 0 \quad \text{all } j=1 \text{ to } n \quad (3)$$

Where:

Z	=	the objective function (family income)
X_j	=	the level of activity j
P_j	=	the price per unit of the j output activity
C_j	=	the cost per unit of j input activity
n	=	number of possible activities
m	=	number of resources and constraints
a_{ij}	=	technical coefficient (amount of i the input required to produce one unit of j the activity)
bj	=	amount of i the resource available

The programming model was created depending on the last mathematical concepts. The data was based on a short field survey, Rapid Rural Appraisal and meeting with key persons in the study area carried out in 2010. The objective function is intended to maximize the family income under the condition of the resources availability. To maximize the family income the resources are allocated between different activities in a way that the difference between the total cost and the total revenue is the maximum. The model maximizes the objective function under the conditions of limited constraints and resources for the various activities. The family-household models are constructed to represent the four zones in the study area, these are:

- Zone 1: near the treatment plant, very low quality.
- Zone 2: before King Tallal Dam, low quality.
- Zone 3 & 4: mixed water fresh water zones in Jordan Valley.

The objective function contains the following components:

- The variable costs -excluding costs of hired labour- per unit area of different crops (dun), per greenhouse in the zones where they are used, and per unit of head for the livestock production.
- The sale prices of crops and livestock products
- The consumption activity of crops and livestock products.
- The wage of the hired labour as a farming wage rate per man-day.
- The family labour in the farm.
- Off-farm income.
- The monthly irrigation water.
- The value of the rented land.
- Transfer Activities; any cash surplus at the end of each month can be transferred to the next month through cash transfer activity.

The model contains the following constraints:

- Greenhouses in the basic model were restricted as the average number of greenhouses in the study area because they require high investments.
- The average number of sheep was restricted as the average number in the study area.
- Household consumption items were displayed, as a minimum required of family annual requirements as in the Rapid Rural Appraisal. The farm families satisfy their requirements from their own production or through purchases at the markets.
- To estimate the quantity of water in the model, it is assumed that the quantity of consumed water is open.
- Family labour, which works on the farm, was classified into two main types; the first one is heavy work, for which men are used, and the second one is light work, like harvesting, for which both men and women are used. The first one is restricted to the male members of the family between 14-60 who are not studying. The second one is restricted to the labour capacity in the family. No restriction was applied to hired labour activities.
- Off-farm work was equal to the male members of the family between 14-60 who are not studying.

- Monthly cash inflow and outflow was considered in the model. The cash inflow consists of the cash from selling farm products and off-farm activities. The cash outflow consists of the cost of production, purchasing activities, home consumption goods from the market and family expenses.

The following assumptions were assumed in the models:

- It was assumed that farmers could hire labour throughout the year at an average wage between 8-12 JD per day.
- Water constraints in cubic meters were used for irrigation and none for animals because the quality and source of water in all zones for livestock production is different, many farmers had access to free water sources like springs, or they purchase water from other zones.

Cash is transferred from month to month with the financial year beginning in January. The farmer can buy on credit from the traders at the beginning of the year and repay when his products are sold.

4.3 The Results of the models

To validate the model the results of the static models were compared with the farm survey results (the situation in reality). Since models optimize resource allocation or maximize income, the results are more an indicator of reality and therefore may not be identical with the survey results. In reality, the farmer may not reach the optimal situation as he will be affected by some factors, which happen during the season of production especially in agricultural sectors in which the uncertainty and the risks are high.

Criteria for validation of the models consist of:

- Farm, off-farm and family income.
- Water quantity as a resource.

4.3.1 Farm, off-farm and family income

Farm income is calculated from the objective function by calculating the differences between all the cost and all the revenue from using the resources. Off-farm income is the income from off-farm activities. Family income consists of farm and off-farm income. The results of the basic linear programming models show that the family income was higher than the family income of the real income in the study area. The differences between the family practices and the model results can be explained by two reasons. The first one is that there are many members of the family who can work off-farm but did not, thus the difference in off-farm income is high as shown in Table 4.1. The second reason is that the main activities in the model in Zones of treatment plant are olives and clover cultivation and in Zones of Jordan Valley they are tomato and cucumber cultivation in greenhouses depending on the data at the time of the survey. These activities in the model need high investments in the first year and in the case of olives and citrus the productivity differs from one year to the next, thus the data from one year is not sufficient to provide the real solution.

In this study crop activities were divided into three main groups: vegetables, fruit and olive trees, and field crops. Livestock production was goats and sheep. The results of the static model show that the use of land in Zones near treatment plant is allocated mainly for olive trees with between 35- 70 Dun. While in the Jordan Valley is allocated mainly for tomato under the greenhouses and to use these greenhouses for tomato and then plant it to produce Gewish-mellow. The results show also that the greenhouses that were available in the farm are used, which means if there are more greenhouses they could be used, but they require high investments.

Table 4-1: Farm, off-farm and family income as results from basic models comparing to the real situation in different water qualities zones, Zarqa Basin Jordan 2009/2010

Zone	Near treatment plant		Before King Talal Dam		Jordan Valley	
	Present situation	Basic model	Present situation	Basic model	Present situation	Basic model
Family income JD	9724	7125	15593	11845	16031	13074
Off farm income JD	2801	1500	5286	2340	6605	3000
Farm income JD	6923	5624	10307	9505	10026	10074

4.3.2 The quantity of water in the model

Results of the model show that the quantity of water in the model is less than what is used in the reality in zones near treatment plant where water is available and farmers can consume as much as they need from the treatment plant. In this zone, in reality, they planted clover, which requires a high quantity of water. In the zones before the Dam where the treated wastewater is used also, the quantity of water in the model is higher than that in reality. In Jordan Valley where mixed water and fresh water are used, the quantity of water in the model is less than in the survey. The scarcity of water will be in where fresh water is used. One solution to the expected water scarcity is to use mixed water in this zone instead of fresh water.

Water for irrigation is used in all months of the year except December, January and February because in these months all zones are dependent on the rainfall. In the zones where the vegetable crops are the main activities in the model, water for irrigation is very low in August and September.

4.3.3 Conclusions of main results of the model

The model results are close but not identical to the survey considering that the models optimize resource allocation and maximize income. The comparison of data in one year in the model is the reason behind the high difference between the farm income in the survey and in the static model. Some crops need high investments in the first year and the revenue is very low at the beginning, then after many years the revenue increases. In addition to that, many farmers refused to take loans to cover the high investment. This explains the differences between the results of the survey and the models in these zones.

4.4 Impact of different scenarios of the expectation of climate

For analytical purposes in this study, potential effects of climate change on changing water qualities were assumed on two levels. The first assumption supposed a negative impact on yields from polluted water, which might be regarded as a hypothesis on long-term effects. The second assumption makes reference to the current Jordanian legislation, which restricts the choice of cropping patterns in areas with low quality water, and supposes that these restrictions will also apply to any further extension of those areas. The scenarios from these assumptions and their application to models of the study area are compiled in Figure 4-1.

Scenario of very low quality zones o If the concentration of salts in water is increased.
Scenarios of low quality water zones-quality becomes worse o If the concentration of salts in water is increased.
Scenarios of fresh water zones o Replacing the fresh water with mixed water.

Figure 4-1 The main scenarios in the models

4.4.1 Future impact in the very low quality water zone

In this zone, the increase of water quantity has no effect on the optimal solution because the quantity of water in the model is less than that in the survey, but there could be an effect if the quality becomes worse. Regarding the different possibilities in the water quality in this zone, the following scenario was tested:

- If the productivity of crops decreases when the concentration of salts in the water increases. The electrical conductivity of water (ECw) was used to measure the water salinity in this analysis. As the value of ECw increases the productivity of crops decreases but the percent of decrease is different from one crop to another depending on the sensitivity of the crop to the water salinity (FAO, 1979). Regarding the sensitivity of crops to water salinity, the crops are classified to four main groups: tolerant, moderately tolerant, moderately sensitive and sensitive. At the level of ECw of the water in this zone the productivity of moderately tolerant crops is 90% of the normal productivity for olives and clover. Productivity of tolerant crops like barley is 100% (RJSS, 2000). The effect of increasing the salinity of water was tested if the ECw is increased by 50% more than the present value. The decrease in productivity of moderately tolerant crops is 17% less and 0% for the others.

The family income of the farmer is highly affected if the salinity of water increases. In this case, the average family income is 5480 JD if the water salinity increases 50%. The effect of increasing water salinity is very great on family income after eight years; if the ECw increases 50% more than the value of ECw in the year of the survey, the family income decreases about 23%.

In all cases, any policy to increase the quantity of water from the treatment plant will negatively affect the living standard of the farmers in this area. To decrease the negative effect of increasing the quantity of treated wastewater, the quality of water should be suitable for planting olives in all cases and there should be no change in the salinity of the water.

4.4.2 Future impact in the low quality water zone (before KTD)

The following scenario was tested in theses zones:

- Regarding the salinity of water before applying these scenarios, the productivity of sensitive crops like citrus was 75% of the normal productivity and 90% for the moderately tolerant crops e.g. olives in this zone. The effect of increasing the salinity of water was tested if the ECw increases 50% more than its present value. The decrease in productivity of sensitive crops is 33% less and 17% for the moderately tolerant.

Any change in the quality of water or the salinity will decrease the income greatly especially if the quality is not suitable for planting olives because olives are dominant in this zone. In the case If the ECw increases 50% more than its present value, the average income becomes 8176 JD by 31% decreased comparing to the basic model. This means in this zone the increase in the quantity of water is important and could be a good option for improving the living standard of the farmers because the revenue from olives is high, but a change in water quality will greatly affect the living standard of the farmers in this zone in a negative way. An increase in suitable quality water is a good strategy for improving the living standard of farmers in the long term and also by considering the development over time.

4.4.3 Future impact in the mixed and fresh water zone in Jordan Valley

The following scenarios were tested in zone of Jordan Valley:

- The quantity of water increases and the salinity of water increases by 50%. The assumption is that the productivity of all products in the survey is 100% of the normal productivity. The decrease in productivity of sensitive crops is 10% less and 0% for the moderately tolerant crops.
- The quantity of water increases and the salinity of water increases by 100%. The assumption is that the productivity of all products in the survey is 100% of the normal productivity. The decrease in productivity of sensitive crops is 25% less and 10% for the moderately tolerant crops.

The 50% increase in the Ec will not affect the family income because the main crops in this zone are moderately tolerant crops, which means the small change in the Ec will not affect the productivity, but the change of Ec by 100% will affect these crops and in this case the average income of will be 10681 JD, this signifies a decrease of 18% less than the average income in the basic model.

4.4.4 Conclusions of the results of the scenarios

Applying and testing scenarios were carried in each zone. These scenarios mainly reflect the impact of climate change in the future. The application of these scenarios is at the macro level but the impacts of these strategies are at the macro level and micro levels. The main scenario is to test the impact of the increase of low quality water from the treatment plant and decrease fresh water in the study area. The testing of these scenarios was done by using different sub-scenarios.

The quantity of water in the optimal solution will be less than that before applying these scenarios, if the quality becomes worse or the salinity of water is very high. The average income is highly affected in all scenarios in case of very high salinity. This reflects that the effect of water with high salinity, influences income negatively. This means if the quality becomes worse the impact of climate change will be highly in all zones on the living standard of the people. This result reflects the indirect impact of climate change on the quality of water; by using treated wastewater, which its quality is worse than fresh water, for irrigation as a result of decreasing the rainfall.

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Appendixes

Appendix 1

1Worksheet: [Linear model.xls] Near As-Samra Treatment Plant Zones

Report Created: 1/11/2011 7:25:25 PM

Target Cell (Min)

Cell	Name	Original Value	Final Value
DB5	objective function RHS	1232.3126	-7124.946086

Adjustable Cells

Cell	Name	Original Value	Final Value
B6	extent clov(dun)	1	6.43818E-13
C6	extent barl dun	1	4.74065E-13
D6	extent corn dun	1	2.721428571
E6	extent oliv dun	1	35
F6	extent goats head	1	8.93507E-13
G6	extent sheeps head	1	15
H6	extent goats purch	1	0
I6	extent sheeps purch	1	0
J6	extent selclov.Jan.	1	6.81772E-10
K6	extent selclov.feb.	1	6.8301E-10
L6	extent selclov.mar.	1	6.82381E-10
M6	extent selclov.apr..	1	6.81772E-10
N6	extent selclov.may.	1	6.81801E-10
O6	extent selclov.jun.	1	6.81772E-10
P6	extent selclov.Jul.	1	6.81763E-10
Q6	extent selclov.ouq.	1	6.81807E-10
R6	extent selclov.sep.	1	6.81807E-10
S6	extent selclov.oct.	1	6.81801E-10
T6	extent selclov.nov.	1	6.8301E-10
U6	extent selbarl.jun	1	2.49543E-10
V6	extent selhay. Jun	1	0
W6	extent selcorn	1	0
X6	extent seloliv.oct	1	17375
Y6	extent selgaots	1	0
Z6	extent selsheeps	1	13.5
AA6	extent selgaots	1	1.54679E-10
AB6	extent selsheeps	1	1536
AC6	extent cons.far.olv	1	125
AD6	extent cons far meatgt	1	0

	AE6	extent cons far meat sh	1	3.3
	AF6	extent cons far milkgt	1	0
	AG6	extent cons far milk sh	1	339
	AH6	extent cons.mark.olv	1	0
	AI6	extent cons mark meatgt	1	0
	AJ6	extent cons mark meat sh	1	0
	AK6	extent cons mark milkgt	1	0
	AL6	extent cons mark milk sh	1	0
	AM6	extent seed far barl.	1	2.25242E-12
	AN6	extent seed mark barl.	1	0
	AO6	extent feedgt far hay	1	0
	AP6	extent feedsh far hay	1	0
	AQ6	extent feedgt far corn	1	8.80557E-11
	AR6	extent feedsh far corn	1	3810
	AS6	extent feedgt mark hay	1	0
	AT6	extent feedsh markhay	1	0
	AU6	extent feedgt mark corn	1	0
	AV6	extent feedsh mark corn	1	0
	AW6	extent family expen.	1	1
	AX6	extent miantnance and dep	1	1
	AY6	extent male lab prep+seeding	1	63
	AZ6	extent malelab pest+irrig	1	0
	BA6	extent male lab harv.	1	0
	BB6	extent malelab harv.olv	1	0
	BC6	extent male labfert	1	67.08214286
	BD6	extent malelab clover	1	0
	BE6	extent male labour animal	1	99.16428571
	BF6	extent female lab harv.olv	1	43
	BG6	extent fam male lab prep	1	0
	BH6	extent fam male lab pest+irrig	1	95.08214286
	BI6	extent fam male lab harv.	1	4.082142857
	BJ6	extent fam male lab harv.olv	1	0
	BK6	extent fam male labfert	1	0
	BL6	extent fam male lab clover	1	0
	BM6	extent fam male labour animal	1	50.83571429
	BN6	extent fam female lab harv.olv	1	90
	BO6	extent off-farmJan	1	0
	BP6	extent off-farmfab	1	0
	BQ6	extent off-farmmar	1	0
	BR6	extent off-farmapr	1	25
	BS6	extent off-farmmay	1	25
	BT6	extent off-farmJun	1	25
	BU6	extent off-farmJul	1	25
	BV6	extent off-farmaug	1	25
	BW6	extent off-farmsep	1	25
	BX6	extent off-farmoct	1	0
	BY6	extent off-farmnov	1	0
	BZ6	extent off-farmdec	1	0

	CA6	extent irrgjan	1	0
	CB6	extent irrgFab.	1	0
	CC6	extent irrgmar.	1	195.9428571
	CD6	extent irrgapr.	1	3660.942857
	CE6	extent irrgmay	1	3660.942857
	CF6	extent irrgjune	1	3660.942857
	CG6	extent irrgjul.	1	3465
	CH6	extent irrgaug.	1	3465
	CI6	extent irrgsep.	1	3465
	CJ6	extent irrgoct.	1	3465
	CK6	extent irrgnov.	1	5.94468E-10
	CL6	extent irrgdec	1	1.25596E-10
	CM6	extent cred	1	3394.362529
	CN6	extent transjan	1	2951.757124
	CO6	extent transFab.	1	2509.151719
	CP6	extent transmar.	1	1290.495
	CQ6	extent transapr.	1	3009.508281
	CR6	extent transmay	1	2660.703191
	CS6	extent transjune	1	2134.816215
	CT6	extent transjul.	1	1890.23581
	CU6	extent transaug.	1	1645.655405
	CV6	extent transsep.	1	0
	CW6	extent transoct.	1	5291.041446
	CX6	extent transnov.	1	3980.667934
	CY6	extent transdec	1	0

Appendix 2

Worksheet: [Linear model.xls]Treated WW Zones less17% prod				
Report Created: 1/16/2011 7:30:41 AM				
Target Cell (Min)				
	Cell	**Name**	**Original Value**	**Final Value**
	DB5	objective function RHS	1232.3126	-5480.598448
Adjustable Cells				
	Cell	**Name**	**Original Value**	**Final Value**
	B6	extent clov(dun)	1	6.41598E-13
	C6	extent barl dun	1	11.31578947
	D6	extent corn dun	1	0
	E6	extent oliv dun	1	23.68421053
	F6	extent goats head	1	9.97535E-13
	G6	extent sheeps head	1	15
	H6	extent goats purch	1	0
	I6	extent sheeps purch	1	0
	J6	extent selclov.Jan.	1	1.05864E-10
	K6	extent selclov.feb.	1	1.05864E-10
	L6	extent selclov.mar.	1	1.05864E-10
	M6	extent selclov.apr..	1	1.05864E-10
	N6	extent selclov.may.	1	1.05864E-10
	O6	extent selclov.jun.	1	1.05864E-10
	P6	extent selclov.Jul.	1	1.05864E-10
	Q6	extent selclov.ouq.	1	1.05864E-10
	R6	extent selclov.sep.	1	1.05864E-10
	S6	extent selclov.oct.	1	1.05864E-10
	T6	extent selclov.nov.	1	1.05864E-10
	U6	extent selbarl.jun	1	5001.578948
	V6	extent selhay. Jun	1	8263.947369
	W6	extent selcorn	1	0
	X6	extent seloliv.oct	1	9703.947369
	Y6	extent selgaots	1	0
	Z6	extent selsheeps	1	6.589732793
	AA6	extent selgaots	1	1.52049E-10
	AB6	extent selsheeps	1	1536
	AC6	extent cons.far.olv	1	125
	AD6	extent cons far meatgt	1	0
	AE6	extent cons far meat sh	1	10.21026721
	AF6	extent cons far milkgt	1	0
	AG6	extent cons far milk sh	1	339

	AH6	extent cons.mark.olv	1	0
	AI6	extent cons mark meatgt	1	0
	AJ6	extent cons mark meat sh	1	0
	AK6	extent cons mark milkgt	1	0
	AL6	extent cons mark milk sh	1	0
	AM6	extent seed far barl.	1	316.8421053
	AN6	extent seed mark barl.	1	0
	AO6	extent feedgt far hay	1	0
	AP6	extent feedsh far hay	1	3810
	AQ6	extent feedgt far corn	1	1.11611E-10
	AR6	extent feedsh far corn	1	1.09037E-09
	AS6	extent feedgt mark hay	1	0
	AT6	extent feedsh markhay	1	0
	AU6	extent feedgt mark corn	1	0
	AV6	extent feedsh mark corn	1	0
	AW6	extent family expen.	1	1
	AX6	extent miantnance and dep	1	1
	AY6	extent male lab prep+seeding	1	58.47368421
	AZ6	extent malelab pest+irrig	1	0
	BA6	extent male lab harv.	1	0
	BB6	extent malelab harv.olv	1	0
	BC6	extent male labfert	1	60.73684211
	BD6	extent malelab clover	1	0
	BE6	extent male labour animal	1	100.0526316
	BF6	extent female lab harv.olv	1	0
	BG6	extent fam male lab prep	1	0
	BH6	extent fam male lab pest+irrig	1	77.42105263
	BI6	extent fam male lab harv.	1	22.63157895
	BJ6	extent fam male lab harv.olv	1	0
	BK6	extent fam male labfert	1	0
	BL6	extent fam male lab clover	1	0
	BM6	extent fam male labour animal	1	49.94736842
	BN6	extent fam female lab harv.olv	1	90
	BO6	extent off-farmJan	1	0
	BP6	extent off-farmfab	1	0
	BQ6	extent off-farmmar	1	0
	BR6	extent off-farmapr	1	25
	BS6	extent off-farmmay	1	25
	BT6	extent off-farmJun	1	25
	BU6	extent off-farmJul	1	25
	BV6	extent off-farmaug	1	25
	BW6	extent off-farmsep	1	25
	BX6	extent off-farmoct	1	0
	BY6	extent off-farmnov	1	0
	BZ6	extent off-farmdec	1	0
	CA6	extent irrgjan	1	0
	CB6	extent irrgFab.	1	0
	CC6	extent irrgmar.	1	803.4210527
	CD6	extent irrgapr.	1	3148.157895

	CE6	extent irrgmay	1	3148.157895
	CF6	extent irrgjune	1	3148.157895
	CG6	extent irrgjul.	1	3148.157895
	CH6	extent irrgaug.	1	2344.736842
	CI6	extent irrgsep.	1	2344.736842
	CJ6	extent irrgoct.	1	2344.736842
	CK6	extent irrgnov.	1	803.4210527
	CL6	extent irrgdec	1	803.4210526
	CM6	extent cred	1	2068.114974
	CN6	extent transjan	1	1624.769281
	CO6	extent transFab.	1	1181.423588
	CP6	extent transmar.	1	0
	CQ6	extent transapr.	1	1163.823596
	CR6	extent transmay	1	851.4959297
	CS6	extent transjune	1	1879.155895
	CT6	extent transjul.	1	1451.588755
	CU6	extent transaug.	1	1223.072009
	CV6	extent transsep.	1	0
	CW6	extent transoct.	1	3938.531491
	CX6	extent transnov.	1	2699.733562
	CY6	extent transdec	1	0

Appendix 3

Basic model of the zones before KTD

Cell	Name	Original Value	Final Value
BJ5	objective function RHS	997.42402	-11845.15574

Cell	Name	Original Value	Final Value
B6	extent citrus dun	1	0.264150943
C6	extent olives dun	1	59.73584906
D6	extent wheat dun	1	0
E6	extent sel citrus	1	0
F6	extent sel oliv.oct	1	38738.30189
G6	extent sel Wh.	1	7.81351E-11
H6	extent cons mark citrus	1	0
I6	extent cons mark oliv	1	0
J6	extent cons far citrus	1	140
K6	extent cons faroliv	1	90
L6	extent seed farwh.	1	2.94986E-13
M6	extent seed markwh.	1	0
N6	extent r.land	1	60
O6	extent maint and dep	1	1
P6	extent male lab prep+seeding	1	0
Q6	extent male lab pest+irrig	1	0
R6	extent male lab harv.	1	0
S6	extent male lab harv.olv	1	0
T6	extent male labfert	1	0
U6	extent female lab harv.	1	0
V6	extent female lab harv.olv	1	0
W6	extent off-farmJan	1	25
X6	extent off-farmfab	1	25
Y6	extent off-farmmar	1	25
Z6	extent off-farmapr	1	4.211320754
AA6	extent off-farmmay	1	0
AB6	extent off-farmJun	1	25
AC6	extent off-farmJul	1	25
AD6	extent off-farmaug	1	25
AE6	extent off-farmsep	1	25
AF6	extent off-farmoct	1	25
AG6	extent off-farmnov	1	5

AH6	extent off-farmdec	1	25		
AI6	extent irrgjan	1	0		
AJ6	extent irrgFab.	1	0		
AK6	extent irrgmar.	1	26.41509433		
AL6	extent irrgapr.	1	4274.264151		
AM6	extent irrgmay	1	4274.264151		
AN6	extent irrgjune	1	4261.056604		
AO6	extent irrgjul.	1	4261.056604		
AP6	extent irrgaug.	1	4267.660377		
AQ6	extent irrgsep.	1	4267.660377		
AR6	extent irrgoct.	1	26.41509433		
AS6	extent irrgnov.	1	0		
AT6	extent irrgdec	1	0		
AU6	extent cred	1	7893.548887		
AV6	extent transjan	1	8001.285887		
AW6	extent transFab.	1	8109.022887		
AX6	extent transmar.	1	7496.759887		
AY6	extent transapr.	1	7223.526321		
AZ6	extent transmay	1	5712.934264		
BA6	extent transjune	1	4271.549755		
BB6	extent transjul.	1	2530.693547		
BC6	extent transaug.	1	2465.610924		
BD6	extent transsep.	1	0		
BE6	extent transoct.	1	7878.074887		
BF6	extent transnov.	1	7785.811887		
BG6	extent transdec	1	0		

Appendix 4

Scenario of 33% less Productivity of Zones Before King Tallal Dam			
Cell	**Name**	**Original Value**	**Final Value**
BJ5	objective function RHS	997.42402	-8175.844134
Cell	**Name**	**Original Value**	**Final Value**
B6	extent citrus dun	1	0.394255139
C6	extent olives dun	1	59.60574486
D6	extent wheat dun	1	9.21485E-14
E6	extent sel citrus	1	0
F6	extent sel oliv.oct	1	32067.29935
G6	extent sel Wh.	1	0
H6	extent cons mark citrus	1	0
I6	extent cons mark oliv	1	0
J6	extent cons far citrus	1	140
K6	extent cons faroliv	1	90
L6	extent seed farwh.	1	0
M6	extent seed markwh.	1	2.29039E-12
N6	extent r.land	1	60
O6	extent maint and dep	1	1
P6	extent male lab prep+seeding	1	0
Q6	extent male lab pest+irrig	1	0
R6	extent male lab harv.	1	0
S6	extent male lab harv.olv	1	0
T6	extent male labfert	1	0
U6	extent female lab harv.	1	0
V6	extent female lab harv.olv	1	0
W6	extent off-farmJan	1	25
X6	extent off-farmfab	1	25
Y6	extent off-farmmar	1	25
Z6	extent off-farmapr	1	4.315404111
AA6	extent off-farmmay	1	0
AB6	extent off-farmJun	1	25
AC6	extent off-farmJul	1	25

AD6	extent off-farmaug	1	25
AE6	extent off-farmsep	1	25
AF6	extent off-farmoct	1	25
AG6	extent off-farmnov	1	5
AH6	extent off-farmdec	1	25
AI6	extent irrgjan	1	0
AJ6	extent irrgFab.	1	0
AK6	extent irrgmar.	1	39.42551393
AL6	extent irrgapr.	1	4281.289777
AM6	extent irrgmay	1	4281.289777
AN6	extent irrgjune	1	4261.577021
AO6	extent irrgjul.	1	4261.577021
AP6	extent irrgaug.	1	4271.433399
AQ6	extent irrgsep.	1	4271.433399
AR6	extent irrgoct.	1	39.42551393
AS6	extent irrgnov.	1	0
AT6	extent irrgdec	1	0
AU6	extent cred	1	7893.933995
AV6	extent transjan	1	8001.670995
AW6	extent transFab.	1	8109.407995
AX6	extent transmar.	1	7497.144995
AY6	extent transapr.	1	7223.630404
AZ6	extent transmay	1	5714.058364
BA6	extent transjune	1	4273.303559
BB6	extent transjul.	1	2533.337264
BC6	extent transaug.	1	2467.062887
BD6	extent transsep.	1	0
BE6	extent transoct.	1	7878.459995
BF6	extent transnov.	1	7786.196995
BG6	extent transdec	1	0

Appendix 5

Basic model of the zones Jordan Valley

Cell	**Name**	**Original Value**	**Final Value**
CL6	objective function RHS	3832.26462	-13074.01503
Cell	**Name**	**Original Value**	**Final Value**
B7	extent Tomato dun	1	0
C7	extent Tom G.h.	1	14.92307692
D7	extent Cuc G.H	1	0.076923077
E7	extent onion dun	1	3.76588E-13
F7	extent potato dun	1	0.057416268
G7	extent Gewish mellow gh	1	14.82669138
H7	extent only Gewish mellow gh	1	0
I7	extent squesh dun	1	0.048192771
J7	extent peper dun	1	7.28084E-13
K7	extent citrusdun	1	12.44258373
L7	extent sel tomato may	1	61293.53846
M7	extent selTomato jun	1	59592.30769
N7	extent selcuc gh may	1	0
O7	extent selcuc jun gh	1	53.84615395
P7	extent selonionmay	1	5.16707E-10
Q7	extent selonionjun	1	0
R7	extent selpotato may	1	0
S7	extent selpotato june	1	54.83253599
T7	extent selGewish mellow	1	27833.65987
U7	extent selsquash	1	0
V7	extent selpeper may	1	0
W7	extent selpeper june	1	2.40844E-11
X7	extent selcitrus june	1	20908.42584
Y7	extent selcitrus juli	1	18643.8756
Z7	extent cons farTomato	1	200
AA7	extent cons farcucumber	1	200
AB7	extent cons faronion	1	0
AC7	extent cons farpotato	1	120
AD7	extent cons farGewish mellow	1	85
AE7	extent cons farsquash	1	80
AF7	extent cons farpeper	1	0
AG7	extent cons farcitrus	1	40
AH7	extent cons markTomato	1	0

AI7	extent cons markcucumber	1	0
AJ7	extent cons markonion	1	100
AK7	extent cons markpotato	1	0
AL7	extent cons markGewish mellow	1	0
AM7	extent cons marksqaush	1	0
AN7	extent cons markpeper	1	20
AO7	extent cons markcitrus	1	0
AP7	extent r.land	1	20
AQ7	extent miant and dep	1	1
AR7	extent mian and dep g.h	1	15
AS7	extent family expen.	1	1
AT7	extent male lab prep+seeding	1	197.9305998
AU7	extent male lab pest+irrig	1	112.8640044
AV7	extent male lab harv.	1	0
AW7	extent male labfert	1	127.7307249
AX7	extent female lab harv.	1	326.8263932
AY7	extent off-farmJan	1	25
AZ7	extent off-farmfab	1	25
BA7	extent off-farmmar	1	25
BB7	extent off-farmapr	1	25
BC7	extent off-farmmay	1	25
BD7	extent off-farmJun	1	25
BE7	extent off-farmJul	1	25
BF7	extent off-farmaug	1	25
BG7	extent off-farmsep	1	25
BH7	extent off-farmoct	1	25
BI7	extent off-farmnov	1	25
BJ7	extent off-farmdec	1	25
BK7	extent irrgjan	1	0
BL7	extent irrgFab.	1	0
BM7	extent irrgmar.	1	1500.910705
BN7	extent irrgapr.	1	1559.919618
BO7	extent irrgmay	1	3923.859155
BP7	extent irrgjune	1	4235.209298
BQ7	extent irrgjul.	1	3241.685346
BR7	extent irrgaug.	1	647.014354
BS7	extent irrgsep.	1	647.014354
BT7	extent irrgoct.	1	647.014354
BU7	extent irrgnov.	1	2294.244578
BV7	extent irrgdec	1	0
BW7	extent cred	1	9375.564785
BX7	extent transjan	1	6166.389645
BY7	extent transFab.	1	3174.890545
BZ7	extent transmar.	1	2467.246646
CA7	extent transapr.	1	0
CB7	extent transmay	1	0
CC7	extent transjune	1	4345.676332
CD7	extent transjul.	1	13929.83109

CE7	extent transaug.	1	13179.18352
CF7	extent transsep.	1	12978.00316
CG7	extent transoct.	1	11065.99994
CH7	extent transnov.	1	9567.039925
CI7	extent transdec	1	0

Appendix 6

Scenarios of the zones before KTD

Target Cell (Min)				
	Cell	**Name**	**Original Value**	**Final Value**
	CL6	objective function RHS	3832.26462	-10681.09683
Adjustable Cells				
	Cell	**Name**	**Original Value**	**Final Value**
	B7	extent Tomato dun	1	0
	C7	extent Tom G.h.	1	14.91452991
	D7	extent Cuc G.H	1	0.085470086
	E7	extent onion dun	1	5.19362E-13
	F7	extent potato dun	1	0.057416268
	G7	extent Gewish mellow gh	1	14.81814437
	H7	extent only Gewish mellow gh	1	0
	I7	extent squesh dun	1	0.048192771
	J7	extent peper dun	1	7.28084E-13
	K7	extent citrusdun	1	12.44258373
	L7	extent sel tomato may	1	55122.53846
	M7	extent selTomato jun	1	53592.30769
	N7	extent selcuc gh may	1	0
	O7	extent selcuc jun gh	1	53.84615395
	P7	extent selonionmay	1	1.09658E-10
	Q7	extent selonionjun	1	0
	R7	extent selpotato may	1	0
	S7	extent selpotato june	1	54.83253599
	T7	extent selGewish mellow	1	25027.30927
	U7	extent selsquash	1	0
	V7	extent selpeper may	1	0
	W7	extent selpeper june	1	2.40844E-11
	X7	extent selcitrus june	1	20908.42584
	Y7	extent selcitrus juli	1	18643.8756
	Z7	extent cons farTomato	1	200
	AA7	extent cons farcucumber	1	200
	AB7	extent cons faronion	1	0
	AC7	extent cons farpotato	1	120
	AD7	extent cons farGewish mellow	1	85
	AE7	extent cons farsquash	1	80
	AF7	extent cons farpeper	1	0
	AG7	extent cons farcitrus	1	40
	AH7	extent cons markTomato	1	0
	AI7	extent cons markcucumber	1	0
	AJ7	extent cons markonion	1	100
	AK7	extent cons markpotato	1	0
	AL7	extent cons markGewish mellow	1	0
	AM7	extent cons marksqaush	1	0
	AN7	extent cons markpeper	1	20
	AO7	extent cons markcitrus	1	0
	AP7	extent r.land	1	20
	AQ7	extent miant and dep	1	1
	AR7	extent mian and dep g.h	1	15
	AS7	extent family expen.	1	1
	AT7	extent male lab prep+seeding	1	147.9220528
	AU7	extent male lab post+irrig	1	87.87255142