Evaluation of Agricultural Water Management Options in the Lower Jordan Valley – Palestine Using "WEAP

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Abstract:

The objective of this paper is to evaluate the best sustainable water management options for future agriculture in the lower Jordan Valley (LJV) area of Palestine. LJV is the most important agricultural area in Palestine. Detailed - long term water management scenario analysis up to the year 2025 was conducted using the computer water planning model 'WEAP". Seven potential future water management options were tested including: optimal water use, optimal land use, supplementary water resources including water harvesting and treated wastewater reuse, virtual water trading, food security, political status, and poverty linkage and socioeconomic linkage water management option. Model simulations indicated that one water management scenario or option would not lead to an optimal water management in agriculture in the LJV and a combination of options would better achieve this goal. Accordingly a combination of the first three scenarios (water and land use efficiency and supplementary water resources scenarios) along with stable political solution (scenario number seven) is the best combination to achieve better future water management in Palestinian agriculture in the LJV. The results obtained demonstrate the feasibility and usefulness of simulation analysis using WEAP model.

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1. Introduction:

Water is needed in all aspects of life and it is one of the most valuable resources in the world (Quran: Ayah 30,Sura 21). Agriculture is the largest user of fresh water, accounting for 75% of current human water use (Wallace, 2000). In dry and semidry areas, water resources are limited and the share available water in agriculture is decreasing due to combination of population growth economic and agriculture development.

The world is facing huge freshwater management challenges. Allocation of limited water resources, environmental quality and policies for sustainable water use are highly concerned. Water resource planning requires the application of scientific principles of hydrologic and environmental engineering, economics, system analysis, and information management for the purpose of predicting the availability and managing water resources.

With time the water situation and availability will be changed. This change is due to general and worldwide reasons and influences such as population growth, agricultural development, socioeconomic conditions and poverty... etc., or it may be due to specific reasons and influences concerning that part of the world such as Palestinian case, where the Israeli military occupation of land and water resources is the main influence on water management and economic development.

Agricultural sector plays a crucial role in the social well being of the Palestinian people. The agricultural sector, which utilizes anywhere between 50-80% of total water resources in each country, has a very low rate of efficiency. As a result, the agricultural sector consumes more than half of the water resources and contributes to a fraction of the total GDP outcome each year. Agriculture however, still provides sustenance and employment for a sizeable portion of the population in the Middle East. Therefore, it is important that (1) Palestinian agriculture need to be looked at from cultural heritage angle and point of view and (2) new irrigation methods like drip irrigation are installed in order to reduce wastage of water in the agricultural sector. Also instead of using freshwater for irrigation, infrastructure should be set in place that would utilize treated wastewater (Haddad 2010)

Although, the West Bank economy continued to grow in the first half of 2010 and the real growth rate, combined with Gaza, is likely to reach the projected 8 percent for the year, Sustainable economic growth in the West Bank and Gaza, however, remains absent. Some of the increase in economic activity can be attributed to improved investor confidence. The main driver of growth, however, remains external financial assistance. (World Bank, 2010).

Total current water use in the West Bank and Gaza Strip (WBGS) is estimated to be about 331 million cubic meters (MCM) per year. Agriculture continues to be the largest consumer of water accounting for about 60 percent of total use (167 MCM, about half each in the West Bank and in the Gaza Strip (WASAMED, 2004 and PWA 2009,, PWA 201 and PWA 2012).

FAO, 2003 found that the OPT is not self sufficient in food and relies upon commercial imports to supply domestic demand. It was also found that With rising poverty and unemployment, the food security situation has considerably deteriorated over the past three years, with four out of ten Palestinians food insecure. Food insecurity is a reality for 1.4 million people (40 percent of the population) and a near constant worry for an additional 1.1 million people (30 percent) who are under threat of becoming food insecure should current conditions persist. People’s physical access to food and farmers physical access to the inputs and assets to produce food have been severely affected by restrictions on the movement of people and goods and the damages to personal property.

Economic access to food in terms of the ability to purchase food rather than lack of food is the main constraint to securing a healthy nutritious diet. The numbers of meals, the portion size and the frequency by which certain foods are consumed have all been reduced. Many meals consist solely of bread and tea. Cereals and increasingly potatoes, pulses, the cheaper vegetables and fruits form the core of their diet. Though nutrition surveys are not conclusive, they do indicate that childhood malnutrition is a major concern for some groups and that some more widespread nutritional problems are emerging. Micronutrient deficiencies are also a concern, especially in iron, foliate, vitamin A, zinc and iodine (FAO 2003).

The scarcity of conventional renewable fresh water sources in arid and semi-arid regions in many parts of the world like South Africa, the Middle East including Palestine, Southern Europe and South America has prompted the search for additional supplementary conventional and non-conventional water sources (Haddad and Mizyed 2011).

This paper will evaluate and discuss the best sustainable water management options for future agriculture in the lower Jordan Valley (LJV) area of Palestine using the water planning and evaluation computer model WEAP.

2. Study area

2.1 Location

Palestine, Palestinian Territory, or the Occupied Palestinian Territory (OPT) as presented in this paper consists of the West Bank including East Jerusalem and the Gaza Strip. The West Bank and the Gaza Strip are those parts of Historic Palestine which were occupied by the Israeli army during the 1967 war between Israel and Egypt, Syria, and Jordan. The land area of the West Bank is estimated at 5572 km^2 extending for about 155 km in length and about 60 km in width. The Gaza Strip, with an area of 367 km^2 extending for approximately 41 kilometers in length and approximately 7 to 9 kilometers in width (see Figure 1, Abdel Salam 1990, and Haddad 1998).

LJV part of the Jordan rift valley laid on the eastern part of the West Bank until reaching the Jordan River on the east .from the west it is started with high mountainous area and becoming lower in elevation and more flat when going towards the Jordan river .Figure (1a) give an idea about the location of the study area .it is covered all the eastern slope, but during our study we will concentrate mainly on part of it which is illustrated in Figure (1b) due to the fact that it is more irrigable and have more water resources and have higher population who mainly worked in agricultural sector. This area is spread in 3 districts including: All Jericho district, all Tubas district and part of Nablus directorate with a total area of (1070.66 km2).

2.2 Population

Palestinian population projections reveal that mid year population in 2008 totaled 4.048 millions, of whom 2.513 in the West Bank and 1.535 in Gaza Strip (PCBS, 2010---see Figure 2)). According to the official list of local authorities added by the

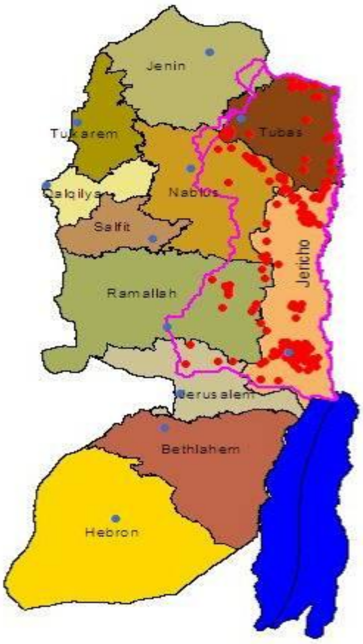
Palestinian Central Bureau of Statistics (PCBS, 2003) and the ministry of local governments, there are 686 localities in Palestine. The localities are distributed by type as 54 urban, 603 rural, and 29 refugee camps. These localities distributed by type of authority as 107 municipalities, 11 local councils, 374 village council or project committee, and 29 director of refugee camp (additional 76 rural localities are either not inhibited or joined to larger locality).

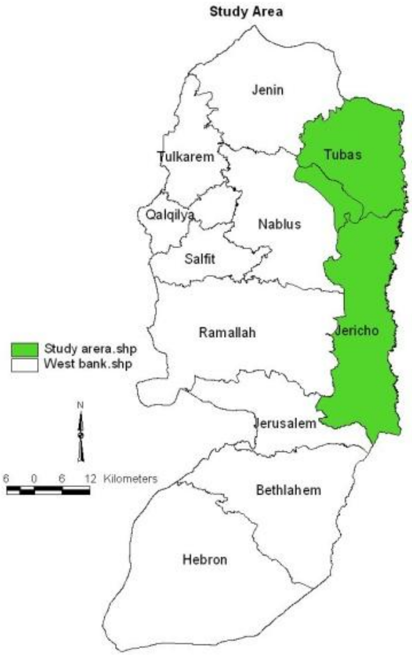
Current Palestinian population in the West Bank and Gaza Strip is about 4.5 millions and in the year 2050 it will exceed 12 millions (Haddad 2012). Securing food for the Palestinian population under available water resources constraints is a key driver for agricultural development and a critical issue for Palestine in this 21st century and beyond. Accordingly
Tubas & Jericho are considered low in population density with respect to other directorate and so to the total Palestinian territory (136&77 person \km2 respectively), while it is 444 person \km2 for the West Bank and 673 person \km2 for the Palestinian territory.

During the last 10 years the unemployment percentage from the labor force reduced significantly to reach 9.9% in Jericho while 16.7% in Tubas to be very closed to the West Bank percentage (19%).(for the current year).

Source: UNEP 2003

Figure 1. General location Map of Palestine





Figure(2a): West Bank Location Map ***Figure(2b): WB Map with the Study Area in Green***

Figure 2 West Bank and Lower Jordan Valley

2.3 Available Water Resources

The estimated average annual ground water recharge in Palestine is 698 to 708 mcm/yr (648 mcm/yr in the West Bank and 50 - 60 mcm/yr in the Gaza Strip). As listed in Table 1, the estimated average annual ground water recharge in Palestine is 703 mcm/yr (648 mcm/yr in the West Bank and 55 mcm/yr in the Gaza Strip). This groundwater is placed in four major aquifers: The western, northern, north-eastern, and the coastal aquifer basin (SFG 2010, Haddad 1993).

Table 1. Groundwater Balance in Palestine

Hydrologic Parameter	Contribution to Water Balance				
	West Bank		Gaza Strip		Palestine
	Percentage	mcm/yr	Percentage	mcm/yr	mcm/yr
Annual Rainfall	100	2248	100	101	2349
Evapotranspiration	-68	-1529	-52.5	-53	-1582
Surface Runoff	- 3.2	-71	-1.98	-2	-72
Groundwater Recharge	28.8	648	45.5	46	694
Return Flow (RF)	-----	RF	8.9	9	9 + RF
Overall Balance		648 + RF		55	703 + RF

RF = Return Flow
Source: Haddad 1993

The only surface water source in the West Bank is the Jordan river and its tributaries. In the Johnston plan, the Palestinian share in the Jordan River of 257 was considered as part of the Jordanian share of 774 mcm/yr as the West Bank was under the Jordanian rule. Since 1967 and until present, Palestinians were prohibited by the Israeli army from using the Jordan river water and their lands and farms located along the western side of the river were confiscated and the area was declared as a restricted security zone (Haddad 1993).

A project called the West Ghore Canal was supposed to utilize these quantities side by side with Eastern Ghore Canal that established by Jordan on the east side .so the net is that no surface water are involved in the

The Palestinian Central Bureau for Statistics reports for the 2008 indicates that the water quantity from these two sources (wells and springs) was 308.7 MCM .With 225.7 MCM from wells represented 73.1% from the total. The quantity purchased from Mekorot about 57.8 MCM and the remaining from Spring.

For the LJV area the data obtained from the same source (Palestinian Central Bureau of statistics for the same year (2008) showed that the whole quantity available for this area is around 34MCM , 22 MCM are from the spring and the remaining 12 MCM form the wells . Comparing these numbers with data obtained from the previous years (2004 until 2007) we can notice great reduction in the quantity mainly from spring sources due to bad use and rainfall reduction.

All 117 springs are located in West Bank and 49 of them are in the study area representing around 86.35% from the total spring annual discharge. There are 272 wells from the470 in WBGS are classified as agricultural and the remaining 198 are for domestic use.

2.5 Agriculture

In Palestine, agricultural land was estimated at 1.854 million dunams or about 31% of the total area of west bank (91%) and Gaza Strip (9%). of which 86% are rain fed and 14%is irrigated. In the LJV, the irrigable area was estimated at 87.9 km2. (WASAMED 2004).

Rain fed agriculture: The extent of the rain fed farming is reduced with time in the Jericho and Nablus district of the study area due to limited rainfall , but still common on the north part (Tubas area) because the rain fed are more sufficient (more than 300 mm). Cereals such as wheat and barley are the most spread in this compared with other field crops while Olive tree are the most found among trees fruits. For the rain fed vegetables tomato, cucumber, squash, are the most familiar. Table (2) shows the areas of the rain fed crops.

Irrigated agriculture: Irrigated farming is the dominant pattern in the study area mainly in Jericho and Nablus districts. it is consist of tunnel , greenhouses , and open irrigated field. Drip irrigation system for covered crops is the most used on the farm level and with less extent on the open field for open irrigated vegetables. But for the trees the percent of drip irrigation become of less important where surface irrigation are also used (Table 2).

3. Materials and methods

3.1 The WEAP Evaluation and Planning Model

WEAP, water evaluation and planning system developed by the Stockholm Institute (SEI, 2001), is an adaptable water resource planning model that is scalable depending on the complexity of the system under investigation. WEAP is a water demand and supply accounting model (water balance accounting), which provides capabilities for comparing water supplies and demands as well as for forecasting demands. It has an accessible interface and transparent data structure that make it suited as a tool for deliberations between diverse groups of stakeholders.

Table (2): Area, Production, Productivity, Annual Water Needed for Planted Crops in the Study Area

crop	Area (dunum)	Productivity (ton)	Production (ton)	water CM /dunum	Water needed CM/kg	Needed water MCM
greenhouse	2369	12.4	29375.6	1000	0.08	2.369
Tunnels	5193	3.8	19735	500	0.132	2.5967
Irrigated field vegetable	46745	2.45	114513.9	500	0.2	22.9
Irrigated field crops	13091	1.4	18327.4	300	0.21	3.93
Irrigated Banana	1540	4	6160	1500	0.375	2.31
Irrigated Date	428	1.0	428	1100	1.1	0.4708
Irrigated Citrus	4379	1.94	8320	850	0.44	0.365
Irrigated Grape	557	2	1114	500	0.25	0.0.2785
Irrigated fruits	12154	1.5	18231	850	0.57	10.39
Rain fed crops	40994	0.3	12298.2	0	0	0
Rain fed vegetables	5320	0.460	2447.2	0	0	0
Rain fed trees	17561	0.35	6146.35	0	0	0
TOTAL	**150331**					**42.1857 MCM**

WEAP is a generic computer package that suitable mainly for surface water planning. It develops a model schematization consisting of a network of nodes connected by links or branches. WEAP can simulate a water allocation policy. Water allocation priority rules are set within WEAP based on either first come first served, or specific use or user, and/or making allocation proportional to demand. Because it is generic, it is not capable of capturing every fine distinction or detail of a water resource system and as such is best applied to scenario screening and pre and feasibility levels of analysis rather than to detailed design and permitting tasks.

One of WEAP's advantages is that it places the demand side of the water balance equation on a par with the supply side, and addresses some of the critiques of water DSSs (Loucks 1995). WEAP main disadvantages include its reliance on the development of scenarios that can be quantified, without notifying how these scenarios should be developed and placing the actors deliberately outside the system's architecture.

WEAP outputs include various water demand parameters, tables, schemes, charts, estimates, and others.

3.2 Development of Agricultural Water Management Scenarios

To predict where LJV will be standing in the future in regards to agricultural water management, six scenarios were developed and tested under three political conditions: current status of Israeli military occupation with quoted/constrained access and mobility to Palestinian water resources, compromise political solution with limited access and mobility to Palestinian water resources, and comprehensive political solution in which a full Palestinian State will be established with free access and mobility to Palestinian water resources (see Figure 3 below).

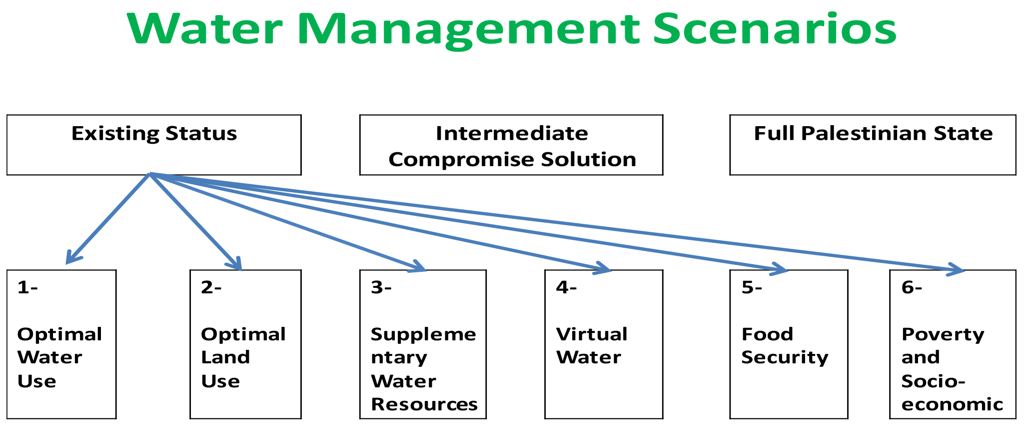


Figure 3 Political Options and Water Management Scenarios

The six scenarios and associated main concepts are given below:

1. Optimal Land Use Scenario

The optimal land use scenario aims to find the best growth pattern and crops type to obtain the best benefits from the same present amount of water. This scenario assumed that:

1. Having limiting water resources under the current political situation
2. Intensive agriculture (greenhouses & tunnels) are times in their productivity than open field ones.

2. Optimal Water Use Scenario

For the optimal water use scenario, the following assumptions were set:

1. Conveyance and farming efficiency (Econv) included and applied and it is extend from the demand site until the farm gate .
2. Application efficiency (Eappl) included and applied (Howell, 2003 and Theodore et al.2007).
3. Consumptive efficiency (Eet) included and applied (Theodore et al.2007).
4. Transpiration efficiency (Etr) included and applied (Fischer and Turner 1978)
5. Assimilation efficiency (Eas) included and applied (Steduto et al 2007).
6. Biomass efficiency (Ebm) included and applied (Steduto et al 2007).
7. Yield efficiency (Eyld) included and applied (Donald 1962).

3. Supplementary Water Use Scenario

Three supplementary water resources were considered in this scenario: rainwater harvesting, treated wastewater reuse, and desalination of brackish water.

4. Virtual Water Scenario

To apply this scenario the following are suggested:

- Shift all banana area to covered vegetables
- Shift Citrus fruit to covered vegetables.
- Shift dates and other fruit trees to grape (knowing the fact that stone fruit has limited age).
- Shift 50% from open vegetables to covered ones and irrigated open field potato.
- Shifted 5000 du from open irrigated field crops to irrigated potato

5. Poverty Linkage/Impact Scenario

On the other side improving the living level in a significant way and so reducing both poverty and deep poverty of farmers and increasing their income by means of return profits and new markets, planting high cash crops and applying new technologies in irrigation and agricultural practices beside good postharvest and marketing will affect positively the water using efficiency and the area and type of growth pattern towards more profitable crops. According to this assumption it is estimated that the water use efficiency will be improved by 5% and crop pattern will shift as follows:

a. The entire crop pattern except the covered one will stay the same.
b. All the saved water due 5% water using efficiency will be used for protected agriculture.
c. So, around 2.2 MCM will be saved and used for both greenhouse and tunnels (50% for each).

6. Food Security Scenario

For the LJV which is an agricultural area that participate significantly in the food basket of WBGS, applying the food security scenario will take these assumptions:

- The study area participate in about 25% of the irrigated area from WBGS, Where 53% of the irrigated vegetables in WBGS are located.13091 dunums of irrigated field crops are present out of 54085 du the total.
- To achieve food security assumption it was assumed that : the consumption in kg per capita yearly will be the same(for the all period from 2010- 2025).
- Assumption concentrated only on plant production part , Animal welfare was not considered.
- The goal was toward moving to better food security situation under the existing condition through reallocating the agricultural area and planting new ones.
- The sub scenarios for this goal was as follows :
- Keeping the area planted in vegetables as the same. we will reach an equivalent point between demand and supply.
- Increase the area planted with both potato and wheat as follows:
- At the year 2025 the consumption of potatoes will increase to reach 163605 tones which represent around 50000 dunums with productivity of 3.3 tones \ du. , assuming that the studied area will participate of 50% of our needs, so it is a need to raise the area planted with potato up to 25000 dunum (additional 20000 dunums).
- For wheat which is a basic food with 135 kg\capita\ year, and with the limited area in WBGS. It is impossible to reach sufficiency from this crop, but to reach 5 % of our demand (around 505000 ton) additional 75 thousand dunums are needed to be planted from the irrigable land in the study area with this important crop and increase the potato area which is another source of carbohydrates.
- Fruit trees: Nowadays, the study area participate with 13.5 % from the total fruits production with a 29650 ton annually. On the 2025 this amount will represent only 9% from the demand (estimated to be 384798), referring to previous tables (mainly7& 10), Next Table (table 19) shows the suggested changes in this sector to reach 15% from the needed fruits in WBGS.

4. Results and Discussion

4.1 Input and Output of Individual Political Scenario

The results of the WEAP computer model runs for the three political alternatives: current status, intermediate Palestinian State, and Full State Solution under the six agricultural water management developmental scenarios are listed in Tables 3, 4 , and 5, respectively.

Table (3): Input And Outputs for Different Scenarios, Current Political Situation

Developmental scenarios	**Currnet politcal situation (MCM)**	**Output productions**
1- Optimal land use	42	+ 45536(28% from rainfed)
2- Optimal water use	42 +6.4=48.4	+ 25803
3- Supplemetry water use	49 +7=56	+ 47800
4- Virtual water	42	+ 108327
5- Poverty	42 +2.2 =44.2	+ 22000
6- Food security	69(27 as unmet demand)	+ 120867
7- Integration of scenarios(1,2,3,4,5)	42+ 15.6 =57.6	

4.1.1 Current Political Scenario Outcome:

To implement the assumptions of this scenario and for better optimization of land and water use (irrigated more irrigable land) in the LJV we need an additional 110 MCM of water. Under the limited water resources in the study area integrating all the scenarios (land use, water use, poverty, supplementary resources) rather than driven one scenario will be the better choice that will give additional 15.6 MCM to close the gap toward more food security as clear in table(20).

Table (4): input and outputs for different sub- scenarios , intermediate political situation

Developmental scenarios	**Inputs for Intermediate political situation (MCM)**	**Output Increase in productions(tons)**
1. Optimal land use	57	113100
2. Optimal water use	57+22.68 = 79.68	107993
3. Supplemetry water use	57 + 30 =87	189200
4. Virtual water	57	226727
5. Poverty	62.7(5.7 MCM additional)	180652
6. Food security	57 **(12 MCM as unmet demand)**	+120867
7. Integration of scenarios(1,2,3,4,5)	**115.38 MCM**	**938539**

4.1.2 Intermediate State Scenario Outcome:

Running WEAP model in the assumptions of this scenario with its six elements (optimal land use, optimal water use, supplementary water use, virtual water, poverty and food security), shows the same trend, and integration of all scenarios more than applying one scenario alone (table 26). The increase in cultivated area and production were significantly higher than current political situation scenario and lead to partial tested food security. The new water resources and the saved water will be sufficient for all the irrigated and irrigable land.

Table (5): input and outputs for different sub- scenarios, full-state main scenario

Developmental scenarios	Inputs full-state Scenario MCM	Output Increase in production (TON)
1. **Optimal land use**	191	736000
2. **Optimal water use**	225	899977
3. **Supplemetry water use**	236	905200
4. **Virtual water**	191	100568
5. **Poverty**	211.7	879130
6. **Food security**	191	293865
7.		

4.1.3 Full-State Scenario Outcome:

Under this scenario, more water supplies will be available for agricultural and other sectors which may affect the pattern of planted crops. In addition to that there is an opportunity for cultivating all the irrigable area. Data in table (34) summarize the water supply and the assumed production. Applying any scenario under this main scenario will be allowed to utilize all the irrigable land in the study area.

4.2 Comparison of different scenarios under the three main political situations:

A summary of needed water supply, unmet water demand and agricultural production for the three political alternatives: current status, intermediate Palestinian State, and Full State Solution under the six agricultural water management developmental scenarios are listed in Tables 4 , and 5, respectively.

In analyzing data in Tables 6 and 7, it is clear that:

- The current political scenario (current) is the worst expected scenario,
- Applying the intermediate political scenario with integration of its assumed scenarios will be able to plant the irrigable land for the study area,
- Applying the full-state scenario will be the best one leading to plant all the irrigable land and saving reasonable amount for other sectors and for future.

- Applying the land use scenario: both intermediate and full state scenarios will have more water compared to current situation, and so more planted area.
- Applying the water use scenario: the full state scenario was the best performance while the intermediate scenario was slightly and positively different from the current situation.
- Applying the Supplementary water use: valuable amount of water from conventional and non- conventional resources will be available under the full state. About 7, 30 and 45 MCM for the current, intermediate and full state scenarios, respectively can be gained. The additional amount of water saved from current and compromise situations more important than that of full state scenario.
- Applying the virtual water scenario: Under the first two scenarios (current and intermediate), the study area will suffer from water shortage. Using the concept of virtual water in full state sufficient water for all sectors will be saved. For this reason, the current situation virtual scenario was considered as basic for the three political scenarios, followed by applying the concept of virtual water for additional water supply for the second two scenarios.
- Applying the poverty linkage scenario: The amount of water is directly proportional to the socioeconomic situation. Using advanced technique in agriculture, the percentage of water saving and improving water use efficiency increase by 5, 10 and 15% in political scenarios (current, intermediate, full state), respectively. The most positive change in production was recorded in the 3rd scenario (full-state) followed by the second (intermediate), and the 1st (current) scenarios. It indicates that the shared of water supply will be more for crop types under the 3rd scenario.
- Applying the food security scenario: Data in tables (7) shows that one level of food security was proposed for the three main scenarios. The full state scenario was the only one that achieved this level of food security without any unmet water demands.

Table (6): Water Supply and Unmet Demand for Different Scenarios under the Main Three Scenarios.

Developmental scenarios	Currnet politcal situation (MCM)		Copmromise state (MCM)		Independent state (MCM)	
	Water supply	Unmet demand	Water supply	Unmet demand	Water supply	Unmet demand
Optimal land use	42	149	57	134	191	0
Optimal water use	48.4	142.8	79.68	111.32	225	-34
Supplemetry water use	56	135	87	104	236	-45
Virtual water	42	149	57	134	191	0
Poverty	44.2	146.8	62.7	128.3	211.7	-20.7
Food security	69 (27 MCM as unmet demand)	149	57 (12 MCM as unmet demand)	146	191	0

5. Conclusions

Based on the results of this study, the following concluding remarks were observed:

- For current political and intermediate state scenario analysis, integrating the scenarios: land use, water use, poverty, supplementary resources is much better than applying one scenario separately. An additional 15.6 MCM is needed to close the water gap needed to achieve food security.

- The increase in cultivated area and agricultural production were significantly higher in intermediate scenario than current political situation scenario and lead to partial tested food security.

- Under full state scenario, more water supplies will be available for agricultural and other sectors which will affect the pattern of planted crops. There is an opportunity for cultivating all irrigable area. All six developmental scenarios under full state political situation could be optimized separately and no need for integration.

Table (7): Agricultural Production for Different Scenarios under the Main Three Scenarios.

Developmental scenarios	Current political situation Production changes (tons)	Compromise state Production changes (tons)	Full- state Production changes (tons)
Optimal land use	+ 45536(28% from rainfed)	113100	736000
Optimal water use	+ 25803	221093	899977
Supplemetry water use	+ 47800	302300	905200
Virtual water	+ 108327	335054	100568
Poverty	+ 22000	293752	879130
Food security	+ 120867	233967	293865

- The current political scenario is the worst expected scenario,

- The intermediate scenario with integration of more than one developmental scenarios will be able to plant the irrigable land for the study area,

- The full-state scenario will be the best one leading to planting all the irrigable land in the LJV.

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