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Management model for water demand using the WEAP tool: Case of Setif Province – Algerian highlands

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Abstract

The pressure on the use of water and climate change has caused a decreased availability of water resources in semi-arid areas in the last decades. The Setif Province is one of the semi-arid zones of Algeria as it receives an average less than 400 $mm \cdot year^{-1}$. The question of the evolution of demographic pressures and their impacts on water resources arise. By applying WEAP software (water evaluation and planning), the aim is to develop a model of water resources management and its utilization, assess the proportion of the resource-needs balance and analyse the future situation of water according to different scenarios. This approach allows to identify the most vulnerable sites to climatic and anthropogenic pressures. The estimation of the needs for drinking water and wastewater in the Setif Province has shown that these needs increase over time and happening when the offer is not able to cover the demand in a suitable way. It is acknowledged that there is a poor exploitation of water resources including underground resources, which translates into unmet demand in all sites of demand.

Key words: *different scenarios, unmet demand, wastewater, water, water evaluation and planning (WEAP)*

INTRODUCTION

Integrated Water Resources Management (IWRM) is a matter of coordinated planning and management of land, water and other natural resources with regards to their equitable, efficient and sustainable use [CALDER 1999].

VAN HOFWEGEN and JASPERS [1999]; defined IWRM as a process of assigning functions to water systems, setting standards, enforcing (monitoring) and managing, including data collection, physical process analysis and socio-economic considerations of different interests and decision-making in relation to the availability, exploitation and use of water resources. The decision support system (DSS) is a software product that gives the user the capability to calculate and visualize the effects on a hydraulic system over time, if one or many of the system's parameters change; DSS-users can easily build scenarios of those changes in a Graphical User Interface (GUI) and directly view the results [DROUBI *et al*. 2008]. The approach of this study is based on the use of WEAP software (water evaluation and planning) developed by the Stockholm Environment Institute [SEI 2008]. WEAP is one of the digital tools of integrated planning of water resources. It is a modelling platform that allows for assessing the integrated watershed climate, hydrology, land use, infrastructure and water management priorities [YATES *et al*. 2005]. Its operation is based on the principle of accounting for the balance of water. The user represents the system of supply sources (rivers, aquifers and reservoirs), the withdrawal, the demand for water and the requirements of the ecosystem [HERVE *et* *al*. 2003]. In order to maintain people's livelihoods, water management needs to be adapted. Water assessment and planning system, WEAP, has been widely used to examine complex water systems in the field of water resources planning around the world [JOHANNSEN *et al*. 2016].

In Algeria, WEAP has been used in different regions. A model was applied to the watersheds of western Algeria to assess and analyse the current and projected balance of future resource management scenarios by taking into account the different policies and operational factors that might affect the demand until 2030 [HAMLAT *et al*. 2012]. Another model was developed to simulate water resources and evaluate water management strategies in the region of Annaba [AOUN-SEBAITI *et al*. 2013].

MANSOURI *et al*. [2017] carried out a wider study on the Seybouse Basin (Annaba) and East Coast of Constantine (El-Taref), whose purpose is interregional planning and resource analysis using the WEAP model, to estimate the water demand, to analyse the multiple uses of the hydro-system and to make a comparison with the proposed water storage estimations.

BOUKLIA *et al*. [2016] developed a model to study the management of water resources in this region in a unified framework that takes into account both the changing of water demand of different sites and the hydrological processes in watersheds that largely determine the volume of water mobilizable resources. BOUZNAD *et al*. [2016] applied the WEAP software to develop a decision support system (DSS) to model water resources and uses, evaluate the balance between the resource and needs, and to analyse the future water situation under different scenarios. BERREDJEM *et al*. [2017] focused on modelling the current and future supply and water demand in the northern region of the Seybouse valley.

MATERIALS AND METHODS

STUDY AREA

The Setif Province is located in eastern Algeria, in the highlands region. It is 300 km from Algiers, and rises to 1100 m of altitude. It covers an area estimated of 6549.64 km^2 and it is administratively composed of 20 districts divided into 60 communes (Fig. 1).

The Setif Province is characterized by the diversity and the variation of its natural environment, namely its topography, climate, soils and geological formations and the distribution of its water resources. The steppe zone is characterized by simplicity in terrain and ease of movement and mobility, which gives it an advantage over other regions to attract human activities. The mountainous areas are characterized by the difficult terrain and natural obstacles, which makes them unpleasant and discouraging to inhabitants and activities. The region suffers from a lack of water resources due to the continental climate factor and relief factor. It is ranked among the most populated provinces in Algeria. It comprises about one and a half million inhabitants; most of them are concentrated in the administrative headquarters. The total population of the province is increased to 1,504,128 in 2008 and reached 1,823,802 inhabitants in 2016, a rate of an annual average of 2.4%.

Fig. 1. Geographical situation and administrative division; source: own elaboration

SURFACE WATER

The distribution of rainfall at the scale of this study area is not homogeneous. In fact, the average annual rainfall during the period under study (1990–2016) shows areas where rainfall does not exceed 300 mm·year^{-1} in the southern zone, wetland areas exceeding 700 mm·year^{-1} in mountain areas and rainfall of 400 mm·year^{-1} in high plains (Tab. 1). Altitude, wind direction and proximity to sea play an important role in the variability of precipitation. These different factors point to a considerable hydrographic network (Fig. 2a), the most important of it is Bousalem River with an average monthly flow of 0.20 m^3·s^{-1}.

The total calculated annual gross water runoff volume over the whole province is 338.9 hm^3. The mobilizable volume is estimated of 65.3 mln m^3.

Table 1. Monthly inflow and outflow amounts from the Boussalem basin

Parameter	Amount											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall (mm)	42.2	37.2	37.5	42.2	45.4	20.4	11.3	13.7	42.1	31.9	37.5	39.8
Evapotranspiration (mm)	6.0	6.6	9.6	12.4	17.4	22.9	26.7	26.4	21.5	16.9	10.8	6.9
Flow (m^3·s^{-1})	0.26	0.23	0.23	0.26	0.28	0.13	0.07	0.09	0.26	0.20	0.23	0.25

Source: own elaboration.

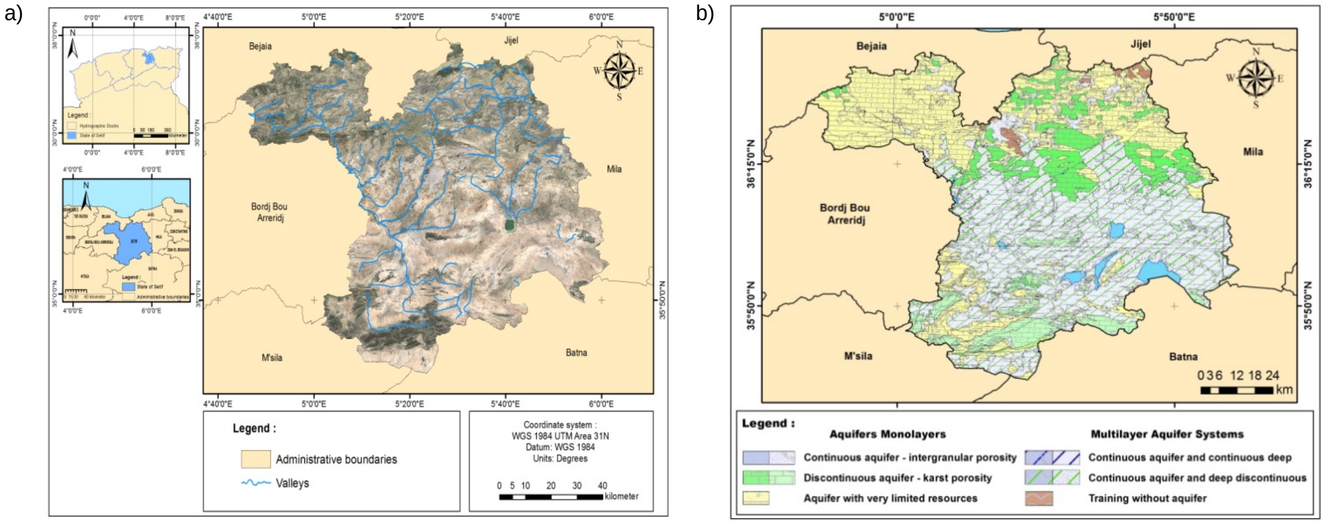

Fig. 2. Map of the network of Setif Province: a) hydrographic, b) hydrogeological; source: own elaboration based on the map of: Hydric Water National Agency (ANRH)

Table 2. Volumes of the mobilized groundwater (mln m^3)

Aquifer	Storage capacity	Initial storage	Withdrawal
Western part of the Djebel Medjounes aquifer	85.10	42.50	10.70
Portion of the Rochbet El Djemel aquifer	9.30	4.60	0.80
Beni Mansour aquifer	20.50	10.20	1.80
Hodna Mountains aquifer	38.40	19.10	0.60
Djebel Sekhine aquifer	11.80	5.90	1.80
Djebel Youcef aquifer	3.70	1.80	0.40
Djebel Arrasa aquifer	6.90	1.30	3.40
Hodna Mountains karst aquifer	5.40	1.08	0.50
Babor karst aquifer	14.50	2.90	0.40
Portion of the Djebel Takoucht aquifer	0.79	0.16	0.30
Portion of the Djebel F'kirida aquifer	0.45	0.09	1.10
Ain Messaoud	2.04	0.40	0.02
Fermatou aquifer	12.30	2.46	0.20
Djebel Taj Babor aquifer	1.60	0.32	0.30
Portion of the Ain Touta Plain Aquifer	178.90	143.10	0.10
Small Kabylia aquifer	113.50	68.10	5.50
Portion of the Tellian Atlas aquifer system	3.19	1.90	0.40
Beidha Bordj aquifer system	2.40	1.20	0.30
Portion of the Hodna Mountains aquifer system	6.40	3.80	0.10

Source: own elaboration based on data of: Hydric Water National Agency (ANRH) and PMH inventory and development study. Final report of province the Setif SOGREAH (2009).

GROUNDWATER

The hydrogeology of Setif region is diversified and the high plains have been the subject of many studies by the hydraulics services or within the framework of relevant researches. The Setif region has two distinct hydrogeological domains. The first is of superficial aquifers and the other is of karstic aquifers found in the carbonate massifs of the province (Fig. 2b). These aquifers are located in the geological formations of the Djemila aquifer, the slicks of the high plains of Setif Province, southern limestone of Setif and the aquifer of Hodna. Table 2 summarizes most of the aquifers operated in Setif Province.

The known water resources are 517 mln m^3 with a mobilizable volume of 310 mln m^3. The resources mobilized are of the order of 29 hm^3. Setif Province does not have a large hydraulic dam on its territory. Nevertheless, regarding its needs for drinking and industrial water, it carries out transfers of water by adduction from the dam of Ain Zada, located in Ain Taghrout, in the province of Bordj Bouarreridj. The collection was 22.07 mln $m^3 \cdot year^{-1}$.

METHODS

The WEAP approach method was used because the management of water resources requires knowledge of both the current state and future state of this resource, and this is in order to model the resources available and the needs for drinking water of the population of Setif Province.

Running the WEAP requires the input of a large data base for every element in the network. The data structure and level of detail may be easily customized to meet the requirements of a particular analysis and to reflect the limits imposed when data are limited [YATES *et al*. 2005].

Input data. The methodology adopted was based, first of all, on the construction of a cartographic database (DB) of three layers, a demand site (administrative division) represents the water user that depends on the common water distribution system [HASSAN *et al.* 2019] and a physical form of the hydrographic network and aquifers (19 aquifers) covering the study area. In the second stage, a conceptual model of the surface water mobilization system is developed on the WEAP software. The third step was to establish relationships between the nodes of the conceptual model with the DB. This step calculates the inflow and outflow of water for each node and link in the system during that month. This includes the supply calculations in order to satisfy demand. For this, WEAP uses linear programming to solve the corresponding equations. Equilibrium equations represent the monthly water balance basis in WEAP. This work led to the construction of a modelling tool for the water needs of the 20 urban sites as well as the flows in the connection links.

Analysis of development scenarios. The year 2016 was chosen as a reference for all information on the system: application sites, supply data, consumption, links and transmission (Fig. 3). Economic information, demographics and water use are used to construct alternative scenarios that examine the manner whereby the total and disaggregated water consumption changes over time. Repeated simulations for different management scenarios may significantly enlarge the set of indicators' values thus creating complicate analysis framework and imposing difficulties to recognize best or most desired scenario [SRDJEVIC *et al.* 2004].These demand scenarios are calculated in the WEAP and applied deterministically to an assignment algorithm based on a linear program. Demand analysis is the starting point for conducting an integrated analysis of water planning, since all supply and resource calculations in the WEAP are conducted by the optimization routine that determines the final delivery to each request node, according to the priorities specified by the user.

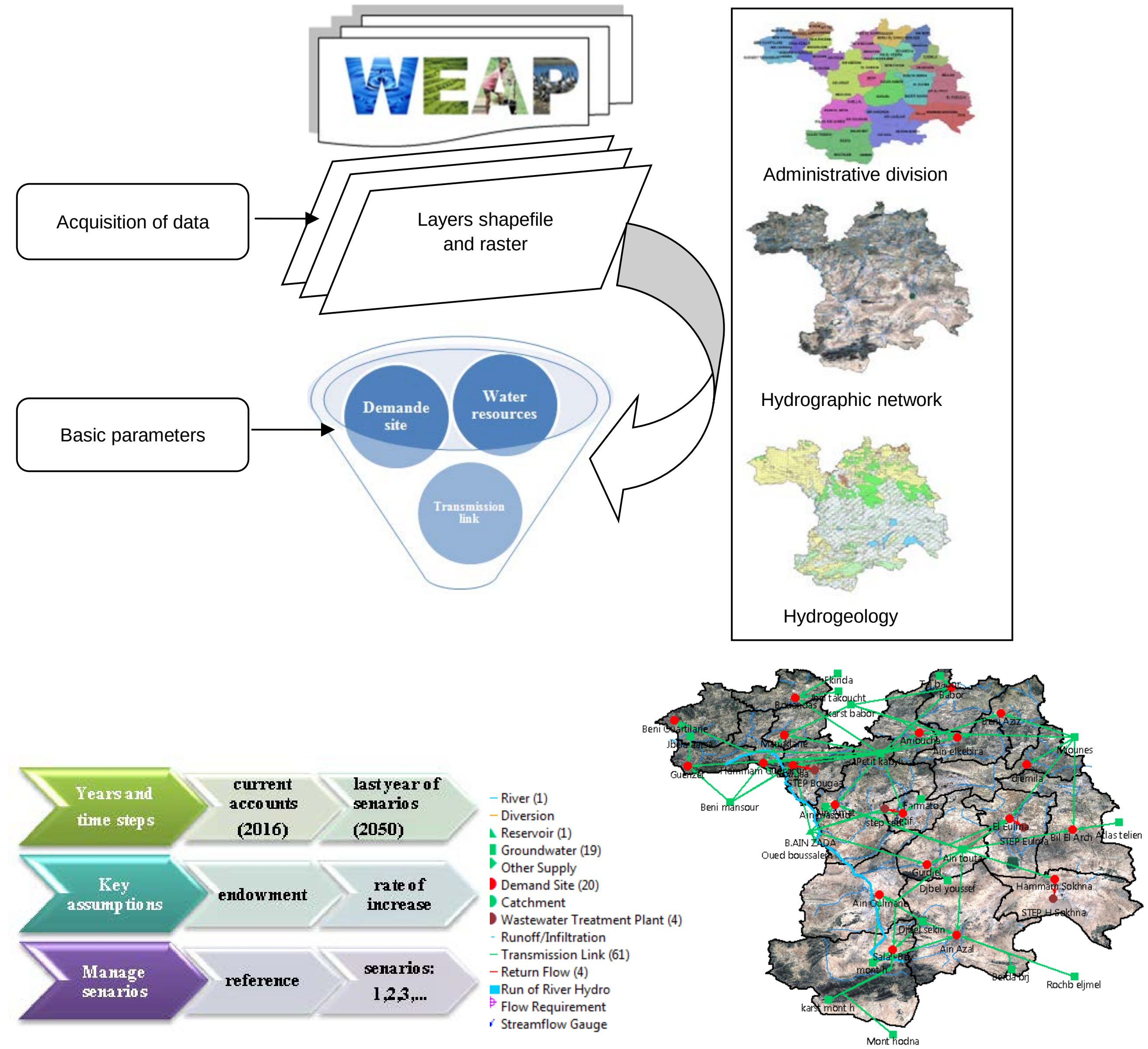

Fig. 3. Adopted methodology and final diagram of the water evaluation and planning (WEAP) model; source: own elaboration

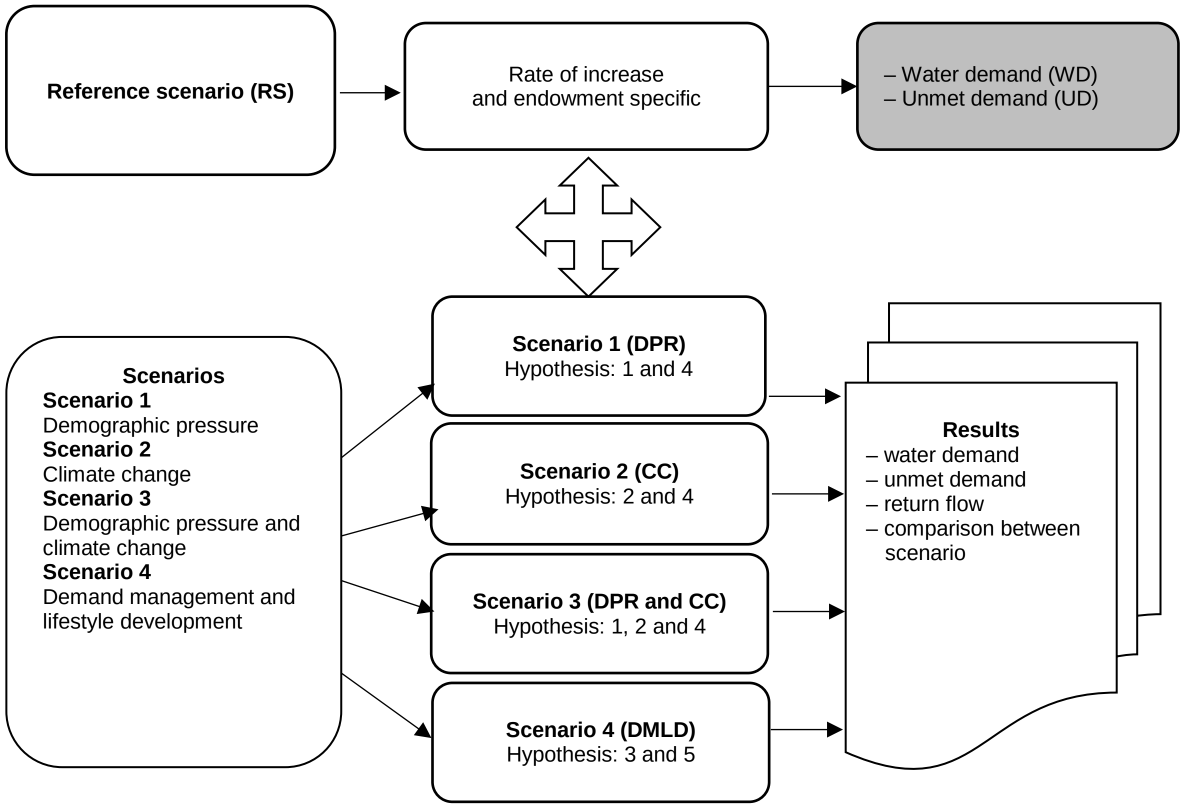

Fig. 4. Organization chart of the creation of scenarios in AEP model; source: own elaboration.

Many variations can be created and simulated by introducing changes to the current account to assess the effects caused by changing the rules and technologies of water management.

A reference scenario (RS) is established from the current account in which all basic data will be introduced to simulate the same evolution of the system without intervention. The reference scenario covers the period 2016–2050; it reflects a projection of current trends without major changes. Thus it serves as a point of comparison for other scenarios in which some changes in the system data can be made. The daily allowances introduced for this scenario are those used by the official water services institutions of Setif Province. The population growth is expected in developing countries, first in Africa, then in Asia, where the shortage of drinking water is already a major problem [BORETTI *et al.* 2019].Projections of the population trends are modified with the current growth rate of 2.4 during the projection period. The annual water consumption is the same as that of the current account, and the losses due to water leakage are estimated at more than 40%. Then, four scenarios were proposed where economic, demographic and physical information in addition to the use of water are used to construct alternative scenarios that examine how the total and disaggregated water consumption changes over time (Fig. 4). These scenarios are elaborated by introducing mathematical expressions in the form of key hypotheses reflecting the different cases to be examined. In this case, five key assumptions are proposed and based essentially on the increase in the population rate, climate change, endowments and improvement of distribution networks:

– hypothesis 1: strong population growth rate 3.5%,
– hypothesis 2: decrease in rainfall by 10% (National Water Resources Agency – Fr. Agence Nationale des Ressources Hydrauliques, ANRH). In Algeria, the last 20 years have been particularly characterized by a long period of drought due not only to the usual alternation between dry and wet periods but also to the phenomena of climate change [KENDOUCI *et al.* 2019],
– hypothesis 3: reduced losses by 20%,
– hypothesis 4: staffing according to the Ministry of Water Resources Standard 120 dm^3 per person,
– hypothesis 5 increased staffing 150 dm^3 per day per person.

RESULTS AND DISCUSSIONS

WATER DEMAND (WD)

Demand sites are represented by the current population count calculated by the WEAP software using the 2016 Census population number of the base year 2016 and the growth rate.

In view of the population growth of agglomerations, the demand for drinking water for the reference scenario is steadily increasing between 2016 and 2050: it increased by 120 mln m^3 in 2016, reaching in 2030 approximately 153 mln m^3 and it will reach a total of about 247 mln m^3 in 2050. The graph mentioned below (Fig. 5) shows that the cities of Setif, Eulma, Salah Bey and Hammam Sokhna, which are the cities that consume the most domestic water. This is explained by the high number of population and the life style in these cities.

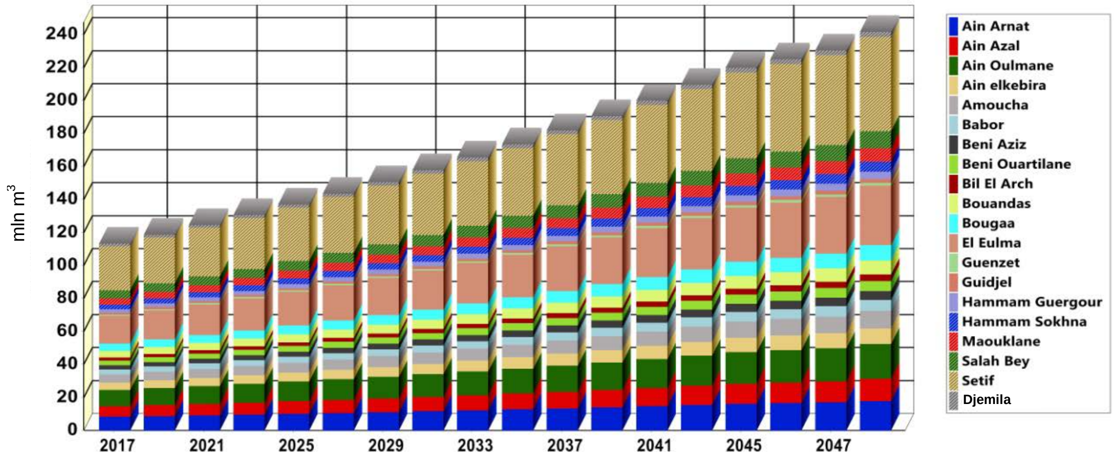

Fig. 5. Evolution of water demand in Setif Province – reference scenario; source: own study

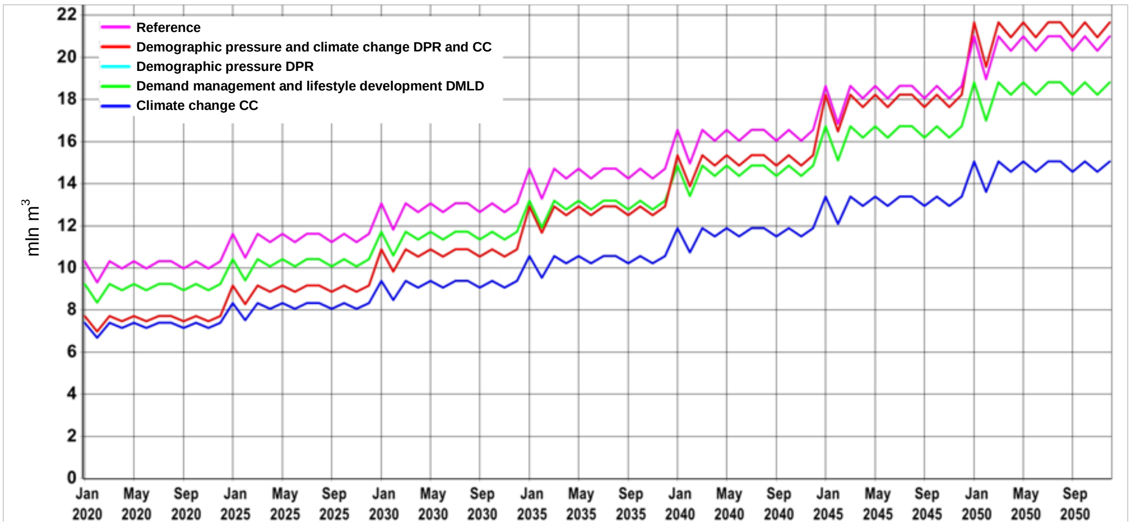

Fig. 6. Evolution of the monthly water demand in Setif Province – reference scenario; source: own study

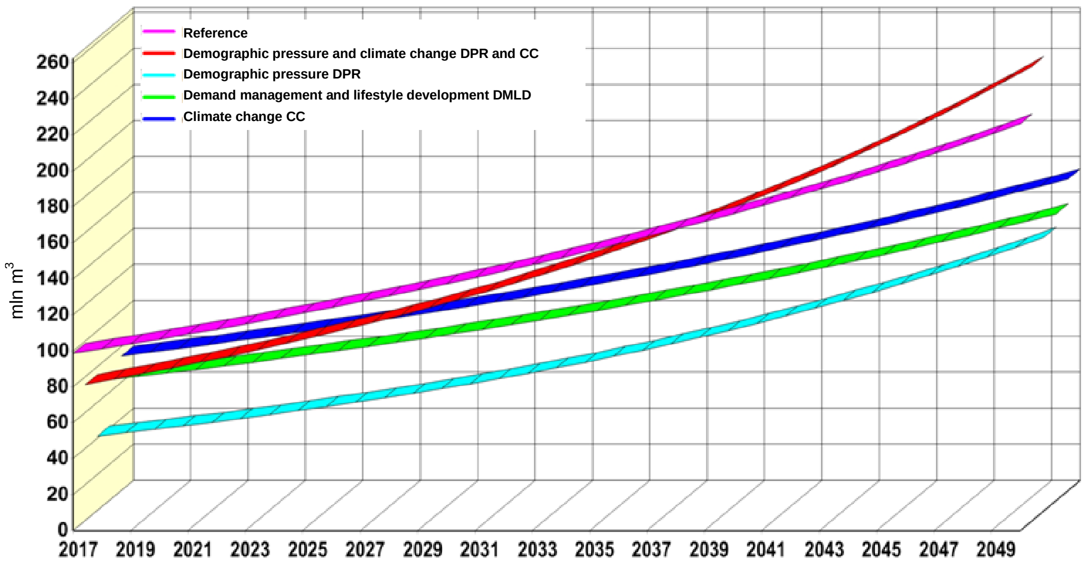

Fig. 7. Evolution of unmet water demand in the Setif Province – all scenarios; source: own study

The monthly total water demand increases at the same rate from 2016 to 2050 for all scenarios where the demand is higher during the period from May to September. This increase is due to the intensive use of water during summer, the decrease of resources by the effect of climate change and the increase of endowment. The results obtained show that in January 2020, the water demand varied between 7.4 mln m^3 for the CC scenario and 10.30 mln m^3 for the RS scenario (Fig. 6). This demand will increase throughout the period to reach 15 mln m^3 for the CC scenario and 21 million m^3 for the RS scenario. The water demand for the DPR and CC scenario shows a remarkable increase from January 2040 (14.85 mln m^3) and exceeds the water demand of the DMLD scenario. This evolution will continue to reach 21.66 mln m^3 in January 2050 and will exceed the values of the scenario RS. The progressive increase in water demand for this scenario comes from the combination of population pressure and lack of water resources due to climate changes.

UNMET DEMAND (UD)

The results of the unmet demand show a deficit in drinking water for all scenarios (Fig. 7). The UD regularly increases for the entire scenario starting from the base year. This deficit is clearly visible in the reference scenario where the demand is not satisfied during all the simulation period with important values of the order of 100 mln m^3 in 2017, goes through 140 mln m^3 in 2035 and exceeds 200 mln m^3 in 2050. It can be noted that adopting an endowment of 120 dm^3 per day per person and a higher rate of increase compared to the reference scenario renders the unmet demand visibly less with a difference of 60 mln m^3. The curve of the CC scenario shows that the deficit is more important when the region goes through a period of drought where there is a loss of 10% of rainfall. It reaches 120 mln m^3 in 2035 and exceeds 180 mln m^3 in 2050. This is how a low climate change towards drought directly affects water supply. A decrease in unmet demand is remarkable in the DMLD scenario (Fig. 8), when distribution network management programs are applied (20% loss reduction), and even with increased access to water drinking water (150 dm^3 per day per person). In the DMLD scenario, it is observed that the water demand will decrease and result in a lower overall unmet demand compared to the reference scenario, mainly due to the distribution network management programs. The combination of population pressure by a high rate of growth and the effect of climate change in the DPR and CC scenario highlights a considerably large deficit that exceeds the water shortage in the baseline scenario in 2037 where the deficit reaches 150 mln m^3 and exceeds 240 120 mln m^3 in 2050.

It should also be noted that the effect of improving the distribution networks in the DMLD scenario by reducing the losses by 20% is significant and the quantity of water that can be preserved sometimes exceeds 10 mln m^3 in the case in of the communes: Ain Oulmane, Ain Arnat and Amoucha.

The unmet water demand is the difference between the amount of water required and the amount of water distributed. This ratio is useful for understanding the scale of the shortage. Table 3 shows that 85% of the demand sites will not be satisfied for all scenarios.

This situation will continue until the end of the simulation period. Only the settlements of Setif, Hammam Sokhna and Bougaa are satisfied where this satisfaction is due essentially to the variation of water supply by the dam of Ain Zada and groundwater.

The most pessimistic scenario brings together the strong growth of the population and the impact of climate change (DPR and CC) where the deficit gap is noticed in most sites. The second critical scenario will be the reference scenario (RS): the unmet demand varies between 5 and 16 mln m^3 in 2020 and reaches 10 and 35 mln m^3 in 2050. The intensive increase of population and the specific variations of the daily allocation (70 dm^3 per day per person and 200 dm^3 per day per person) in the reference scenario of each site request will create a pressure on the resource during all the simulation period. Therefore, it is a phase of water scarcity in the cities that are fed only by groundwater. A lack of intervention to diversify and increase the supply will lead to a deficit which exceeds 15 mln m^3 in 2050 in the most part of the cities: Ain Oulmane, Ain Azal, Ain Arnat, Salah Bey, Ain Elkebira and Bil El Arch, which endangers the development of the province.

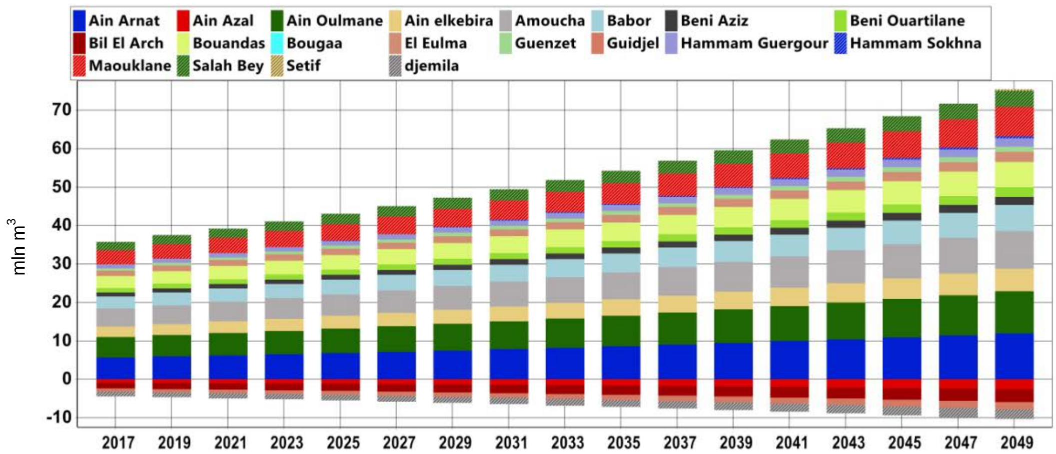

Fig. 8. Evolution of unmet water demand for scenario demand management and lifestyle development (DMLD) relative to a reference; source: own study

Table 3. Evolution of unmet demand for scenarios demand management and lifestyle development (DMLD), demographic pressure and climate change (DPR and CC), reference scenario (RS) for all demand sites

Demand site	2020			2030			2040			2050		
	DMLD	DPR and CC	RS	DMLD	DPR and CC	RS	DMLD	DPR and CC	RS	DMLD	DPR and CC	RS
Ain Oulmane	11.10	12.78	16.75	14.37	18.39	21.47	18.54	26.31	27.46	23.82	37.48	35.05
Ain Azal	10.36	12.43	9.39	13.79	18.29	12.40	18.14	26.55	16.22	23.65	38.22	21.05
Ain Arnat	7.98	9.27	14.17	10.40	13.40	18.18	13.47	19.23	23.26	17.35	27.44	29.69
Salah Bey	5.44	6.53	7.73	7.24	9.61	10.06	9.53	13.96	13.01	12.43	20.10	16.76
Ain elkebira	4.98	5.56	7.93	6.33	7.87	10.07	8.04	11.12	12.78	10.21	15.70	16.21
Bil El Arch	4.76	5.39	3.11	6.10	7.68	3.99	7.80	10.91	5.11	9.95	15.47	6.52
Beni Ouartilane	3.78	4.23	5.01	4.81	5.99	6.36	6.12	8.47	8.08	7.77	11.96	10.25
Bouandas	3.72	4.18	7.08	4.74	5.92	9.00	6.03	8.38	11.42	7.68	11.85	14.50
Amoucha	3.59	4.18	8.59	4.69	6.05	10.99	6.07	8.68	14.03	7.83	12.40	17.88
Beni Aziz	3.35	3.81	4.44	4.31	5.44	5.68	5.52	7.74	7.24	7.05	10.98	9.22
Djemila	3.25	3.71	2.05	4.22	5.37	2.69	5.46	7.72	3.50	7.02	11.02	4.53
Maouklane	2.95	3.31	6.80	3.76	4.70	8.63	4.79	6.65	10.96	6.09	9.40	13.91
Hammam Guergour	2.51	2.83	3.61	3.21	4.03	4.60	4.10	5.71	5.85	5.22	8.08	7.43
Guidjel	2.44	2.95	1.55	3.27	4.36	2.09	4.31	6.35	2.78	5.64	9.15	3.65
Babor	1.93	2.19	5.35	2.47	3.13	6.81	3.17	4.45	8.65	4.05	6.31	11.00
Guenzet	0.55	0.63	1.24	0.71	0.90	1.58	0.91	1.28	2.01	1.16	1.82	2.56
Eulma	0.08	0.77	1.60	0.60	1.67	2.41	1.27	2.94	3.43	2.12	4.73	4.73
Bougaa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hammam Sokhna	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.12	0.31	0.00	0.38	0.54
Setif	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56

Source: own study.

RETURN FLOW

Urban wastewater return flows and other non-consumptive uses are often poorly accounted for in large-scale water resources models, but clearly make major contributions to farmers dependent on surface water for irrigation [THEBO *et al*. 2017].

The water used from a demand site is sent to a variety of destinations, such as a treatment plant or the receiving environment (valleys). In the present case study, there are four treatment plants that treat the wastewater discharges of the settlements of Setif (66,000 $m^3 \cdot day^{-1}$), Eulma (43,000 $m^3 \cdot day^{-1}$), Bougaa (11,500 $m^3 \cdot day^{-1}$), and Hammam Sokhna (1,900 $m^3 \cdot day^{-1}$).

$$Q_{return} = Q_{sd} - C_{sd} - Q_{step} \quad (1)$$

Where: Q_{return} = return flow from a request site; Q_{sd} = incoming flow in a request site; C_{sd} = the amount consumed from each application site by use; Q_{step} = flow entering the treatment plants.

The C_{sd} values introduced in the WEAP model are percentages of demand sites consumption (this is the portion of water that comes out of the system when water is used in demand sites).

The results mentioned in Figure 9 show a progressive evolution of discharges in all treatment plants. It is observed that the values of the discharges for the upcoming decades are very high (11.50 mln m^3 in 2050) for the reference scenario and the DPR and CC scenario. The impact of reducing the losses and the climate change is clearly visible when the values of the releases are lower, of the order of 6 mln m^3 in 2050 and reach 8.5 mln m^3 in 2050.

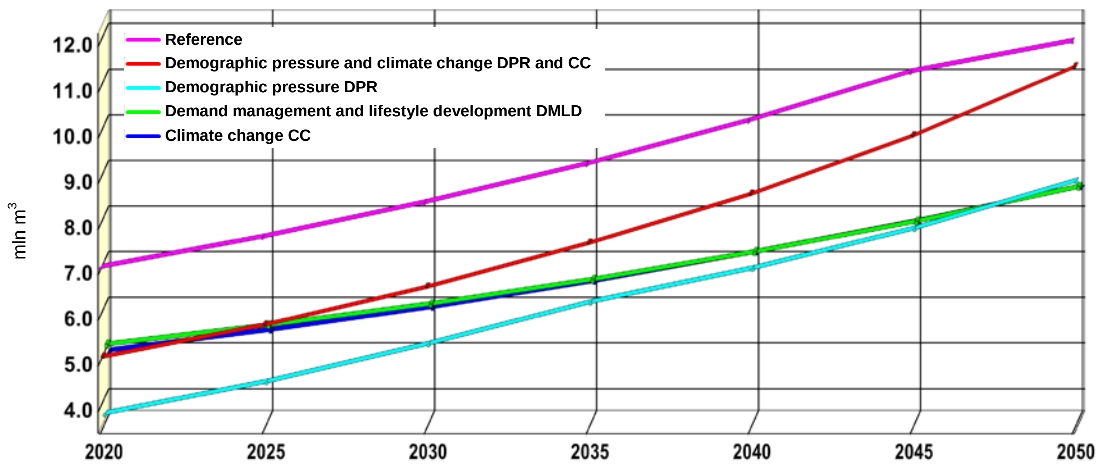

Fig. 9. Evolution of return flows in sewage treatment plants for all scenarios; source: own study

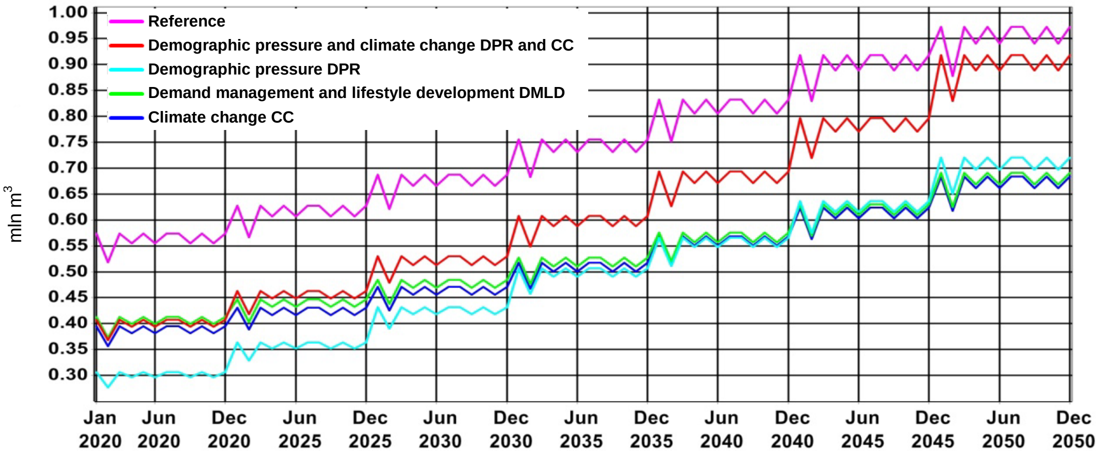

Fig. 10. Evolution of monthly return flows in sewage treatment plants for all scenarios; source: own study

The monthly return flows presented in Figure 10 show the values of the reference scenario which reflects the real case. They are of the order of 0.57 mln m^3 in December 2020, and exceed 0.70 mln m^3 in December 2035 to reach 0.96 mln m^3 in December 2050. These flows are considerable in terms of unconventional waters. The treated water can minimize the lack of water if it is reused for daily needs, artificial recharge of groundwater or for the agricultural and industrial field.

Figure 11 shows the variation of return flow rates entered in the four purification stations for the reference scenario, DMLD and DPR and CC. It is noted that the water treated by the station of Setif is highly important in all scenarios as it reached a volume of 8.9 mln m^3 in 2050 against 1.5 mln m^3 in the station of Bougaa. The discharges in the stations of Eulma and Hammam Sokhna are lower as they do not exceed 1.27 mln m^3 and 0.46 mln m^3, respectively, in 2050. It is noted that the four purification stations with their purification capacities can treat the releases of the agglomerations of Setif, Eulma, Bougaa and Hammam Sokhna, and this is for all scenarios. There is a considerable reduction in the agglomerates releases of Setif Province, which exceeds 3.25 mln m^3 in 2050 for the DMLD scenario compared to the baseline scenario. This is one of the consequences of improving the management of the distribution networks and wastewaters.

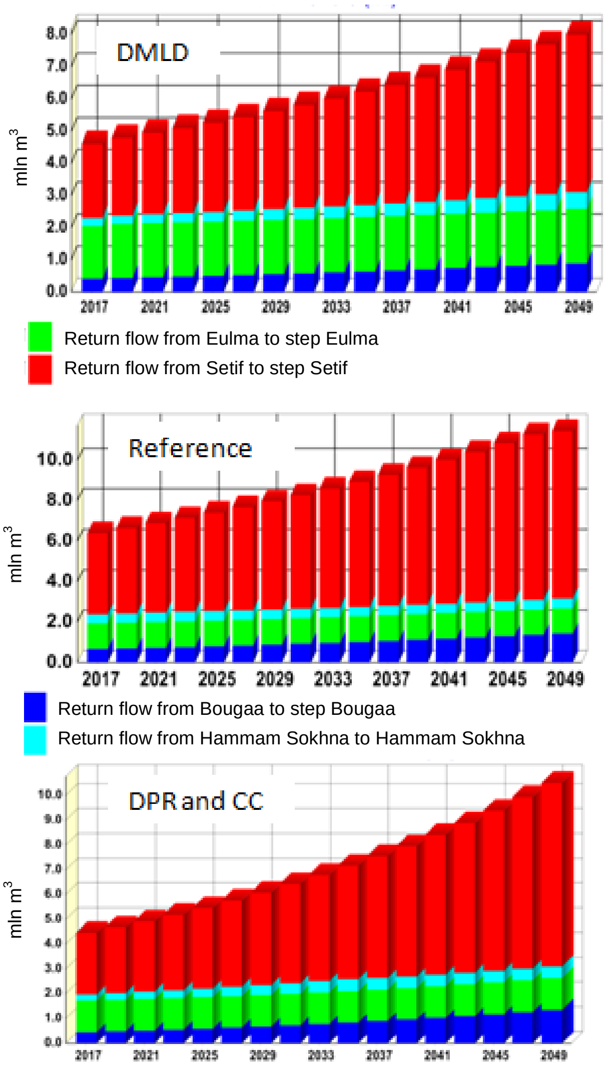

Fig. 11. Evolution of the return flows of each treatment plant for the different scenarios; DMLD, DPR, CC as in Fig. 4; source: own study

CONCLUSIONS

The pressure on water demand in the highland region depends on many factors, namely: demographic, social, climatic and economic. These various factors lead to instability of water resources, which results in a shortage of water in agglomerations and an increase in wastewater discharges, in the absence of an adequate and functional sanitation network in certain agglomerations. Releases can cause a mixture of good and poor quality waters in the medium and long term. This study used an integrated water management model, WEAP, for modelling the water demand and creating scenarios to assess future water availability and estimate releases in some sites of Setif region.

This work demonstrates a method of using an accessible modeling tool to integrate hydrological, hydrogeological and demographic data to facilitate water management decision-making.

The results of the WEAP model show that water scarcity is a real challenge in this region. The impact of climate change and demographic pressure shows a very large deficit that exceeds 240 mln m^3 in 2050.Climate change and food demand may act as additional drivers for water resource conflicts due to increasing water needs, especially for irrigated agriculture [GONDIM *et al*. 2018]. The 20% reduction in losses through the improvement of distribution networks shows a significant effect as this action can preserve more than 10 mln m^3.

The flow of return increases according to the evolution of the demand sites consumption. The discharges in the four purification stations in the region will exceed 11.50 mln m^3 in the upcoming decades. These treated waters offer solutions to the decision makers to satisfy the constantly increasing demand for water. In the context of scientific development, and confronted by an increasing water crisis, wastewater reuse merits consideration because the practice helps decrease water use pressure and moderates water pollution [JARAMILLO *et al*. 2017].

The situation of water resources in Setif Province requires a reaction from decision makers, users and administrators. These problems can be solved by implementing a new strategy based on the management of water demand, raising users' awareness regarding water economy, improving distribution networks and diversifying water resources.

According to the results obtained from return flows, wastewater treatment offers additional resources (unconventional water). These resources can be used to meet the demand for water in agriculture or industry, or for the artificial recharge of aquifers. Another interest of this action is protecting the environment against pollution and the diseases that are transmissible by polluted water.

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