Review Article

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Hydraulic budget for water resources management in region of Djelfa (Algeria)

Abstract

Under serious climatic changes and population rapid growth up, semi-arid areas become most sensible to water resource penuries. The increased water demand in Djelfa city conducts to over exploitation of the shallow aquifer which carries out to aquifer quality and quantity depletion. Furthermore groundwaters are affected by human activity (extensive pumping, arising agricultural and industrial activities). This work aim to establish a hydraulic water budget for water resources management and prevision. The results show that the demand of water will increase from 18 Hm^3 in 2017 to 35 Hm^3 in 2028 and the deficit become high (13 hm^3) ; this needs to reduce the daily water endowment from 90 to 80l/hab/day. The situation will be critical in the future because the abstraction from aquifer is 20mm/year against an average recharge of 12mm/year, for this reasons it is necessary to begin a strategy to develop groundwater resource in the region by renewing the networks supply and establish water transfer system from the neighbored regions.

Keywords: climate change, population growth, semiarid areas, hydraulic water budget, djelfa city

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Ali Rahmani SE, Chibane B
Geo Environment laboratory, FSGAT, USTHB, Algeria

Correspondence: Ali Rahmani SE, Geo Environment laboratory, FSGAT, USTHB, Algeria,
Email alirahmani101990@gmail.com

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Introduction

Mediterranean countries are among the most vulnerable to water stress,[1] due to high climatic variability, demographic and economic growth. Fluctuation observed in precipitations and temperature has altered the local water cycle, leading to a significant reduction in surface runoff and groundwater recharge. Drought has disrupted several hydrological systems in the world; many of them were suffering from insufficient water resources (North Africa, Middle East). Water resource requirements continue to increase with population growth up.[2] Citizens in Djelfa city were supplied totally by groundwater resources mobilized from wells, spring sources and boreholes. With population growth, the authority work to deploy better and boreholes to assure the increased water demand.[3] Supplying the population at the long term becomes a serious problem to the Algerian authority because of insufficient water resources in the region. Actually the population in Djelfa city was supplied every three day with autonomy of 4 hours by day. The water supply system was composed from 33 wells and boreholes secure all population, industrial and agricultural activities. The actual number of population is 507 561 inhabitant the average annual water demand is 18 525 968m^3. The calculus of water need is based on the daily water endowment (100liter/habitant/day). This endowment is lower than the minimum of the world health organization (WHO) recommendation (150liter/habitant/day)**.** This short communication aims to establish the hydraulic budget for water resources management in semiarid case study from Djelfa city (Algeria) to predict the water supply situation along the ten future years.

Material and method

The basis of this study is the identification and calculation of the entire hydraulic water budget for drinking water supply system in the Djelfa city. The global equation of the hydraulic budget is given by the equation (eq.1)

$$Vp = Vd + Vl + Vq \qquad \text{(eq.1)}$$

Where Vp: total volume produced (m^3/day); Vd: total distributed volume (m^3/day); Vl: total losted volume (Leaks in distribution and supply networks) (m^3/day); Vq: unusable water (very bad quality) (m^3/day). The parameter Vp, Vd, Vl and Vq data was communicated by the Algerian company for water.[4] These kinds of data present the actual production volume, distribution volume to supply population in Djelfa city. The projection of Vp was down by assumption that the produced water must augmented by increasing the number of Boreholes (Actually 33 boreholes). By tacking the average of extracted water flow. Vp was projected in the future in function of number of boreholes (Figure 1). However the ratio Vd/Vp steels the same across the time, because the performance of distribution networks assumed to be the same during the simulation period.

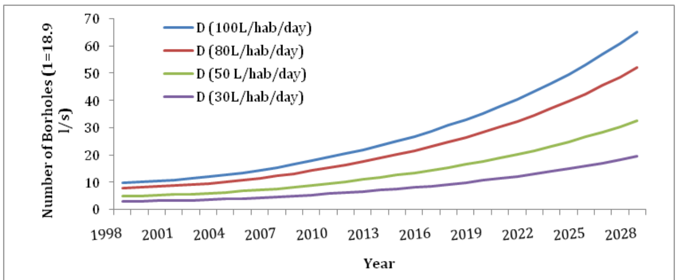

Figure 1 Evolution of boreholes number in function of simulation period and the daily water endowment needed (the average discharge rate of one borehole is 18.9l/s).

Results and discussion

The Figure 2 shows the predicted evolution of population during the simulation period. The actual population growth coefficient is around 6.74% which considered as a highest coefficient growth in Algeria; the population in the end of 1998 was 164 126 habitant, and will be 1 068 340 habitant in the end of 2028. This high growing need to mobilize more water to satisfy the population needs. In the Figure 3 the evolution of water need in function of the proposed daily endowment, is illustrated. The results of simulation of hydraulic budget show a deficit in term of water supply in the next ten year. The actual water demand is about 18 millions of m3 by year; however the water demand will achieve 40 millions of m3 for a total population of 1,200,000 inhabitants. The region is under a real dangerous; because it is impossible to satisfy this high demand with the actual data. The Figure 4 show the evolution of water production (Vp), the corrected produced water (Vpc) and the need of water (100l/hab/day) and the need for a daily endowment of 80 l/hab/day. The corrected produced water (Vpc) is given by assumption that lost of water in production and distribution networks are equal to 20% as follow.

$$Vpc = Vp - 0.2 * Vp$$

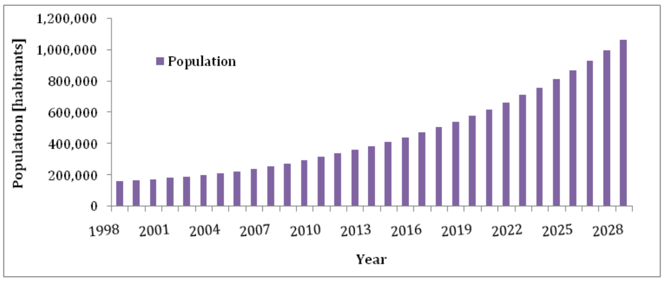

Figure 2 Population growth from 1998 to 2028.

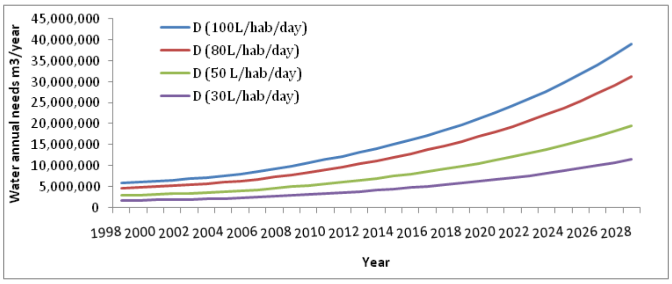

Figure 3 Water needs in function of four possible scenarios (Daily water endowment of 100Liter/day, 80 liter/day, 50liter/day, 30liter/day).

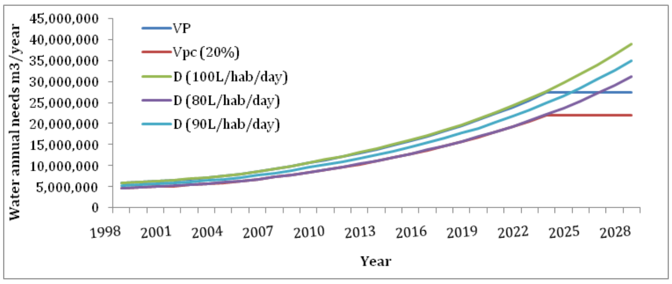

Figure 4 Evolution of water production, water need and water lost during the simulation period.

From the simulation in the graph of Figure 4 we can conclude that the need of water (D=100l/hab/day) is greater than the produced water (VP), because lost in leakage (Vl) is important (Bad water supply networks). Furthermore, when the daily endowment is reduced (8l/hab/day), the deficit to satisfy water needs will appear in the year 2023(D80>Vp); however we need to reduce again the daily endowment to can satisfy the population needs. After the year 2023 the Vp and Vpc steal constant because the production capacity will steal the same because it is impossible to arise the number of boreholes and the aquifer is in its critical state. The Vpc is less than water demand for a daily endowment of 100 liter/habitant, the situation actually is 90 liter/habitant, however for the next year we can't assure the daily endowment of 90l/hab/day, it must be reduced in the 2019 to 80 liter if no solutions are available. The Figure 1 illustrate the need of boreholes number in function of daily water endowment for the simulation period , it appear that if the actual daily water endowment steal at (100l/hab/day) we need in the 2024 50 boreholes, which mean we need (50-33=17) 17 new boreholes to satisfy the population demand. The capacity of aquifer is 12mm; however the actual production of 33 boreholes was estimated to 13 mm/year. In addition the 17 new boreholes are the equivalent to 7mm/year which mean the aquifer abstraction rate pass from 13mm/year in 2017 to 20mm/year in 2024. In the same way the aquifer is under the maximum water production, which is considered in critical situation. This scenario doesn't tack the climate changes factor. The depletion of aquifer will be rapid and this over exploitation will accelerate the dropdown of the water table level. The solution maybe reducing the daily water endowment to the half which mean D = 50 liter per habitant per day (Warming solution), or to make a new water transfer from the neighbored regions. The potentially of aquifer cannot be more than 12mm/year according to the recent work of Ali Rahmani et al.[5]

Conclusion

In conclusion, this short communication shows the future situation in Djelfa city, we need to arise the number of boreholes from 31 to 47 by the end of 2028. This augmentation in boreholes number will transform the aquifer to their maximum velocity of exploitation. However, the deficit will be important and the daily water endowment automatically reduced. To solve this problem we must construct small dams to stock water of runoff in winter period, and also it is necessary to establish water treatment statement for domestic water reuse and the last solution is to make a water transfer system from the neighbored regions.[6,7]

Acknowledgments

None.

Conflict of interest

Authors declare there is no conflict of interest in publishing the article.

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