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ScienceDirect

Energy Procedia 119 (2017) 870–882

Energy Procedia

www.elsevier.com/locate/procedia

International Conference on Technologies and Materials for Renewable Energy, Environment and Sustainability, TMREES17, 21-24 April 2017, Beirut Lebanon

Water Demand Assessment of the Upper Semi-arid Sub-catchment of a Mediterranean Basin

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Abstract

In the southern Mediterranean countries, levies probably reach the limit level of renewable water resources by mid-century. With an annual storage capacity of 14.6 million m^3 Algeria is one of the poorest countries in renewable water resources, in the Mediterranean coastal watersheds, representing 7 % of the land area and accounts for 90 % of total surface runoff of the country. In this paper, we assess water demand to meet the needs of water users in Boumerzoug, the upper sub-catchment of Kébir-Rhumel basin. The latter is located in the Kébir-Rhumel Mediterranean basin under semi- arid climate with relatively high growth rate of population, agricultural and industrial activities. Using Water Evaluation And Planning system (WEAP), we built a model for managing water demand of Boumerzoug sub-catchment. A business as usual and five scenarii of «water demand " were calculated by WEAP model to simulate the uncertainties over the period of 30 years (2008-2037) : Population growth(1), increase in irrigated crop lands (2), decrease in basic drinking water consumption (3), decrease in basic irrigation water consumption (4) and increase in basic industrial water consumption (5). The results showed that the decrease in basic consumption of drinking water scenario (3) is the best alternative scenario and the most efficient by reducing drinking water demand for about 37 Mm^3 in 30 years;

Keywords: water resources, water demand, IWRM, WEAP, scenarii, sub-catchment, semi-arid, mediterranean basin.

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1876-6102
10.1016/j.egypro.2017.07.140

1. Introduction

The Mediterranean population suffering from a good quality water shortage estimated at less than 1000 m^3/cap/y renewable resources, currently stands at 180 million and could reach 250 million by 2025. In addition, these resources are unevenly distributed. Indeed, the countries of the southern shore receive only 10% of total precipitation and population in shortage situation (less than 500 m^3/cap/y) is about 20 million. On the southern and eastern sides of the Mediterranean basin, agriculture remains the largest consumer of water, whose needs estimated at 82% of water mobilized mainly from renewable and fossil resources. Simulated projections show that the irrigated area could still increase, they will increase to 38% in the South Basin and 58% to the east of it towards the year 2030 [1].

Algeria is one of the Mediterranean countries, where there is currently a high population growth, rapid urban growth and multiplication of mainly industrial and agricultural socio-economic activities. This was accompanied by an increase in water demand, increased pollution and water shortage, estimated at about 350 m^3/cap/y [2] [3].

In basin-scale management of coupled human-water systems, water resources managers, like other decision makers, are frequently confronted with the need to make major decisions in the face of high system complexity and uncertainty. The integration of useful and relevant scientific information is necessary and critical to enable informed decision-making. However, how to establish effective communication between science and policy to generate useful information in a specific decision context remains a major challenge [4].

Although involving the stakeholders and decision-makers in the entire process of model development, implementation, and analysis can help enhance the transparency and credibility of the modeling results, there might still exist additional limitations of decision-makers not selecting a scenario due to political or other concerns/considerations [5]. The gap between theory and practice in water resources planning and management was described two decades ago by [6] [7], and still, models are often not adopted by the intended end users [8]. Since [9] water resource, systems have been modelled as networks to represent hydrology, infrastructures and diverse water demands. Decision support system are interactive mathematical and computational models that represent the natural system whose objective is to quantify, evaluate and compare the benefits and worsening of different water management policies [10]. For the vast majority of models the source code is unlikely to be available. We can only look at the output, at the documentation, run scenarios, analyse trends, but we ultimately have to trust the model developers in that the model is programmed properly. More recently, there has been a trend toward the adoption of the open source principles in modelling. Once the model is open source it is not just free for reuse, it also means that its code is available offering unrestricted opportunities for modifying and upgrading [11].

WEAP ("Water Evaluation And Planning" system) was selected for the purpose of our study, over other water resource models because it is a user-friendly software tool, well documented, with a nice graphic user interfaces (GUI). WEAP focus on water resource management and hydrologic mass balance and is distinguished by its integrated approach to simulating water systems and by its policy orientation. Operating on these basic principles WEAP is applicable to many scales; municipal and agricultural systems, single catchments or complex transboundary river systems. WEAP does not only incorporate water allocation but also water quality and ecosystem preservation modules. This makes the model suitable for simulating many of the fresh water problems that exist in the world nowadays [12]. WEAP was used, for several demand and/or supply studies: the Aral Sea Region [13], the upper Chattahoochee River Basin in Georgia in USA [14], the Olifants river basin in South Africa [15], the Sacramento Valley in USA [16], the Zabadani basin in Syria [17], Amman Zarqa Basin in Jordan [18], the Ouémé–Bonou catchment in Benin [19], the Lake Tana catchment in Ethiopia [20], the California's central valley in USA [21], the Okanagan Basin, British Columbia [22], imbalances in Iran, Morocco and Saudi Arabia [23], The Hérault River catchment in France [24], the Lake Victoria region in west Africa [25], the Vit River in Bulgaria [26], Zeuss Koutine Aquifer in Tunisia [27], the Ebro basin in Spain [28], the Langat catchment in Malaysia [29], the Han River basin in Korea [30], coastal Binhai New Area in China [31] and Constantine province in Kébir-Rhumel catchment in Algeria [32].