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Water Resource Development by Using Water Evaluation and Planning system "WEAP" (Case Study: Masouleh River)

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ABSTRACT
In all the worldrenewable water resource is decreasing. Masouleh River in Guilan Province, is supplied by Sefidroud dam and ground water that finally leads to Anzali Wetland. River modeled for 25 years by using Water Evaluation and Planning System (WEAP). In this research, based on comparison between the designed scenarios (reference, change of demand priority and population growth) in development section, maximum amount of water lack is in population growth scenario (211 million cubic meter in 25 years). In the case of development and progress in the region of case study, the water need that has not been supplied for agriculture section will be decreased about 30 million cubic meter during future 25 years in comparison with the reference scenario. The only scenario that shows increase in request and unsupplied needs in rural district in the results of model is population growth scenario.To solve the mismatch between demand and supply, improve in water distribution and use of new methods in resource utilization can be useful and in addition paying attention to change in need and demand management will be also useful. Demand management is hard in practice but if water is present, its distribution is easier.
***Key Words:**: sustainable development/Water evaluation and planning system WEAP/ water resources management/ Masouleh river*

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INTRODUCTION

In Iran, about 60% of lands are under water cultivation that provides 90% of state foodstuffs production [4]. Regarding to unsuitable local distribution of rain in the country and lack of time accordance of raining with irrigation season, water crisis is a serious problem. Certainly in a near future, Iran would encounter to lack of renewable water resources for continuation of agricultural activities and providing its necessities. Consequently, in order to counter with this crisis, water resources must be managed through the most economized and executable methods [16]. Guilan province has more than 44 rivers that any manipulation in their domain would cause danger for constructed installations and structures due to happen any flood in addition to destruction of the rivers system [3]. If the surface waters would not be controlled or the underground water resources would not be accurately used, they would be considered two main problems in the field of increment and development of agricultural products in the region of case study especially in the drought times [13]. The existing evidences indicate being critical of the water resources status. This matter needs necessity of more consideration to water resources management and optimized using them [1]. Surface runoffs are applied in domestic, irrigation, industrial and urban consumptions. Quantity and qualification of surface waters are managed with management methods similar to the upper lands [2]. Increment of harvesting and more competition in surface waters caused to financial and technological limitations would stop satisfied development and explore of underground waters and resources storages. Decrease of flow and groundwater recharge due to weather changes intensifies this situation. For this reason, more techniques are required especially in rural districts [8]. Dissolving the water shortage problems, qualification decay and increase of demand and renewable energies in hydraulic systems require planning, management and computer simulation. Such management methods help to sustainable usage of water resources [9]. WEAP acts as a tool for analyzing of water resources policies and planning in the integrated framework. The gained results are presented that WEAP is a complete useful tool for study on different options of water management and development [19]. Many regions are facing formidable freshwater management challenges. Allocation of limited water resources, environmental quality and policies for sustainable water use are issues of increasing concern [10]. The system is represented in terms of its various water sources (e.g., surface water, groundwater and water reuse elements); withdrawal, transmission, reservoirs, and wastewater treatment facilities, and water demands (i.e. user-defined sectors, but typically comprising industry, mines, irrigation and domestic supply) [12,17,19]. One of software limitations is shortage in available and homogenous water date in domain, especially ground waters data. Additionally, lack of reliable predictions on weather variety in future would increase incoherence probability in future simulations [7]. Masouleh river basin located in Guilan Province is selected as a case study area. Masouleh is a permanent river that its origin is in 3000 m height of the region and its lenght is about 60 [18]. Rivers are influenced by their natural changes, deep reformation due to effective human activities. Principal operation using river management science may plan the best type of consumption. Objective of this research is to evaluate the amount of influence of development results on Masouleh River with consideration to existence data and applying WEAP Software and study management techniques.

MATERIAL AND METHOD

Masuleh River is one of the main and permanent rivers in region that is the main agricultural water resource in the Fumanat plain in the north of Iran. Its basin is 426.7 Km^2 that Masouleh river flows from Fooman, Someesara and Masuleh urban to Anzali wetland[6], Masouleh river bazinis presented in Figure 1[5]. Masuleh river basin covers about 17% from the Foumanat plains that there are three water resources for different consumptions; 96% agriculturing consumption, 4% drinking and industrial consumption [15]. Regional flowing rivers is charging from the highlands of north west, west and south west of the study area, and is flowing to the west to the east and southwest to the north east [18].

All data related to Masuleh river basin such as climatic data, annual and monthly hydrometer statics, annual and monthly average discharge for 1986 to 2011 water years, are gathered from the Guilan regional Water company.

In the WEAP software there are schematic that shows river, water needed place, catchment area, groundwater, and ... that with placing each one can entered new data in the model. In the following model, Masouleh basin, Sefidrud basin, Masouleh river, 3-point demands (agricultural, industrial, rural), the minimum environmental required point and water supply (rivers, groundwater and Sefidrud dam) is specified.

Minimum environmental required point was defined where the river flows into the Anzaly wetland. This amount is calculated by estimation 10% of the river average discharge during the months October to March and 30 percent of the river average discharge in the months of April to September was entered.

The scenarios have built on existing conditions and their effect on the water access and consumption has been surveyed in the future. The period which considered for scenario is from 2011 to 2035, the software has predicted the conditions up to 2035, based on the existing data were collecting during 25 years (up to 2011). Inheriting from the scenarios is a subset of a scenario that means inherit properties from pre-scenario. In addition, new conditions can be describe or entered new data.

Design scenarios are: 1 - Reference scenario: this scenario inherited input data up to 2011 as the base year and the water situation prediction determined between 2012 and 2035. The population growth rate is calculated 0.7% as the base year in this scenario. 2 – changing Demand priority scenario: Discharge and population changes, all conditions are the same as the reference scenario. The only difference is the demand priority. In this scenario, the agricultural needs - towards the needs of industry and rural - are at the second priority. 3 - Population growth scenario: including the constant water flow to the area, and by inherited data from 2012-2035 of reference scenario, the population growth rate has been estimated 2% by 2035 and surveyed the demand rate.

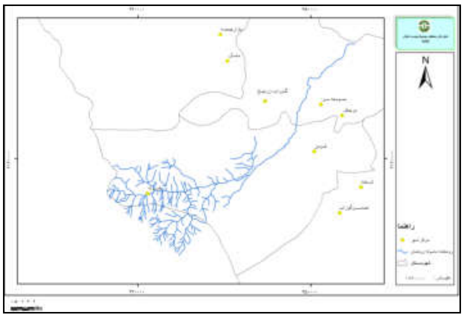

Figure 1. [5]

RESULTS

By the results gained from the WEAP software and gathered data and information the conclusion is conducted and the recommendations and suggestions provide that is shown in Figure 2.

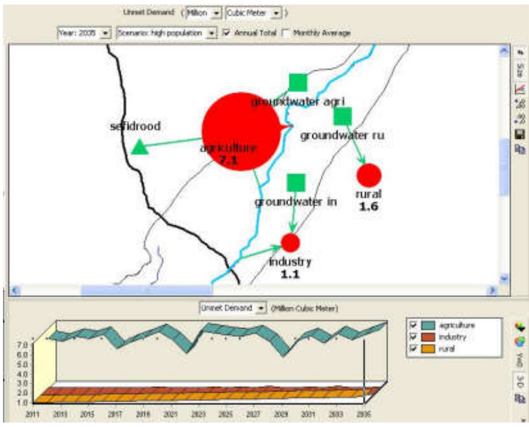

Figure 2. Masuleh river unsupplied demand changes in population growth scenario by demand point division in 2035 in maps and charts format.

Reference scenario: Total annual water need is 22.7 MCM that includes agricultural, industrial and rural water needs respectively 19.7, 2 and 1 MCM.

Monthly agricultural water need was changed in April to September (0.02 to 0.8 MCM). Its for other months of the year is 0. Industrial and rural water need is respectively 0.08 and 0.09 MCM. Monthly industrial water need is 0.08 to 0.09 MCM and rural water need is about 0.09 MCM. Annually agricultural, industrial and rural water need are respectively 6.1, 1 and 1 MCM and for the all demand points is 8.1MCM.

Unsupplied demand has been changing 25 years. Its rate increases from 6.1 to 7.07 MCM in agricultural needs, 1 to 1.07 MCM in industrial needs, and 1 to 1.21 MCM in rural needs from 1 to 1.21 MCM. The final rate is 206.6 MCM in 2035 for 25 years (Figure 3).

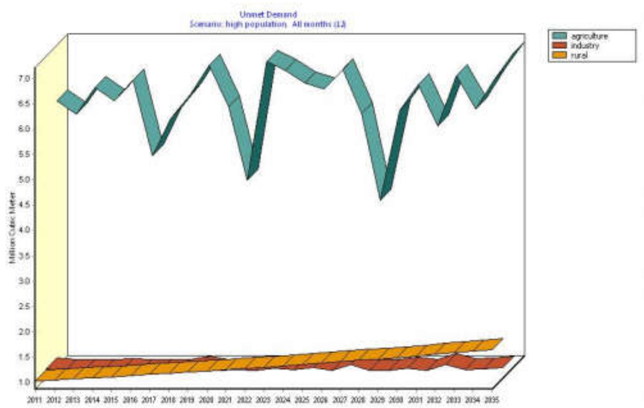

Figure 3. unsupplied water demand in reference scenario for all demand points (years 2011 to 2035)

In the reference scenario annually unsupplied demand is changeable. The agricultural, industrial and rural water need are respectively 70 to 80% , 45 to 55% and 0 in April- September.Demand priorities changing scenario: the unsupplied demand is changeable in this scenario during 25 years. The rate changes from 6.1 MCM to 4.9 in agricultural needs, 1MCM to 1.2 in the industrial needs, and from 1 to 1.1 MCM in rural needs. 179 MCM is the rate for 25 years in 2035 (Figure 4).

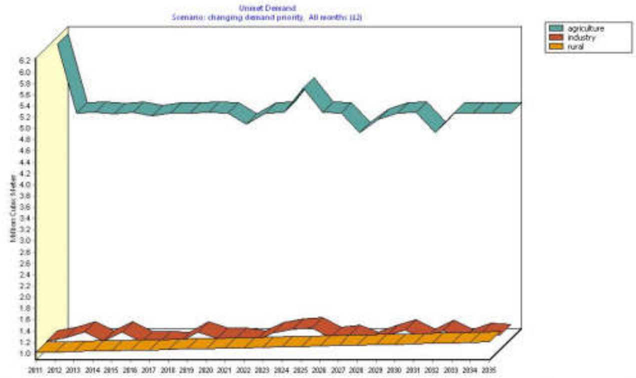

Figure 4. the water unsupplied demand of demand priority changing scenario for all points (2011 to 2035)

Population growth scenario: unsupplied demand is changeable for 25 years. It changes from 6.1 MCM to 7.1 for agricultural need, 1 to 1.1 MCM for industrial need and 1 to 1.6 for rural needs in 2011 to 2035. This rate is 211.6 MCM for all 25 years in 2035 (Figure 5).

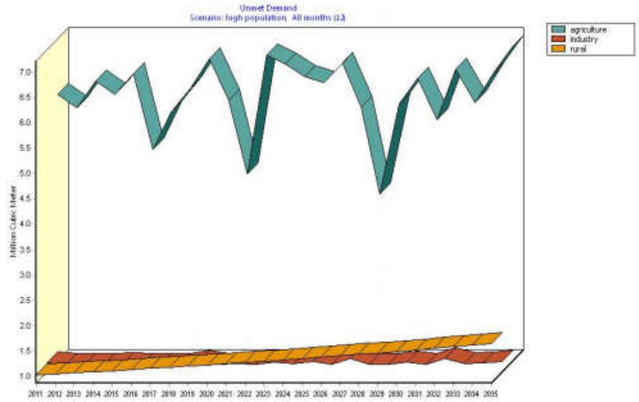

Figure 5. The water unsupplied demand in population growth scenario for all demand points (2011 to 2035)

The demand range is constant over 25 years. This rate from 2011 to 2035 is 19.7 MCM for agricultural needs, 2 MCM for industrial (not show any changes). Demand range increase from 1 to 1.6 MCM for rural needs. This rate is 574.6 MCM for total of 25 years (Figure 6).

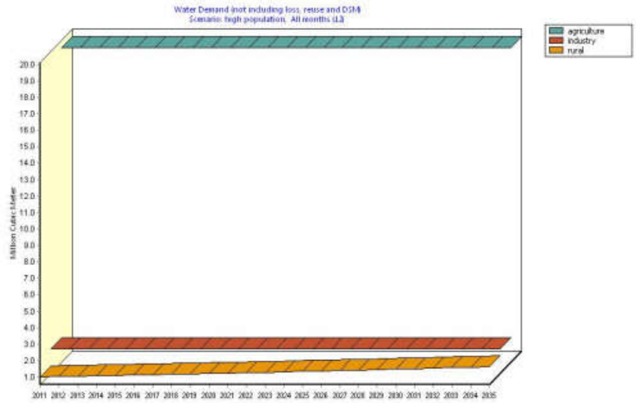

Figure 6.Water demand of population growth scenario for all demand points (to 2035)

Comparison between the reference scenario and demand priority change scenario:
This rate for agricultural needs is from 7.1 MCM in reference scenario to 4.9 in demand priority change scenario. It reduced from 153 to 123.2 MCM during 25 years (Figure 7).

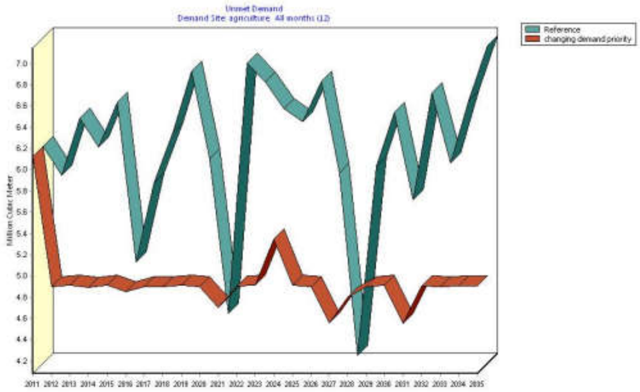

Figure 7. Comparison between water unsupplied demand between reference scenario and the demand priority change scenario in the agricultural needs points.

Water need for industrial changes from 1.1 MCM in reference scenario to 1.1 in demand supply priority scenario that means water need is almost identical for both scenarios in 2035 but reason to predicted fluctuations, it increases by 9.25 MCM to 28 in 25 years (Figure 8).

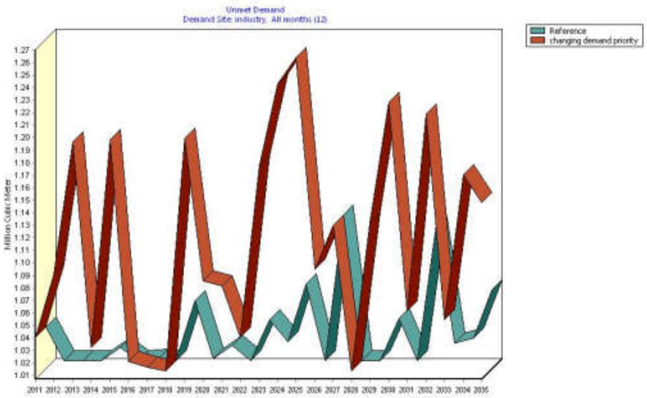

Figure 8. water unsupplied demand comparison between the reference scenario and the demand priority changing scenario in industrial demand point.

Its amount is 1.2MCM in rural needs without any changes. The water unsupplied demand is 27.8 MCM in both scenarios (Figure 9).

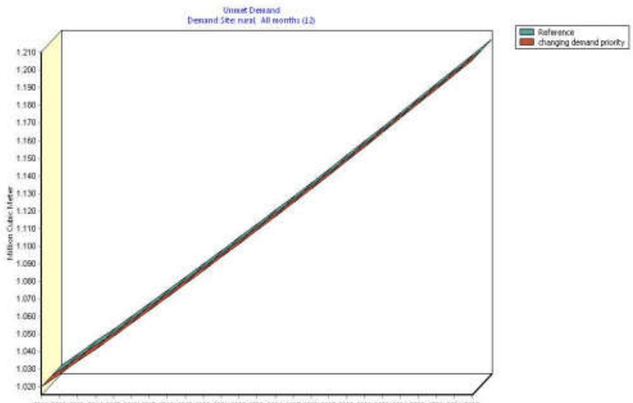

Figure 9. water unsupplied demands comparison between the reference scenario and the demand priority changing scenario in the rural points.

Reference scenario and population growth scenario comparison:
The water unsupplied demand for agricultural use is 7.1 MCM in both scenarios in 2035, without any changes (Figure 10).

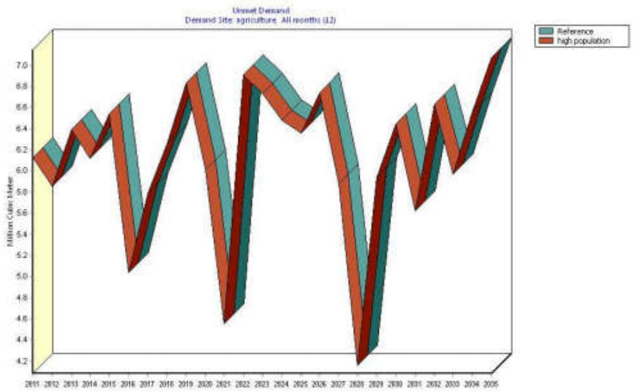

Figure 10. water unsupplied demand comparison between reference scenario and population growth scenario in the agricultural needs point.

water unsupplied demand in The Industrial need is 1.07 MCM in both scenarios in 2035, without any changes (Figure11).

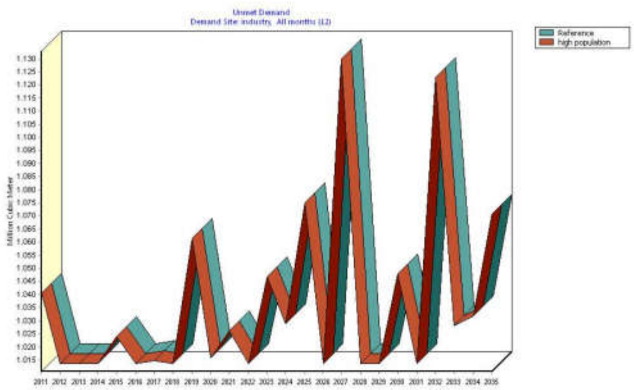

Figure 11. water unsupplied demand comparison between reference scenario and population growth scenario in the industrial point.

The water unsupplied demand for rural needs increases from 1.21 MCM on the reference scenario to 1.64 on the population growth scenario. It increases from 27.76 MCM to 32.67 MCM during 25 years (Figure12).

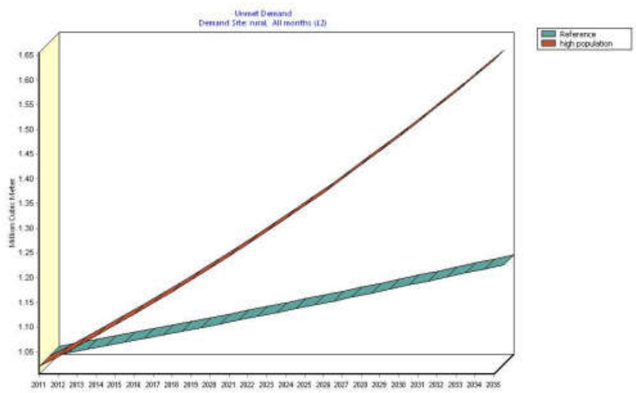

Figure 12. water unsupplied demand comparison between the reference scenario and the population growth scenario in the rural need points.

DISCUSSION AND CONCLUSIONS

in a research study with Iran Hydropoletic water condition title, the water status in comparison with other countries has Shown that the water crisis in the future and Renewable water per capita has declined due to increased consumption in the country and Will be lower than the international standard [14]. Studies to identify sources of groundwater Foumanat plain and qualitative changes and factors affect on regional water balance In an article titled “Foumanat plain Understanding groundwater resources and their qualitative changes” has indicated that This basin has discharge remarkably good quality for drinking, irrigation and industry [13]. Massule River Flood Control Project in Hydrology Report, Source, slope, aspect and elevation are calculated [15]. In the article "Introducing WEAP software as a tool to integrate water resources management." Changes resulting from the development of water resources in the Haraz river Basin checked and shown that the development of this area has the greatest impact on the agricultural sector [11]. In article entitled "The Use of Water Evaluation and Planning (WEAP): A model for assessing the future demand for water in the river Niger (Republic of Niger) ", showing the future needs of its population is optimized River Niger [10]. The results obtained from the present article reviews research confirms previous.

There are several points in the Masuleh river basin that have been surveyed and applied in the modeling. Location of the demand point is base on the existent natural condition which is also visible on the map. Thus the paints get in to position under the river flowing direction and places has been placed in dam network because of water usage of Sefidrud dam. Also demand supply resources has been marked on the map based on their natural placement for several scenarios planning. The minimum ecological requirement point marked at the river flowing rate at the wetland conjunction. Estimating the volume of water which would have normally entered in the wetland, emphasized on the importance of river decontamination. Extryway Debbie to application was derived from the Kumadol stations this was done for two reasons, first: This station has the least distance to demand points rather than the other stations. Second; the most important input branches to River located before this station. Thus, the input Debbie of this is calculated. It is necessary to explain some pants about then selecting view and choosing charts: 1- Model studying period is 25-years, if the results has been shown, there will be complexity in three demand point in this period, that is not very appealing to the viewer. 2 - There is a view in a model results showing three demand points in a column. In cases where there is balanced between points, using this chart makes it easy to express the overall results. The agricultural demand is significantly higher than two other sections in this model and thus it is better do not use this view. 3 - In cases where the graph, shows unchanged and constant results, it is unnecessary to repeat it. Thus the annual demand request has displayed just in reference scenario and population growth scenario. Reference scenario has been modeled, based on the base year with the aim of surveying Masouleh river changes in the next 25 years. Article title emphasis on development effect. Because of this reason climate changes such as precipitation, evaporation and river Debbie changes (defined in blue) was considered constant to survey the population growth due development growth and priority changes.

The only significant variable in this scenario is the population growth rate by 0.7 per cent. (in grow population scenario is 2 per cent). Changing demand priority scenario is planned base on development effect on water demand application. Usually, the number which is considered in industry, drinking and environment is 1 and 2 for agriculture in the demand priority points for developing areas. Based on present results from this research, by study area development, the water unsupplied demand reduces of about 30 million cubic meters for agricultural section in the next 25 years. And just the population growth scenario in comparison between scenarios shows increase in water unsupplied demand model result in rural section.(from 27.76 to 32.67 MCM) It is considered so many needs by increasing population in the states. Undoubtedly one of the most important one is requirement and using the under groundwater is the reason which increase the unsupplied demand. First, under groundwater resource is a limited resource for consumption (Though the underground aquifers in the Masouleh river basin and Foumanat plain and is in a good conditions) and Second, it is impassible the water use for of surplus demand supply and the main reason is its pollution.

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REFERENCES

1. Arabi Yazdi, A., A. Alizadeh, F. Mohammadian.(2008)."Study on Water Ecological Trace at Iran Agricultural Section", Water and Soil Magazine (Agricultural Sciences and Industries), Volume 23, Version 4, Winter 2009, Page No. 15. (In Persian)
2. Droogers, P., J.E. Hunink, J.H. Kauffman and G.W.J. van Lynden.(2011). "Costs and Benefits of Land Management Options in the Upper Tana", Kenya Using the Water Evaluation and Planning system WEAP- Green Water Credits Report 14- www.futurewater.nl- - pp 12- 36.
3. Fayyaz, N., M. Pour Houshyar, B. Nazif, M. Esmaeili Verki.(2011)."Study on the Effect of Construction of Reserve Dams on Morphological Changes of the Rivers, Case Study: Reserve Dam of Polroud River in Guilan Province". Abstract of the Article of the First National Conference and the Third National Conference of Dams and Electricity-Hydraulic Power Plants.(In Persian)

4. Ghaemi, A., M. Hoseinabadi.(2003).“A view on Under-pressure Water and Irrigation Resources”, Collection of Articles of the Third Regional Congress of Khouzestan Province Irrigation and Drainage. – Under-pressure Irrigation System. (In Persian)
5. Guilan Environment Protection Org., (2013). (in Persian)
6. Guilan Regional Water Co.(2013). (In Persian)
7. Holger, H., C. Bonzi, B. Joyce and K. Tielbörger.(2012). “ A Water Resources Planning Tool for the Jordan River Basin”, pp 718-736
8. Höllermann, B., S.Giertz, B.Diekkrüger.(2010). “Benin 2025—Balancing Future Water Availability and Demand Using the WEAP ‘Water Evaluation and Planning’ System” . Water Resources Management, Volume 24, Issue 13, pp 3591-3613
9. Kaloyan, N., H. Kenov and M. Ramos.(2012).“Water and energy sustainable management in irrigation systems network”, INTERNATIONAL JOURNAL OF ENERGY AND ENVIRONMENT, Volume 3, Issue 6, pp.833-860
10. Mahamadou Mounir, Z., Ch. Ming Ma and I. Amadou.(2011). “Application of Water Evaluation and Planning (WEAP): A Model to Assess Future Water Demands in the Niger River (In Niger Republic)” mas Modern Applied Science Vol. 5, No. 1; - -pp38-49.
11. Matin, A. L. Ooshak Saraei F. Shariati.(2012).Introduction of WEAP Software as a tool for making united the water resources management. Abstract of Environment Engineering National Congress Article, the Sixth Period.(In Persian)
12. McCartney, M., Y. Ibrahim, Y. Sileshi and S. Bekele Awulachew.(2011).“Application of the Water Evaluation And Planning (WEAP)”, Model to Simulate Current and Future Water Demand in the Blue Nile,pp 80-88.
13. Mohamadi Fatideh, M. (2003). Introduction of Underground Waters Resources of Foumanat Plain and study on their qualification changes. Iran Agricultural Sciences Magazine, First Edition. (In Persian)
14. Mokhtari Hashi H. (1999). Study on Hydro-politic Status of Iran. Law and Political Science Research Magazine (University of Mazandaran), Third Year, Tenth Edition. (In Persian)
15. Sazehpardazi Iran Consulting Engineers Co. (2007). “Study on Determination the Bed Limitation and Boundary of Masouleh River”, Guilan Regional Water Co.(In Persian).
16. Shamsaei, M. (2013). “Necessities of Under Pressure Irrigation in the Country, Priorities and Procedures”, collection of the articles at the Third Regional Congress Committee of Khouzestan Province Irrigation and Drainage, Under-pressure Irrigation Systems. (In Persian)
17. Stockholm Environment Institute (SEI).(2007). ―WEAP: Water Evaluation and Planning system – user guide.‖ Stockholm Environment Institute, Boston, USA.
18. Kankash Omran Consulting Engineers Co. (2009). “Updating Report on Combination the Water Resources Studies of Great Sefidroud Rivers Drain and Anzali Pool”, the third volume: Analysis of Water Statistics, Information and Balance, Fifth Section: Combination of Water Studies and Balance, Attachment No. 2: Water Balance at Foumanat Study Limitation.(In Persian)
19. Yates,D., J. Sieber, P.David & H.Annette.(2009). “WEAP21—A Demand-, Priority-, and Preference-Driven Water Planning Model Part 1: Model Characteristics- Water International”, pages 487-500

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