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The Economic Impact of Climate Change on Optimal Allocation of Water Resources in Agricultural Sector

(Case Study: Sarbaz River Basin of Sistan and Baluchestan Province)

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Abstract

Agriculture as the largest user of water resources and providing for human needs, water resources management is faced with many challenges. On the other hand, climate change and weather conditions resulted in the production of agricultural products subject to this change. Scarcity of water resources due to reduced precipitation patterns change and global temperature has increased agricultural production and food supply is affected. Due to the adverse effects of climate change on various sectors of production, ecological and human communities, of climate change could be one of the most important environmental challenges mentioned century. Sistan and Baluchestan Province, one of which, unfortunately, has witnessed successive droughts and livelihood and economic problems it has caused, therefore, water management and determine an optimal cropping pattern is consistent with climate change; step is useful for planning and development of the agricultural sector. The aim of this study is to investigate climate change in the southern zone using the GCM, the effects of climate change (precipitation and temperature) crops into the region and a consistent pattern of socio-economic optimization using fuzzy multi-objective programming model is presented.

Keywords: climate change, crop patterns, fuzzy multi-objective programming, Sistan and Baluchestan

1. Introduction

Abnormal increase in greenhouse gases is only one factor that affects the Earth's climate system. Check the status of emissions suggests that the Industrial Revolution in the mid-18th century, due to the increasing industry and by the increased use of fossil fuels, the balance amount of greenhouse gases in the atmosphere is particularly confused and amounts of carbon dioxide has increased. The infrared radiation emitted by the Earth's rise has caused more warming caused by greenhouse gases absorbed by the Earth's atmosphere. Warming the planet, in turn, on the other components of the climate system is affected by the phenomenon of climate change causes (Vaseghi & Esmaeili, 2008). Several factors have been caused by phenomena such as climate change, population growth and the widespread use of fossil fuels, land use change and industrialization ... that gradually changes in Earth's climate have caused today, the average increase in global temperatures and an increase in natural disasters such as floods, hurricanes, melting polar ice caps and rising sea levels and thereby increasing the frequency, duration and intensity of droughts have (Redsma, Lansink, & Ewert, 2009). But as the supply and demand for water is the source of life, are related to climate change is happening on Earth, so Effects and this phenomenon it is necessary. Iran's climate due to its condition has caused water shortages and inadequate spatial distribution of the distant past, when it is faced. So only 0.37 percent of the world's freshwater resources is belonging to Iran. It is clear that due to this phenomenon and the allocation of water resources in the country is of particular importance and it is necessary in addition to the problem of water supply and extraction, to discuss its management should be considered. On the other hand, the agricultural sector as the largest user of water resources between sectors and providing for human needs is water resources management is faced with many challenges and changes in climate and weather conditions in the production of many products, it has changed. On the one hand, the main factor of production in this sector, "water", which is heavily influenced by climate and the availability of other products in this section, time, location and acreage, yield, dry matter, and it, is all affected by climate changes. So that not only can reduce the intense rainfall for crop production per unit area affected; but basically it can disrupt the cultivation and harvesting of crops.

Sistan and Baluchistan province with an area of over 181 square kilometers; in hot and arid region where little rainfall, scattered and uncertain times on the one hand and high levels of evaporation on the other hand has been facing a severe shortage of water resources. The hydrological, climatic conditions and water resources management in special circumstances as hydrological phenomenon is less relevant in this province is not updated. In the northern province of Helmand is plain that our catchment area, the utilization of water resources is limited to surface water resources which stems from neighboring Afghanistan. While in the central part of almost all the exploitation of water resources, groundwater is limited because of the special geological and resource potential of the area are not but are generally stable sources (Sistan and Baluchistan province Regional Water Company, 2002) in the southern province of a combination of surface and ground water resources however, despite the fact that these resources are heavily dependent on the surface and therefore sensitive resources and vulnerability of climate change are considered. The river brought the region may be in a day to reach three million cubic meters a year, or even water in the river is not. It is obvious that water management is essential in this area and determine an optimal allocation of water resources and the optimum model is consistent with climate change; an important step in planning for the future of agriculture in the region and is compatible with these conditions.

More research in this area focuses on long-term relationships between climate and hydrological parameters based and have tried the effects of climate change in the parameters of water resources through climate-hydrological modeling relationships between variables estimate the occurrence or non-occurrence of the phenomenon of climate change. And most of those studies that include: Shen (2010) in a study to demonstrate the relationship between climate change, water resources management, changes in Water Resources in China during the past 50 years. Climate change and water resources in the selection of the seven river basins in the country are according to their predictions for the future. Wang, Huang, and Rozelle (2010) investigated the effect of climate change on water resources and agriculture in China Tanlarj River Basin; the climate effects with the use of general circulation models under three scenarios were simulated. The results showed that climate change will have a significant effect on water supply in the area under the A2 and B2 scenarios arises more serious water shortages. Their results also showed that if farmers are able to reallocation of water between the products, then there will be the possibility of moderating the effects of climate change (Matondo, Peter, & Msibi, 2004).

Effects of climate change on hydrology and water resources in Switzerland using the model output and in three catchment rainfall-runoff models are examined. Their results showed that the annual discharge of the river basin from 4 to 23 percent decline in the future Angavama while there will be little change in the other basins. Research in the area of climate change Aanjam which includes the study of (Nazari, 2012) paid in their study to evaluate the economic impacts of climate change on agriculture in Iran. He works with the simulated precipitation and temperature parameters of the main water sources and its effects on agricultural sector in equilibrium studied and analyzed. Other studies can also be used to study and understand perspective, in 2003 noted that the effects of climate change on water resources are studied. In this study, based on the results of climate change switches shown that with increasing temperature, evaporation increases in most river basins and degree temperature increase of 2 to 6, 6 to 12 percent increase in evaporation and precipitation change the search will be 78-71 percent. Agricultural sector and regional culture model depends heavily on rainfall. Various studies with regard to this issue, the effects of climate change on crops. Including Gupta and Harboe (2000) in their study using fuzzy multi-objective model of the Narmada River in India simulated data to determine the optimum model of the area is water. Model provided timely irrigation will reduce the risk of failure. The study is in accordance with a reduced risk of failure due to the uncertainty on the water, especially in arid regions to provide the appropriate cropping patterns can be seen as very useful.

Bostani and Mohammadi (2011) in a study with the aim of designing optimal utilization in city corruption by integrating multi objective programming and planning phase questionnaire among 90 operators in fuzzy optimal selection of the city studied. The results of their study showed that the optimal fuzzy contour patterns are a definite improvement. It was also demonstrated using fuzzy mathematical programming model to select the appropriate and optimal combination of multiple targets and gives a lot of flexibility. There is conflict between utilization and environmental goals. Alvanchy and Sabouhi (2009) in his study in the Gulf region of Iran using multi-objective decision-making model with three objective maximization gross margin, minimization risk and irrigation water showed interactive crop pattern in the pattern of cropping patterns available to f armers to grow more close agreement in addition, it had better results in the area of agricultural planning. Bostani and Mohammadi (2009) in a study to develop crops at risk, with regard to the reduction of water consumption in the city of Shiraz in Fars province began using multi objective programming approach. Note that targets three goals to reduce water consumption reduce risk and increase the efficiency. Results showed that there was an exchange between the aforementioned purposes. The pattern of the area planted was increased with increasing levels of risk. In these models, vegetables, corn acreage was higher than the current model, but the atmosphere was reduced cultivation. Bean acreage was also close to its current level. The results showed that the optimal pattern of increasing risk with increasing distance between the current models.

2. Method

Agricultural sector is increasingly influenced by the climate, availability of space and time in this sector, and the acreage of crops, dry matter and all of it is affected by climate changes. Therefore, in this study the effects of climate change on water resources in the region, using general circulation models under three switching CGCM3T63 B1, A2, Mix of switching provided by the Inter-governmental Committee on climate change simulations and then the demand for water (irrigation requirements) using the water of reaction was calculated FAO Finally, comparison of baseline and simulation for performance and the demand for water (irrigation requirements) for different products in each of the switches of climate change and the effect of climate change on aquatic products is required. Then the normal application of the product in the area of crop irrigation requirements and to obtain the optimal allocation model is introduced. To the anticipated effects of climate change for water resources, the effects of these changes on the demand, levels and cropping patterns, as determined by the pattern of the ship is consistent with climate change. The basic algorithm for optimizing the allocation of water between different sectors is the linear programming. Accordingly, given the general framework of linear programming can be defined objective of maximizing gross margin business.

$$Z=\sum_{i=1}^{n}\frac{S_i*GER_i}{AW*GER_{maz}} \tag{1}$$

Therefore, it is necessary first of all gross economic returns are calculated for each sector.

2.1 Limitations

A) The limitation of water:

The water supplied to the water sector does not exceed:

$$\sum_{i=1}^{n} S_i +K\leq Aw \tag{2}$$

AW (the volume of water available), due to the volume of water available for allocation between the various competing and technical feasibility, K the amount of water entering the ecosystem (environment) and Si is the share of each of the competing water.

B) Restrictions on water demand:

Share of water allocated to the normal water section shall apply to the portion below the minimum size is the minimum demand.

$$D_{ni} \geq S_i > D_{mi} \tag{3}$$

That Dn (normal demand) for each sector, the conventional demand for water supply, and the demand may be met or not and Dm (demand a minimum): request to the terms of the minimum that must be met.

C) Limitation of water supply:

Total water should be allocated to the different demands of water is normal.

$$\sum_{i=1}^{n} S_i \leq D_{ni} \tag{4}$$

D) Environmental constraints:

According to the characteristic of irreversibility of natural resources if the development process from the initial state to get them back to a previous state is difficult or impossible, it seems that the environmental benefits of the benefits of development in many cases surpass. Because the development of water resources has caused irreparable damage to the ecosystem is the actual utilization of water resources associated with externalities. Therefore, regarding the appropriateness of the use of water resources, a series of future benefits will be lost. The total loss of future profits (ρ) can be a function of the amount of water (w) and the amount of water entering the ecosystem (K) and the lack of value in the form of irreversible (ρδ) is considered:

$$\rho = \alpha W - \beta K + \rho\delta \tag{5}$$

The above discussion leads to a rule-oriented as environmental protection with regard to services that should be protected. If it is assumed irreversibility not is allowed to grow, a stable base for the use of resources will be achieved. This means that to achieve sustainable rule should $\rho = 0$ and it is possible that the irreversibility of time there before the course:

$$\rho = \alpha W - \beta K = 0 \quad \Rightarrow \quad \sum_{i=1}^{n} S_i \ = W = \frac{\beta}{\alpha}\ \mathrm{K} \tag{6}$$

The amount of water for different sectors, as a proportion of the amount of water released in the ecosystem is defined. But because of the irreversibility of time before developing countries are due to lack of attention to environmental issues is evident, there is a solution that is not allowed to expand. Or in other words the situation is not worse than it is. β is the rate of compensation irreversibility of preventive measures because due to the economic needs have to use water resources (harvest) and must be greater than zero and also the amount shall not exceed the resource capacity. Since, at best, preventive measures (allocation of water to ecosystems) can only be irreversible values are taken from the source block. So it is smaller than α. Therefore:

$$0 < \beta < \propto$$

After β simulated by the fact that the amount of water allocated to the ecosystem is the source, different scenarios can be picked up in the water as the ratio of the volume of water allocated to ecosystem determined.

E) Non-negative constraints of activities:

$$S_i \geq 0, \quad D_{ni} \geq 0, \quad D_{mi} \geq 0 \tag{7}$$

As noted with regard to the importance of agriculture in the use of water resources and special effects that affect the climate in this section in particular, this section will be taken into consideration and then, aims to determine the optimal cropping pattern in the study area.

General context of regional planning several criteria: In this research for decision making in the agricultural environment using fuzzy mathematical programming by Professor Lotfi Zadeh was presented for the first time; according to previous research has been followed. Currently one of the most known among models, mathematical programming models; mMulti-objective programming model (prototype) that this type of model to use in the decision-making process has been introduced in the 70's. Then use these models as models for developing a systematic logic of the institution and different types of them were based on theoretical issues. Zeleny (1982) analyzed several criteria included multiple criteria and multiple targets knows (Manus et al., 2009).

Then Lotfi Zadeh (1965) and after that, Zimmerman (1978) fuzzy sets in multiple criteria mathematical programming into the way in terms of the issues that have been resolved by non-MCDM methodology usual, were flat. Many other studies in this regard that has great influence on the MCDM methods such as research studies Lohani et al. (2004); Panda et al. (1996); Anigrahi and Majumda (2000); Zimmerman (1987); Zimmerman (1990); Inuiguchi et al. (1990); Hannan (1981); Sakawa (1987); Yano and Sakawa (1985). Ultimately, these studies point to be known as the fuzzy mathematical programming. Following the decision proposed by Bellman and Lotfi Zadeh fuzzy or minimum operator in 1970, along with various membership functions led to the development of the equivalent linear programming problem. The objective function of fuzzy membership function is known and therefore is bound. The constraints for the optimization of objective functions, one decision at a fuzzy environment is defined as an analogy with a non-fuzzy environment, such as the selection of activities that simultaneously optimizes the objective function and constraints. Making in a fuzzy environment is the intersection of fuzzy constraints and fuzzy objective functions. There is a relationship between constraints and objective functions perfectly symmetric fuzzy environment (Bellman & Lotfi, 1970). The general framework of the model as follows:

The first vector is defined as the maximum of the following form:

$$Max\ Z(x) = \{Z(x) | x \in X\}$$

Where $Z(x) = Z_1(x), \ldots, Z_k(x)$ is operation value. Efficient solution set is defined as the set of all solutions of $\bar{x} \in X$ given the objective function $Z_t(x)$.

$\bar{x}$ An efficient solution would be if there is no $\acute{x} \in X$.

$Z_t(\acute{x}) \geq Z_t(\bar{x}), t = 1, \ldots, k$ and $t \in (1, \ldots, k)$ for at least one of. $Z_t(\acute{x})\ Z_t(\bar{x})$.

Optimal answer to this way you get the full set of answers is a member.

2.2 Objective Functions

1). The profit maximization:

General economic goal of profit maximization by any decision of the planning process is followed. Although the pattern of ships for which farmers would prefer to create greater financial returns. Therefore, this objective can be formulated as follows:

$$Max\ Z1 = \sum_i N_i \times A_i \quad \forall i \tag{8}$$

2). Minimize the need for capital:

Investment is needed for production and investment plays a key role for selected products in particular, this study investigated the farmers in the area have very little financial capacity and cropping patterns that require little capital is generally preferred. So we have:

$$Max\ Z2 = \sum_i I_i \times A_i \quad \forall i \tag{9}$$

A_i: Area under cultivation per hectare for each product and I_i investment product.

3). Minimize water consumption:

According to government policies can reduce water consumption is one of the objectives of the study and this can result in water resource management and extension services to farmers are a special place:

$$Max\ Z3 = \sum_i D_w \times A_i \quad \forall i \tag{10}$$

Where D_w is the need for irrigation water every product.

Limitations of the model:

1) Limit the area:

At the planning level assigned to the various products in each month shall be equal to the total arable area:

$$\sum_j B_i^j \leq A, \quad \forall j \tag{11}$$

Water restrictions are required:

Irrigation water demand in any month shall not exceed the total water in the particular month:

$$\sum_i W_i^j \times A_i \leq SW^j + GW^j, \quad \forall j \tag{12}$$

Limit the extraction of underground water resources:

The use of groundwater resources should be higher than the total amount of allowed extraction of these resources:

$$\sum_j GW^j \leq TAGW \tag{13}$$

2). The activities are non-negative constraints:

The basic assumption of linear programming is that all decision variables should be negative.3. The activitiesare non-negative constraints:

The basic assumption of linear programming is that all decision variables should be negative. A_i

$$A_i \geq 0 \text{ and } GW^j \geq 0 \tag{14}$$

2.3 Membership Functions

Membership in the context of multi-objective function is a special deputy preference in determining optimal results for each of the roles that and the t-th target $\mu_{Z(x)}$ is shown. Membership is subject to the following conditions exist:

$$\mu z(x) = \begin{cases} 1 & if \quad Z_t(x) \geq Z_t^* \\ 0 \leq \mu z(x) \leq 1 & if \quad Z_t^m \leq Z_t(x) \leq Z_t^* \\ 0 & if \quad (x) \leq Z_t^m \end{cases} \tag{15}$$

$Z_t(x)$: The result is that the t-th target.

If a solution with the highest degree of membership in a fuzzy decision as to maximize the definition, then the fuzzy optimization problem can be expressed as follows:

$$Max\ \ Z(x) = (Z_1(x),\ \ Z_k(x))^T \tag{16}$$

Where:

$$AX \leq b$$

$$X \geq 0$$

All objective functions are defined by their membership functions.

This will be followed by all objectives simultaneously optimized membership functions. For the general public:

$$\mu_D(x) = \mu_D\big(\mu_{z1}(x), \dots, \mu_{zk}(x)\big) \tag{17}$$

And general optimization problem is to maximize µD (x). Will become $\bar{x} \in X$ based on defining the optimum vector fuzzy linear optimization problem is called if and only if 17 is an optimum solution for the equation as:

$$\mu_D(x) \le \mu_D(\bar{x}).\ \forall\, x \in X$$

Using the operator minimum (Lotfi Zadeh, 1965) Basic functions of $\mu_D(x)$:

$$\mu_D(x) = min\left(\mu_{zt}(x)\right) = min\left(\mu_{z1}(x), \dots, \mu_{zk}(x)\right) \tag{18}$$

Equation 9 can be written as follows:

$$Maximin\ \ (\mu_D(x)) \tag{19}$$

$$S.t:$$

$$AX \le b$$

$$X \ge 0 \tag{20}$$

Zimmerman (1978) showed that the relation 19 is equivalent to the following schedule:

$$Max\ \lambda$$

$$S.t:$$

$$\lambda \le \mu_t^H Z_t(x)$$

$$AX \le b$$

$$X \ge 0,\ \lambda \ge 0 \tag{21}$$

Multidisciplinary model for determining the optimum model using a fuzzy linear programming:

Formulation of linear programming model based on fuzzy multi-criteria decision-making is quite logical that the nature of the membership function is hyperbolic. Because the marginal utility of decision-making in the real world, however it is reduced utility level (degree of membership) with respect to increases the achievement of the target. Nonlinear Hyperbolic the membership function for the fuzzy goals of the decision maker imagine:

$$\mu_t^H Z_t(x) = \frac{(tanh(\left(Z_t(x)\text{-}b_t\right)+1)}{2} \tag{22}$$

That αt and bt slope parameter value $Z_t(x_t)$ is the way to $\mu_t^H Z_t(x) = 0.5$. Worst and best objective function value of t th respectively Z_t^*, Z_t^m and $b_t = (Z_t^m + Z_t^*)/2$. Using the membership function of the fuzzy hyperbolic shown above for the express purpose of fuzzy making decisions Lotfi Zadeh and Bellman (1970), the general form of the problem can be stated as follows:

$$Max\ \lambda$$

$$S.t:$$

$$\lambda \le \mu_{zt}^H(x), t = 1,2, \dots, k$$

$$AX \le b$$

$$X \ge 0,\ \lambda \ge 0 \tag{23}$$

This formulation $\lambda \le \mu_{zt}^H(x)$ is a nonlinear function and therefore is faced with a nonlinear programming problem. Librling (1981) showed that such nonlinear hyperbolic nonlinear membership functions can be introduced by the linear programming problem becomes routine. Equation 23 can be written as:

$$Max\ \lambda$$

$$S.t:$$

$$\lambda \le \frac{(\tanh((Z_t(x) - b_t) + 1)}{2},\ t = 1, 2, \dots, k$$

$$AX \le b$$

$$X \ge 0,\ \lambda \ge 0 \tag{24}$$

That is synonymous with:

$$Max\ \lambda$$

$$S.t:$$

$$((Z_t(x)\text{-}b_t)\alpha_t \geq tanh^{-1}(2\,\lambda\text{-}1)\ \ t = 1, 2, \ldots, k$$
$$AX \leq b$$
$$X \geq 0,\ \lambda \geq 0 \tag{25}$$

If you define that:

$$x_{n+1} = tanh^{-1}(2\,\lambda - 1),\ \lambda = (tanh^{-1}(x_{n+1}) + 1)/2\ \ \lambda = \frac{(\tan h^{-1}(x_{n+1}) + 1)}{2}$$

So tanh (x) is a strictly increasing monotonic function with respect to x is equal to the maximum λ peak x_{n+1} is the vector of values of multi-objective optimization problem can be transformed into the crisp model:

$$Maximize\ \ x_{n+1}$$

Subject to:

$$\propto_t\ Z_t(x) - (x_{n+1}) \geq \propto_t\ b_t\ , \text{t=1, \ldots, k}$$
$$AX \leq b$$
$$X \geq 0,\ x_{n+1} \geq 0 \tag{26}$$

An optimum relationship between 26 ($x_{n+1}{}^{*}$, x $*$) to get the optimal solution of the original problem can be obtained:

$$(\lambda, x^{*}) = \frac{tanh^{-1}(x_{n+1}) + 1}{2} \tag{27}$$

The regional allocation model multi-objective fuzzy membership functions Hyperbolic can be formulated as follows:

$$Maximize\ A(n+1)$$

Subject to:

1) Constraints by equations 1 -7 as a target allocation model;

2) Restrictions on membership hyperbolic one for each target were investigated:

- Maximizing efficiency program:

$$-\propto_1 \sum_{i=1}^{n} N_i A_i + A_{n+1} \leq -\frac{\alpha_1(Z_1^m + Z_1^*)}{2} \tag{28}$$

- Minimum capital requirements:

$$-\propto_2 \sum_{i=1}^{n} I_i A_i + A_{n+1} \leq -\frac{\alpha_2(Z_2^m + Z_2^*)}{2} \tag{29}$$

- Minimize water consumption:

$$-\propto_3 \sum_{i=1}^{n} W_i A_i + A_{n+1} \leq -\frac{\alpha_3(Z_3^m + Z_3^*)}{2} \tag{30}$$

- Non-negativity constraints:

$$A(n+1) \geq 0$$

3. Results and Discussion

As noted in this study the historical data for the period 1982-2011; hydrometric station and synoptic River basin catchment soldiers in southern Baluchestan were collected. The available water resources among competing sectors (agriculture, water and environment) are assigned. Following the model of optimal planning of land under cultivation in the proposed dam the optimal solution based on the historical conditions for the periods presented. In the second phase of the study with the use of models called general circulation model (GCM) climate data were simulated catchment soldiers in southern Baluchestan and then with respect to the data presented in this large-scale data model are therefore, using purposive sampling techniques were fine-scale view and the discharge capacity of the river soldier using rainfall-runoff model was simulated. This part of the investigation into the exogenous information into fuzzy multi-objective planning model presented in this study has been killed. With regard to the effects of climate change (temperature and precipitation) in the pattern of changes in the volume of water entering the model is, the proposed model is based on the proposed changes, and is adapting to climate change. Differences in the pattern created by cropping patterns based on historical observations of the effects of climate on crops in the basin are studied.

Optimal allocation of water resources in river basins soldier:

After examination of the phenomenon of climate change by examining the homogeneity of the studied basin, using CGCM3T63 model simulation results of climate change during the study Tale 3 is. According to the IPCC (2007) general circulation models under different scenarios of economic, social and environmental considerations offered in which greenhouse gas emissions under different scenarios of population growth, economic growth, technological progress, and the simulation result. As can be seen in the area of climate change simulation study under three scenarios A1B, B1, A2 is done.

Table 1. Simulation results under three scenarios of climate change

Scenario variable	*A1B*	B1	A2
The Maximum Temperature	+1.99	+1.06	+1.9
The Average Temperature	+1.82	+1.17	+1.77
The Minimum Temperature	+1.64	+1.27	+1.69
Rainfall	-12.8%	+5.5%	-10.5%

Resource: Finding Research.

Can be seen that the maximum temperature, minimum and average under all scenarios examined during the 50 years leading up to the year (1440) will increased. Unlike the other two scenarios under the B1 scenario rainfall will decrease 12.8%. Generally, many of compete in the water, should be involved in planning for the allocation of this resource includes 1 Agriculture 2 Industry 3 home 4 Ecosystem 5 Energy. In this paper, according to the conditions prevailing in southern Baluchistan and the absence of any facilities to produce energy (electricity) in area, this part of the program is eliminated. However, given the small size of the industry and the lack of integration of the home ultimately, this lack of information and statistics can also be evaluated separately Planning and so it is with the water sector (domestic and non-domestic) has been studied. Table (1) River Basin Water Allocation Model has been soldiers. Optimal allocation of water for the purpose of maximizing economic efficiency of water use has been the efficiency of agriculture and home the inverse demand function derived from this Shahraki & et.al (2008) in the Helmand river basin is calculated. To prevent the destruction of the environment, preservation of environmental constraints in the form of three scenarios defined for the allocation of water to ecosystems, following fierce study (2012), ith values of 0.25, 0.5 and 0.75 = β% of water allocated to this sector.

Table 2. Monthly allocation model of water in the river basin soldiers in the base period using historical data

Scenario	Section	April	May	June	July	August	September	October	November	December	January	February	March
	Agriculture	795.00	548.06	394.03	398.30	381.49	118.96	162.80	178.47	174.46	1296.62	1780.40	1038.44
B=0.25	Home	1710	1710	1710	1710	246	246	246	246	246	246	246	246
	Environment	626.25	564.51	526	527.07	156.87	91.24	102.20	106.12	105.11	385.65	506.6	321.11
	Agriculture	795	548.06	394.03	398.30	246	246	246	246	174.46	1296.62	1780.40	1038.44
B=0.5	Home	1710	1710	1710	1710	246	246	246	246	246	246	246	246
	Environment	1252.5	1129.03	1052.01	1054.15	313.74	182.48	204.40	212.23	210.23	771.31	1013.20	642.22
	Agriculture	795	548.06	394.03	398.3	381.49	118.96	162.8	178.47	174.46	1296.62	1780.40	1038.44
B=0.75	Home	1710	1710	1710	1710	246	246	246	246	246.	246	246	246
	Environment	1878.75	1693.54	1578.02	1581.23	470.62	273.72	306.60	318.35	315.34	1156.96	1519.8	963.33

Source: research findings.

As such, according to the available water, in all three scenarios, the amount of water allocated home is clearly equivalent to the normal demand of the sector which has been fully answered. It is according to the rules of water management in the country in terms of drinking water supply shortages priority is quite consistent. With the aim of maximizing the efficiency of water use, thanks to the higher efficiency of the agricultural sector is the largest amount of water allocated to this sector. Furthermore, changes in simulated discharge capacity of the former dam and assess the impact on water supply, again, the pattern of resource allocation of water between agriculture, water and the environment provided the summary of changes in the allocation of water before and after climate change is provided in the following table.

Table 3. Effects of climate change on water allocation in various sectors

Scenario	Section	After climate change	Before climate change	Change (percent)
	Agriculture	551.34	605.59	8.95
β=0.25	Home	550.5	734	25
	Environment	251.17	334.89	24.9
	Agriculture	386.72	617.44	37.36
β=0. 5	Home	550.5	734	25
	Environment	502.34	669.79	25
	Agriculture	457.82	605.59	24.39
β=0.75	Home	550.5	734	25
	Environment	753.51	1004.69	24.9

Source: research findings.

As can be seen, the model to changes in demand for home normal; an average annual increase of 25% allocation to a certain level is considered. As for the environmental sector also increased by roughly 24.9% and different values for the agricultural sector in different scenarios, 9, 38 and 24% increase in water allocation is considered. With regard to the optimal amount of water allocated to agriculture in three studied target and multi-objective fuzzy optimization model for the subdivision of agricultural crops in the following table:

Table 4. Optimal cropping pattern for agricultural catchment soldier

Existing model		Minimize water consumption		Maximizing of benefit		minimizing the need for capital		Fuzzy multi-objective model	
Product	Cultivated Area	Before applying climate change	After the climate change	Before applying climate change	After the climate change	Before applying climate change	After the climate change	Before applying climate change	After the climate change
Wheat	450	120	120	125	125	125	118	125	125
Barley	150	75	75	75	75	75	75	75	74
Lentil	5	2.5	2.5	2.5	2.5	393.25	393.25	2.5	2.5
Watermelon	500	3000	3000	6002.5	5170	3000	3000	6603	6271.8
Potato	6000	2500	25.5	29040	123.3	2500	25.5	55.219	96
Onions	1700	850	850	2379.9	1653.3	850	850	2963	2067
Tomato	51	850.75	460	711.97	639.6	460	850.75	460	780
Alfalfa	920	250	250	250	250	250	250	250	250
Total	9776	7648	4783	38586.87	8038.7	7653.25	5562.5	10533.7	9666.3

Source: research findings.

The results show in spite of low water consumption in terms of wheat, barley and lentil, cultivation for the reason that they have low productivity, should be reduced by half in Fuzzy multi-objective model.Cultivation of potatoes from 6,000 hectares reduced to 55 hectares, alfalfa reduced from 920 to 250 acres of hay while the multi-objective optimization model for increasing the area under cultivation of crops from 3000 to 6603 hectares of watermelons, 1700 to 2963 hectares of onions, tomatoes from 51 to 460 acres offers. Table 4 the percentage change in the area of climate change for product improvement shows patterns. Can be seen in the multi-objective optimization model, due to climate change, model 8 shows the percentage change in the total of the single-objective optimization models, model with the objective of minimizing the need for capital changes caused by climate change have the lowest (27%), while the optimal model for maximizing the profit most from climate change is accounted for (75%) and climate change effect caused to 37% in water consumption minimizing model. Therefore capital problem is not preference of farmers in this region while maximizing of profit is prior to other goals. Thus, as expected, the impact of climate change on agricultural sector (of resources and the performance of the products) will have profound effects on farmers' profit.

The result of water consumption minimization model shows that cultivation of some crops such as potatoes and tomatoes because of high need for water should be reduced, while watermelon crop because of to be cash and sowing dates increased. Also the result of profit maximization model inhabits that for all of crops except wheat, barely and alfalfa, cultivation areas decreased. Therefore Cultivate more area of winter crops is a one of the most recommendation we learned from this project. The early planting date is a good adaptation option for cultivating the summer crops to avoid heat stress for the summer crops and consuming less water at the same time. The water use efficiency for the crops cultivated at the early sowing date are more the water use efficiency of crops which cultivated in the late sowing date at the same climatic region. It is also recommended that we cultivate the major field crops to improve food security, using rain water plus supplemental irrigation water at winter.

Table 5. Percentage changes in cropping pattern for agricultural catchment soldier

Product	Model changes aimed at minimizing water consumption	Model changes with profit	Model changes aimed the need for capital	Fuzzy multi-objective optimization model changes
Wheat	0	0	-6	0
Barley	0	0	0	-1
Lentil	0	-25	0	0
Watermelon	0	-14	0	-5
Potato	-99	-100	-99	74
Onions	0	-31	0	-30
Tomato	-46	-10	-85	70
Alfalfa	0	0	0	0
Total	-0/37	-75	-0/27	-8

Source: research findings.

What is more important is that with regard to the objectives of this study, there are huge differences between the cultivation areas of the existing and proposed so that for some products should be more than 11-fold increase in acreage (watermelon) and 9-fold reduction (tomato) will be provided to these goals. So in order to meet the objective of this study is that the concerns of farmers and policymakers in the region and it is necessary to restructure agriculture and water management in the region.

Thus, as policy recommendations, made aim to improve productivity of crops and ensure that the water resources are managed to meet the local demands and to reduce water consumption.

Iran needs to produce more cereal yield with use less water volume, because increase the population makes the available water for the agriculture sector decrease. In the same time the higher population need to more food. These challenge need to adopt climate change strategies and produce the best varieties that are agreeable to high temperatures and low rainfalls. It is mean improve the food security issue for the Iranian especially with the more cultivate of wheat that means self sufficiency of wheat. This work need to improve the on farm management to control the water quantity in the farm level, improve water use efficiency and save water for the new reclaimed land, this work is not applicable without improve the water management in the old land and adopt modern irrigation system in the new reclaimed lands and planning for adoption of climate changes strategies.

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