

WATER-LIVELIHOOD-SUSTAINABLE AGRICULTURE APPROACH FOR ENHANCING ADAPTIVE CAPACITY TO CLIMATE CHALLENGES IN URMIA BASIN

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ABSTRACT

In the Urmia basin, vulnerability context is depicted in water resources of this area as the starting component for policy process analysis through the sustainable livelihood and agriculture approach. The main reason for the focus on 3 elements (water, livelihood and sustainable agriculture) in this study was climate change which contributed to greater water stress and making people more vulnerable in the Urmia basin. The interactions of water, livelihoods and sustainable agriculture have shown that factors such as migration, social capital, business, development, existence level, food supply, health, minor industry, agriculture and services, income variation, variety of crops and horticulture, sustainability of agriculture, livestock, fisheries, crops and horticulture, livelihood security for poor farmers, cover crops, stability of quality, quality of water and soil resources, participation in planning, reduction of water and irrigation losses, reduction of evaporation losses (mulch), pastures regeneration, market security, access to food, environmental sustainability (quantitative and qualitative resources), sustainable livelihoods (sustainable production), development of technology and service activities, compatibility with changing market conditions, reduction of poverty, labor force diversity, job creation, equipping infrastructure, responsibility, investment development, insurance, allocation of resources, improving nutrition, water rights, water use culture are effective on water-livelihood-sustainable agriculture nexus.

Also interdepartmental cooperation in the Urmia Lake basin (Environment, Ministry of Agriculture Jihad, Regional Water Company, Non-Governmental Organizations and Private Sector) with the aim of social participation and responsibility among all stakeholders, especially local communities to revitalize the Urmia Lake and carry out activities in three sectors of water, livelihoods and sustainable agriculture led to job creation, reduction of chemical inputs, and water savings in the field. As a result of training programs and capacity development on water-livelihood-sustainable agriculture nexus project, more than 80% of farmers had used the capacity development techniques. In East Azerbaijan, yield and water productivity were increased by 27.8% and 48.9%, and water consumption decreased by 25.3%. Also, in West Azerbaijan, water productivity increased 46.7% and water consumption indicator decreased by 29.2%. The yield decreased by 12.3% and 60% farmers in the whole of the basin were satisfied with their income received from their agricultural activities.

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1. INTRODUCTION

The Urmia Lake basin covers an area of 51,876 km² and is shared by three different provinces called West-Azerbaijan, East-Azerbaijan, and Kurdistan (Faramarzi, 2012). There are more than 36 cities and 3150 villages and also have about 5 million population in the Urmia Lake basin that more than 60% of the population lives in villages. As a result of climate change and scarcity of water resources, the region is facing unemployment and population growth as well as a decrease in the sex ratio due to the migration of men for finding work (Lotfi, 2012). According to the data of 2006 in the Urmia Lake basin, the area of irrigated crops was about 400 thousand hectares (Iranian Society of Consulting Engineers, 2011). More than 59 percent of the total water use (about 5.6 billion m³) were provided from surface water resources and the rest (about 41 percent) were provided from groundwater resource (Hashemi, 2008).

The agriculture sector is the main consumer of water resources and at the same time releases agricultural chemical residues owing to the use of fertilizers and pesticides (about 200,000 tons fertilizers and 4,000 tons types of pesticides and herbicides) to the environment (Lotfi, 2012). Although the region has experienced significant industrial growth in recent decades, agriculture and livestock continue to be the most important occupation of people in the region. However, drought is a common phenomenon in this region, a long-term and continuous drought occurred in the lake basin in the 1990s. This severe and long-term drought with the extra withdrawal of water for irrigation, especially in West-Azerbaijan and East-Azerbaijan provinces, has led to a significant reduction in water input flow of lake (more than about 50% of the area in 2012) and caused environmental and livelihood problems for people in the region. Based on the existing evidence as well as experiences related to similar lakes worldwide, drought continuity in the Urmia Lake will undoubtedly cause many damages and harms to the health of inhabitants and their livelihoods. In addition, that will create a degradation of the ecosystem and the agriculture sector in the basin

The results of the study on the implementation of a sustainable agriculture project indicate that a sustainable agriculture approach will have a significant impact on the safety of water resources. Since most of the livelihoods of local communities and the provision of water right for the lake depend on agricultural activities. The project is designed to model the participation of people in the Urmia Lake reclamation process with a focus on water, livelihoods and sustainable agriculture.

Urmia Lake plays an important role in terms of ecological and economical in the region. Therefore, reducing the 30 billion m³ of lake water during 1995-2015 has caused environmental and livelihood problems for people in the region (Aghlmand, and Abbasi, 2017). Also, the reasons for the complete dryness of the southern part of the lake in September 2014 and its repetition in September 2015 were caused by the decline in the amount of water entering the lake. Further, during this period, the equilibrium between evaporation and feeding of the lake were disrupted (ULRP, 2015; Aghlmand, and Abbasi, 2017). Although climatic conditions have had an unpredictable impact on the current conditions of Urmia Lake. The most important factor in lake dryness is related to unbalanced and unsustainable development and the extraction of water resources in the basin, especially in the last two decades. Experts have recognized the increased amount of consumption in Urmia Basin as a major reason for the negative balance (Hassanzadeh, 2015). On the other hand, agriculture has severely affected in Urmia basin over the past decades, so that 150

thousand hectares in 1979 increased to more than 400 thousand hectares in 2006 (Lotfi, 2012).

Undoubtedly, the continuation of this trend in Urmia Lake will cause many damages and disadvantages to the inhabitants of the basin through their livelihoods and the destruction of the ecosystem and the agricultural sector. In order to prevent serious damage to people and environment around the lake, under continuous decline in precipitation, stabilization of the current conditions of the lake and prevention of its complete dryness within the framework of water-livelihood-sustainable agriculture can be the only solution to rescue the lake and its basin.

1.1 Conceptual Framework

Considering the consumption of the largest amount of water resources in the agriculture sector and poor management in its application (Dehghanisani, 2018a), one of the most important solutions and priorities for the rescue of the Urmia Lake is to achieve co-operation in three sectors: water, livelihoods, and sustainable agriculture. In this way in addition to the attainment of benefits in each sector, it could be approached to control points in other sectors.

Nexus as lexical mean is connection and linkage the topics you want. In a rural community, in order to achieve the goals of sustainable development, activities in the water, livelihoods and agriculture sector should be accomplished in the context of the control of other areas and the overlapping of topics. Thus, activities in spheres of water, livelihoods, and agriculture should be carried out considering the control of other spheres to create sustainability. Creating a nexus in a region requires care and accuracy, more precise planning and coordination, which can reduce costs, time and consumption of resources.

1.2 Water-Livelihood-Sustainable Agriculture Nexus Approach

Figure 1 indicates the Water-Livelihood-Sustainable agriculture Nexus. This type of nexus expresses livelihood security according to environmental goals as well as refers to the challenges of maintaining food security and access to fresh water and energy for the preservation of livelihood. As a result, this nexus will create inclusive economic growth in the region. At the same time, it attends to the retention of the important capabilities of environmental systems, especially in the context of climate changes.

The benefits of water-livelihood-sustainable agriculture nexus can be:

- 1 It completes the concept of sustainable development.
- 2 It pays attention to the vulnerability caused by environmental pressures.
- 3 This nexus plays an important role in achieving human security.
- 4 The research linkage of this nexus is in the context of sustainable livelihood.

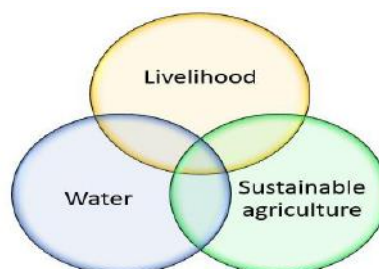


Figure 1. Water-Livelihood-Sustainable agriculture Nexus

Considering that the agricultural sector is the main water consumer in the region, it is necessary to reduce water withdrawal of this sector. Agriculture is the main activity of people in the region. The reduction must be done in a way not to affect the livelihood of people. In this regard, it is necessary to recommend appropriate strategies. In Urmia Lake basin, a sustainable agricultural program has been formed with a participatory strategy for realizing the participation of people in companionship to Urmia Lake restoration. In this program, an evolutionary management system has been conducted in several villages since 2012. Sustainable agriculture program with participatory strategy is a kind of agriculture that popular participation is considered in decreasing water consumption and increasing production efficiency per unit area in Urmia Lake basin. Sustainable agriculture is considered as one of the most important ways of Urmia Lake restoration and contributing to increase water productivity in agriculture through the introduction of various techniques to reduce water consumption at the field scale (Dehghanisani, 2018b). According to the water-livelihood-sustainable agriculture nexus approach, implementation of extensive educational, operational, support activities, etc. are needed to transfer sustainable agriculture techniques to farms.

2. METHODS

Figure 2 shows the stages of implementation of the water-livelihood-sustainable agriculture nexus. In this project, facilitation methods have been well implemented through capacity development to work integration and to understand the concept of nexus in rural life and the conscious participation of local communities. Farmers in the provinces of East Azerbaijan and West Azerbaijan were encouraged to cooperate with the recommendations of experts on reducing the use of water and chemical inputs and improving the crop, and improving the level of rural livelihoods and prosperity at various levels and capacities. As shown in Figure 2, climate change, market, population growth, etc. should be considered as external factors how will drive human irrigation decisions, water use, cultivation and people livelihood, crop water requirements and available water resources.

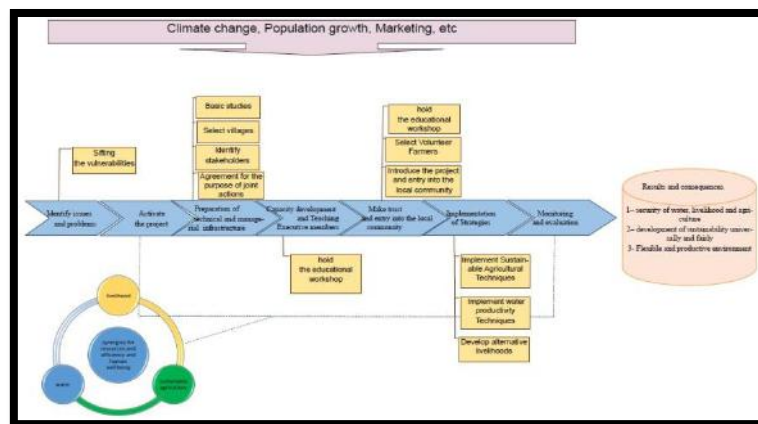


Figure 2. The framework of Water-Livelihood-Sustainable agriculture Nexus

In regard to gain inter-sectional goals, national and international members have been connected to provincial and local members and have been subjected to multilateral interaction in the phase of activating the project. The four levels including international, national, provincial and local had widespread interactions in the clarification of the goals, identifying and defining strategies. At the international level,

the government of Japan took a part of financing the project through the United Nations Development Programme (UNDP). At the national level, the Conservation of Iranian Wetlands Project (CIWP) as the representative the Iranian Department of Environment has managed the project. At the provincial level, the Ministry of Agricultural Jihad had cooperation with the Conservation of Iranian Wetlands Project (CIWP). At the provincial level, the Agricultural Jihad Organization of East Azerbaijan and West Azerbaijan provinces entered the project with local members included Non-Government Organization (NGO), technical and engineering companies, farmers and executive agents (Agricultural Jihad Organization).

In this project, the preparation of technical and managerial infrastructure were provided by the initial platform for implementation of activities through conducting studies, identifying main members, choosing the geographic location. Initially, basic studies were conducted with an emphasis on five spheres of socio-economic studies, biodiversity studies, water, and land resource studies, studies about laws and regulations and analyzing organizational structures for each selected regions. Also, much effort was made to provide a suitable platform for the participation of local and national stakeholders at different stages of implementation of basic studies. For this purpose, the results of studies conducted by the main stakeholders were used as much as possible, and in other cases, studies were individually completed. After basic studies, planning was conducted to select regions and based on that, villages were determined according to the initial indicators. The general categories of final indicators contained public, agronomic, orchard, fertilizer and pesticide inputs, water and soil and water resources of villages that have been shown in table 1.

In the Capacity Development phase, efforts have been made to create learning centers in each region where Water-Livelihood-Sustainable Agriculture nexus project was being accomplished. These learning centers were composed of facilitators and technical experts of the executive company and certain experts of Agricultural Jihad Organization. In addition, based on the needs assessment done in each learning center, appropriate workshops were designed and organized. In this project, entry to the rural community considering all its prerequisites and requirements was occurred using technical and engineering companies (private sector). They identified challenges in the rurales. After entry to the rural community and catching the trust of farmers and rural families, technical advice was taught by local experts to farmers on water management, sustainable agricultural techniques, and alternative livelihoods to women and families. During the implementation of the project, the monitoring and evaluation activities were carried out to assess the effects of techniques used at the field. To assess the opportunities that the project has hereunto put to villagers in the social and economic spheres, and to understand effective process and challenges for attracting farmers' participation in application of sustainable agriculture practices, water management, raising livelihood quality and biodiversity conservation, it was necessary to apply methods that could help to gather data in the least time, but with the deepest and the best quality.

Therefore, to assess quantitatively some indicators and socio-economic variables, questionnaires were prepared and used to be filled by people. For quality assessment, tools such as semi-structured interviews were considered with contributors and main skillful people at provincial and local levels as well as collective discussions with certain groups of villagers. Then, the results of the evaluations and data collection were surveyed and compared.

Table 1. Subcategories of each indicator used in the selection of villages (CIWP, 2017)

Public	agricultural	orchard	Fertilizer and pesticide inputs	water and soil	water resources
Number of irrigated farms	dominant cultivation in autumn	dominant orchard cultivation	The average number of spray poison frequency for dominant cultivation in autumn	Average water use for dominant cultivation in autumn	Surface water resources
Number of rainfed farms	dominant cultivation in spring	The area of dominant orchard cultivation	The average number of spray poison frequency for dominant cultivation in spring	Average water use for dominant cultivation in spring	Groundwater resources
Number of orchard farms	The area of dominant cultivation in autumn	Average yield of dominant orchard cultivation	The average number of spray poison frequency for dominant orchard cultivation	Percent of pressurized irrigation for dominant cultivation in autumn	
Vulnerability and probability of migration due to the water crisis	The area of dominant cultivation in spring	Mechanization coefficient of dominant orchard cultivation	Type of fertilization (soil test or traditional)	Percent of pressurized irrigation for dominant cultivation in spring	
Being within the scope of Urmia Lake Restoration Program (ULRP)	Average yield of dominant cultivation in autumn			Percent of pressurized irrigation for dominant orchard cultivation	
Number of sustainable agricultural companies	Average yield of dominant cultivation in spring				
The distance of the village to the lake (km)	Mechanization coefficient of dominant cultivation in autumn				
The dependent level of livelihoods of local communities to agriculture	Mechanization coefficient of dominant cultivation in spring				

3. RESULTS AND DISCUSSION

Table 2 illustrates the effectiveness of training programs and capacity development for villagers in sustainable agricultural techniques conducted to manage and to reduce water consumption as well as to increase production and income. According to table 2 capacity development process has extremely affected on the behavior of farmers. If capacity development programs with any kind of approach for middle-aged people and more are held and they have continuity and relevance of the teachings to the real life needs, they can change the behavior and insight of their audience. At the first two years, capacity development programs were more discontinuous and more experimental, so we couldn't be decisively say that the attitudes and practices of farmers have been changed since we had not provided a solid record.

However, the evaluation team found signs that, if all the necessary conditions are met, the expectancy will be the impact of capacity development programs to be a success on attracting villagers participation to establish sustainable agriculture. Table 2 shows that among the total of 348 farmers, who their questionnaires were valid, more than 80% of farmers had used at least 9 methods from 19 methods taught. Further details of the capacity development process have shown in Table 2.

Table 2. The effectiveness of training programs and capacity development for villagers

No	Sustainable Agricultural techniques	Have you been trained? (%)		Have you used? (%)	
		Yes	No	Yes	No
1	Proper water transfer by pipe or channel	80.2	19.8	46.6	53.4
2	Choose the best time to cultivate	84.7	15.3	88.5	11.5
3	Choose the best time and irrigation interval	86.8	13.2	88.5	11.5
4	Use of optimal irrigation methods	84.5	15.5	29.9	70.1
5	Use of animal and organic fertilizers	86.8	13.2	84.8	15.2
6	Use of chemical fertilizers based on soil test	78.4	21.6	51.9	48.1
7	Proper land grading	83.0	17.0	92.0	8.0
8	Appropriate terrace and Miniaturizing terrace	88.5	11.5	89.1	10.9
9	Conservative tillage	73.9	26.1	62.9	37.1
10	Returning previous crop residuals to soil	86.8	13.2	89.4	10.6
11	Observe the amount of seed consumption	85.9	14.1	81.3	13.7
12	cultivation with a linear machine	73.9	26.1	50.9	49.1
13	Seed treatment and disinfecting seeds, Seedlings and Transplants with fertilizers and biological toxins	87.6	12.4	85.1	14.9
14	Resistant species to water deficit and salinity	86.5	13.5	77.0	23.0
15	Weed control	86.2	13.8	93.7	6.3
16	Biological combat with pests	58.6	41.4	27.6	72.4
17	Prune orchards	55.9	44.1	49.1	50.9
18	Fertilization holes in orchards	67.8	32.2	51.4	48.6
19	Calibration of agricultural implements	60.9	39.1	59.5	40.5

Figure 3 shows the farmers' situation in terms of the economy that has been provided based on self-assessment tests. In these tests, farmers of the selected villages in each province assessed their economic conditions in comparison to villagers in other villages in pre-prepared forms. The results of self-assessment tests have shown on an average about 60% of farmers of the basin were satisfied with their income received from their agricultural activities after learning and using sustainable agricultural teachings. However, in the whole of Urmia basin, farmers' income in selected villages were not changed about 28.7% and were decreased about 11.5% that are controversial issues because it will cause the incentive to farmers to be weakened for applying continually sustainable agriculture techniques. Some villagers

and experts have argued that the growth of agricultural incomes is not only dependent on increasing or improving product quality. For example, farmers have not been able to increase their income, despite learning the sustainable agriculture techniques and the better quality and quantity products, because of problems such as the lack of market demand for the products, the breakdown of prices from brokers and the cost of warehousing.

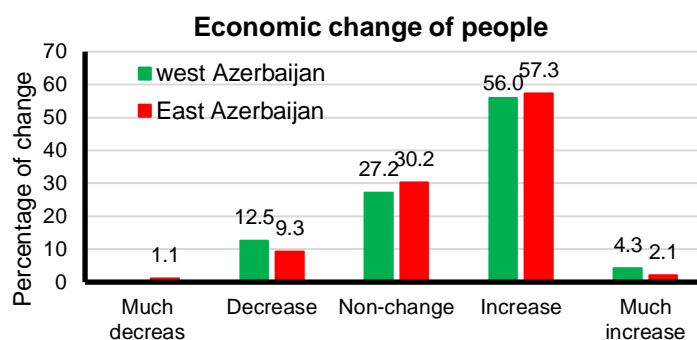


Figure 3. Changes in farmers' economic situation after using sustainable agriculture techniques

In Table 3, yield, water productivity, and water consumption Indicators for wheat were compared in villages where the water- livelihood- sustainable agriculture nexus project has been used as treatment and in villages where villagers haven't used this nexus project as control. Livelihood- sustainable agriculture nexus project with the achievement of the average yield of 7393.3 (kg/ha) and average water productivity of 1.9 (kg/m³) for wheat in East Azerbaijan could be more successful than West Azerbaijan province about 27.6 and 58.3%, respectively (Table.3). While the West Azerbaijan province has been more successful than East Azerbaijan in reducing water consumption. As table 3 shows, West Azerbaijan province has managed to decrease the amount of water consumption by the water- livelihood- sustainable agriculture nexus project from 6988.8 (m³/ha) to 4947.8 (m³/ha).

Table 3. Assessment of the water- livelihood- sustainable agriculture nexus project by yield, water productivity, and water consumption Indicators for wheat

Region	Water consumption (m ³ /ha)		Water productivity (Kg/m ³)		Yield (Kg/ha)	
	treatment	control	treatment	control	treatment	control
West Azerbaijan	4947.8	6988.8	1.2	0.8	7010.8	6607.6
East Azerbaijan	3664.3	4904.4	1.9	1.2	7393.3	5784.7

To compare the effectiveness of the water- livelihood- sustainable agriculture nexus project in two provinces, the radar chart was drawn for the percent changes in the provinces (Figure 4). In East Azerbaijan, yield, water productivity, economy indicators were increased by 27.8, 48.9 and 59.4%, respectively and water consumption was decreased by 25.3%. Also, in West Azerbaijan, water productivity and economy indicators were increased by 46.7 and 60.3%, respectively and water consumption was decreased by 29.2%, while yield indicator was increased by 6.1% (Figure 4). As Figure 4 shows, the effectiveness level of the water- livelihood- sustainable agriculture nexus project in East Azerbaijan has been wider than West Azerbaijan. In this chart, the amount of distance from the center for each variable indicates that the implementation of the project affected wide level.

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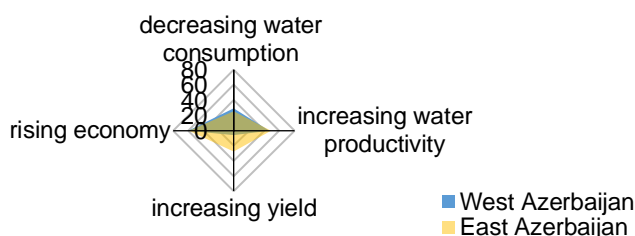


Figure 4. The percent of changes for wheat under the water- livelihood- sustainable agriculture nexus project

4. CONCLUSION

As a result of the role of the Urmia Basin in the provision of food to the country agricultural activity has been developed in this region. Human activities on the one hand and climate change, on the other hand, have led many efforts to reach enough water in many areas, especially in the southern areas of the Basin. The water-livelihood-sustainable agriculture nexus project in Urmia Basin has reduced water consumption by an average of 27.2%, as well as an increase in water productivity of 47.8% achieved. In addition, the project has been able to increase the wheat yield by 16.9% on an average.

While economic growth in the Urmia basin was on average about 60 percent. In some cases, there was a decline in economic growth, but on average, it can be said that the water-livelihood-sustainable agriculture nexus project can take measures to protect the water resources while improving the socio-economic and environmental conditions of the villagers. In addition, people have in turn been able to protect their resources and use them sustainably. In the water-livelihood-sustainable agriculture nexus to test sustainable farming practices need financial resources is needed. It should also be in the midst of fluctuating market prices. Such issues require that other reforms and adjustments be taken into account in the economic cycle in order to create incentives for farmers to cooperate.

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