Effect of water resources on land classification , water harvesting and future development of Darbandikhan territory

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ABSTRACT

This study was carried out in growing season 2013 to study the effect of water resources on land use , water harvesting and future development of of Darbandikhan territory .

Results show that although the studied area is the second richest territory with surface in Sulaimani governorate, but the annual rainfall is still the main source for agricultural activities in Darbandikhan territory despite there were three drought years in which the annual rainfall was highly below the seasonal water requirements for winter and summer crops. The annual rainfall supposed the current classification of agricultural land to irrigate and rain fed lands. Range land and marginal lands comprise the largest land in the territory.

Marginal lands can be transformed to productive lands through its cultivation with wild almond which can absorb their moisture requirement from the buried rocks especially, sand stone, conglomerate and lime stone. Moreover, wild almond can be grafted and budded with peach, apricot and almond.The probability of coming drought years are 1-3 years every 7 years with percentage of 23.08% . The investment area with strategic summer crops was very low reaching 9.50% and for strategic winter crops under rain fed was 53.24%. To change the whole agricultural area of the studied area to full irrigated area only around 1.99% of Sirwan river is enough to be invested.

INTRODUTION

(*) KISSR: ئەندامی دەستەی کوردستانی بۆ دیراساتی ستراتیجیو توێژینەوەی زانستی

Water is an elixir of life. It is a precious natural resource and important component for human survival. It's found in abundant amount on earth. Out of the total water reserves of the world, about 97% is salty water (marine) and only 3% is fresh water. Even this small fraction of fresh water is not available to us as most of it is locked up in polar ice caps and just 0.003% is readily available to us in the form of groundwater and surface water. Due to its unique properties water is of multiple uses of all living organisms. Water is absolutely essential for life. Most of the life processes take place in water contained in the body. Human beings depend on water for almost every development activity. Water is used for drinking, irrigation, and transportation, washing and waste disposal for industries and used as a coolant for thermal power plants. Water shapes the earth's surface and regulates our climate. With increasing human population and rapid development, the world water withdrawal demands have increased many folds and a large proportion of the water withdrawal is polluted due to atmospheric activities.

Water surface now a days are important than any time before due to population increase and extensive pumping of ground water of the region especially in dry seasons which results in severe depletion of ground water level, consequently most of springs discharge decreased and others dried up (Mohammed Ali , 2008).

Darbandekhan territory is one of richest territory of Sulemani governorate with water resources, which involve, annual rainfall, Sirwan river, Darbandikhan Dam ,hundreds of springs , Ghanats (Karezs) , and ground water.

Sirwan river is the third river in annual discharge among the five rivers of Iraqi Kurdistan region with annual discharge of approximately 5.2 billion m water , in which half of its inflow water originates in Iranian Kurdistan mountainous and the other half originates in Iraqi Kurdistan mountains region . The annual discharge is fluctuated from year to year, its discharge decrease to about half of normal discharge in drought years when the rainfall drop down (ALbayaty, 1985).Sirwan river cross the famous fertile plain of Sharazoor and the studied area .

Despite Darbandikhan Dam is located to north of the Darbandikhan city with capacity storage of about 3 billion m^3 water . The dam water have not involved in agricultural production in the region yet except in limited area .

Springs and ghanats: play great role in providing water for irrigated areas ,but its role decrease due to drought years. (Alkharufa and Alkasab,1984 ,Mohammed Ali ,2008)

Rainfall is among the most important surface water in the studied area. The average annual rainfall is not too much less than the European countries and regional countries but the problem, is in its highly fluctuation from year to year beside annual and seasonal rainfall shortage.

Land and water are among the essential natural resources for farming, grazing, forestry, wildlife, tourism, urban development, transport infrastructure and environmental functions.

Agriculture activities are major forms of land use including row crops, rangelands, animal farms and cropping activities. Land is required to support human ecosystem needs. Agricultural land is critical to provide food and fiber to growing

populations and is an important source of employment in many countries. Forest areas provide raw materials for harvesting and are important habitats for wildlife. Wetlands and water bodies cover land and are important in sustaining aquatic habitat and water supplies. Thus, the basic needs of food, water, fuel, clothing and shelter are met from the land which increasingly is becoming limited in supply (FAO,2010).

Dry lands cover about 41% of earth land and about 1/3 of world population living in this area. Dry lands are limited by soil moisture as the result of low rainfall and high evaporation which shows a gradient of increasing primary productivity ranging from hyper arid, arid, semi arid to dry sub-humid areas.(Middleton and Thomas,1997)

Among the motivate reasons that encourage us to perform this study are poorness of studies in the region and importing most of necessary foods and vegetables.

The aim of this stud is to investigate the effect of water resources on land use , water harvesting and future development in Darbandikhan territory in 2013 .

Methods and Materials

Darbandikhan territory is among the big territory of Sulamani governorate which is located at a distance of 67 km south-east of Sulemani city and at east of Iraq and at altitude: 443 m above sea level.

The studied area located between longitudes: 45° 41' 25.5196"- E 45° 41.4253' and Latitudes N 35° 10.2591'- 35.170984 territory with an area of 705 km2.

The studied area is located in Iraqi-Iranian border line, surrounded by mountains of Baranan from the north, Zmnako from the east, Khoresk from the west and Golan, Zarda from the south. Fig(1) shows the geographical site of the Darbandikhan territory corresponding to Sulemani governorate (Directorate statistic of sulaimani governorate- Dept of GIS.

Figure1: The geographic location of Darbandikhan
Reference: Sulemani directorate of statistic -- department of GIS.

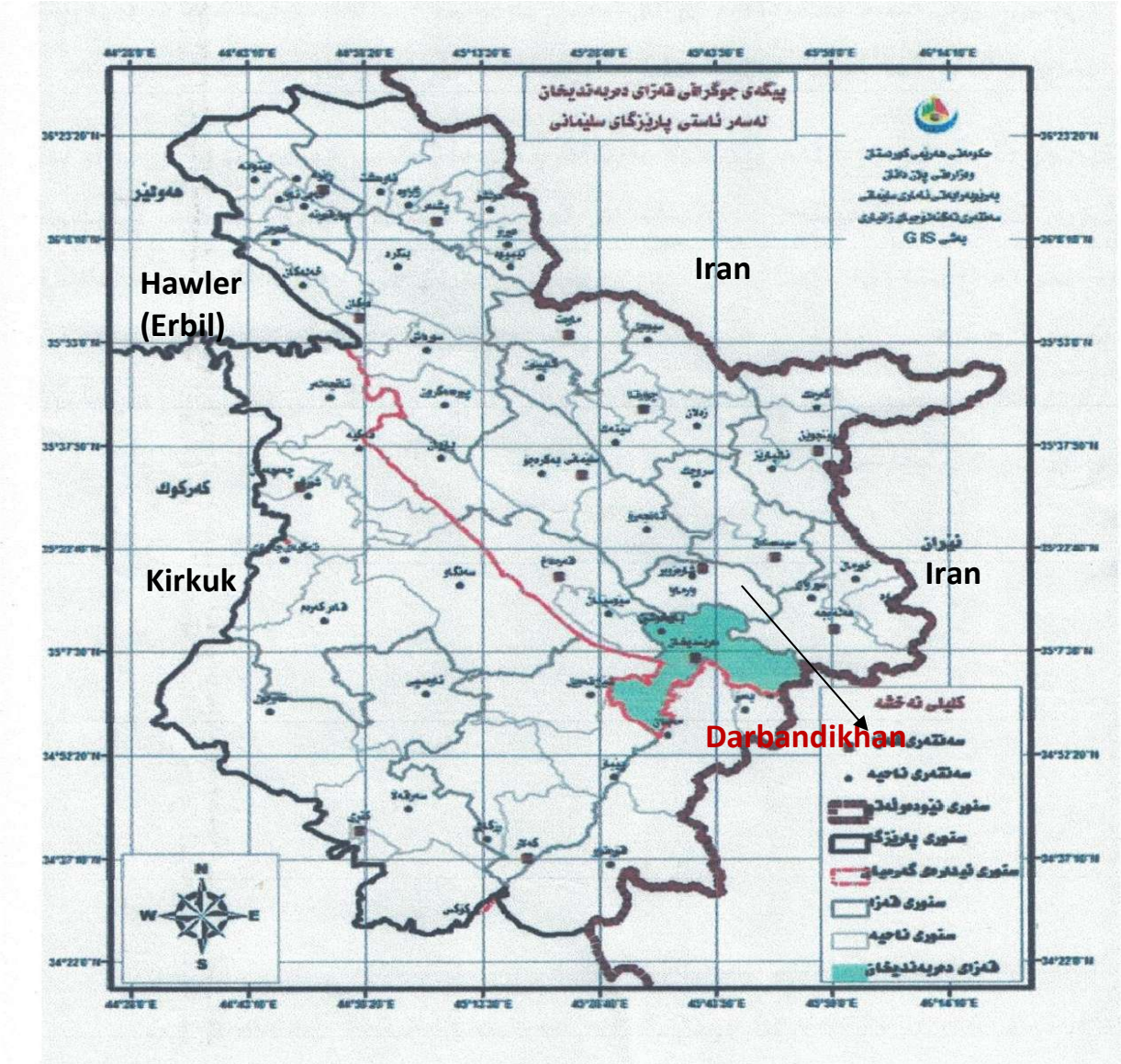
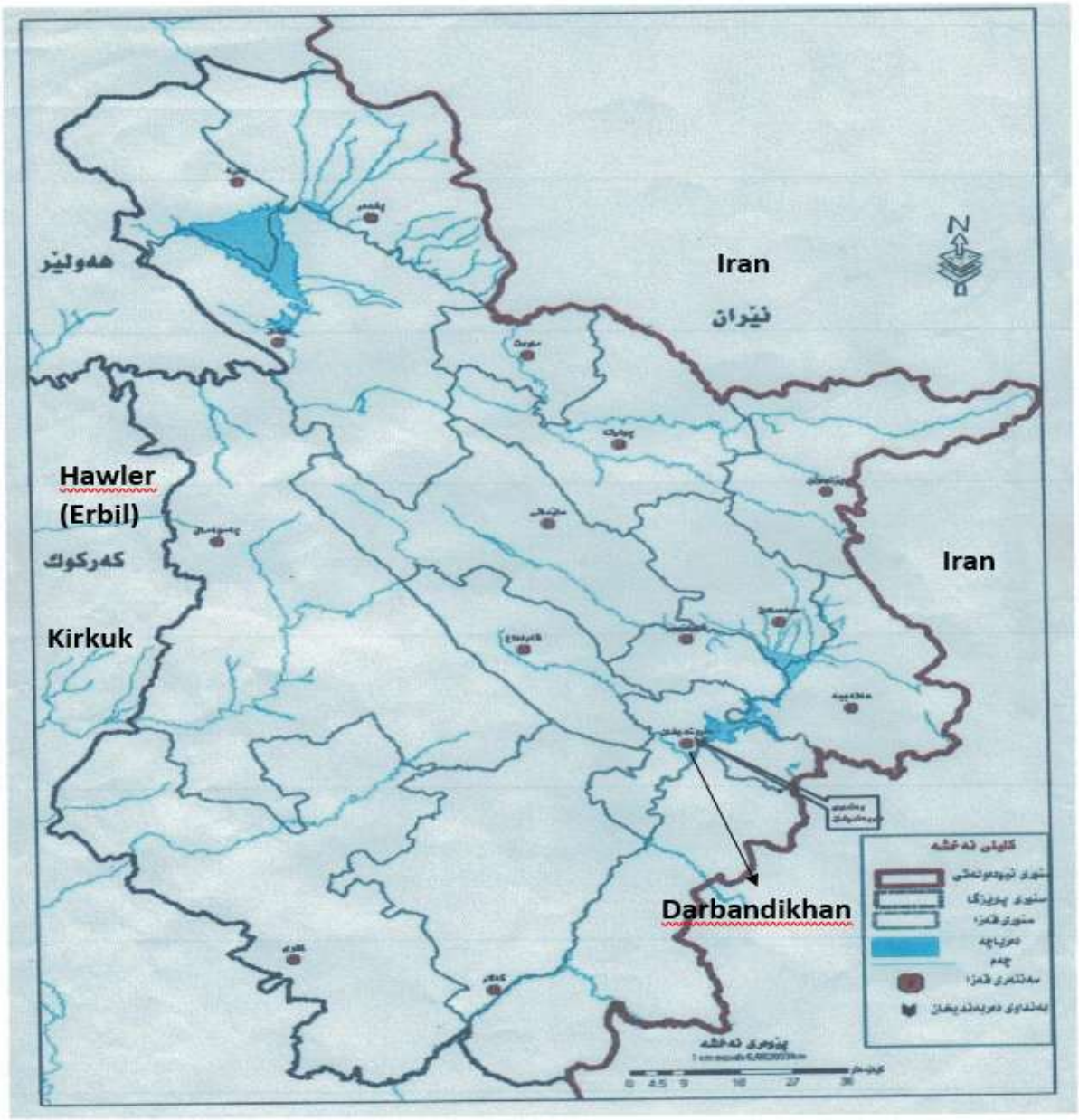


Figure 2. Water Resources in Darbandikhan Territory.



Reference: Directory of Darbandikhan Dam-Hydrology Department

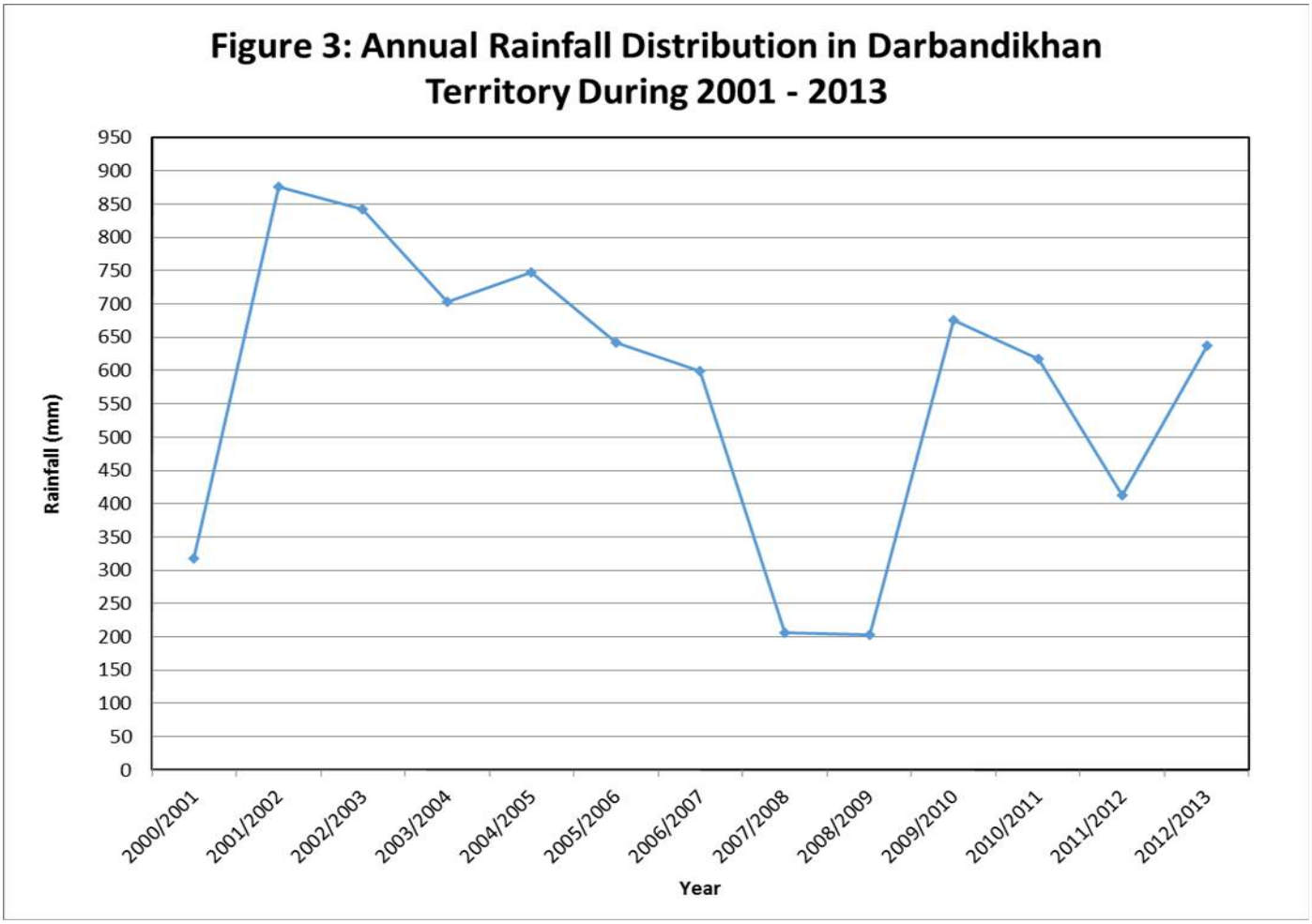
Data collected on climate condition from (Meteoroidal station of Darbandikhan dam land area and cultivated land from (Darbandikhan directorate of agriculture office)

RESULTS AND DSSCUSSIONS

Although Sirwan river has annual discharge of 5.2 billion m^3 cross the Darbandikha, in addition to Darbandekhan dam with storage capacity of approximately 3 billion m^3 of water , the rainfall is the major source for cultivation of the agricultural lands in the region due to, non - organization of water resources in the region beside the high elevation of agricultural area above the Sirwan river runway and eroded soils of of both sides of most surrounded lands .

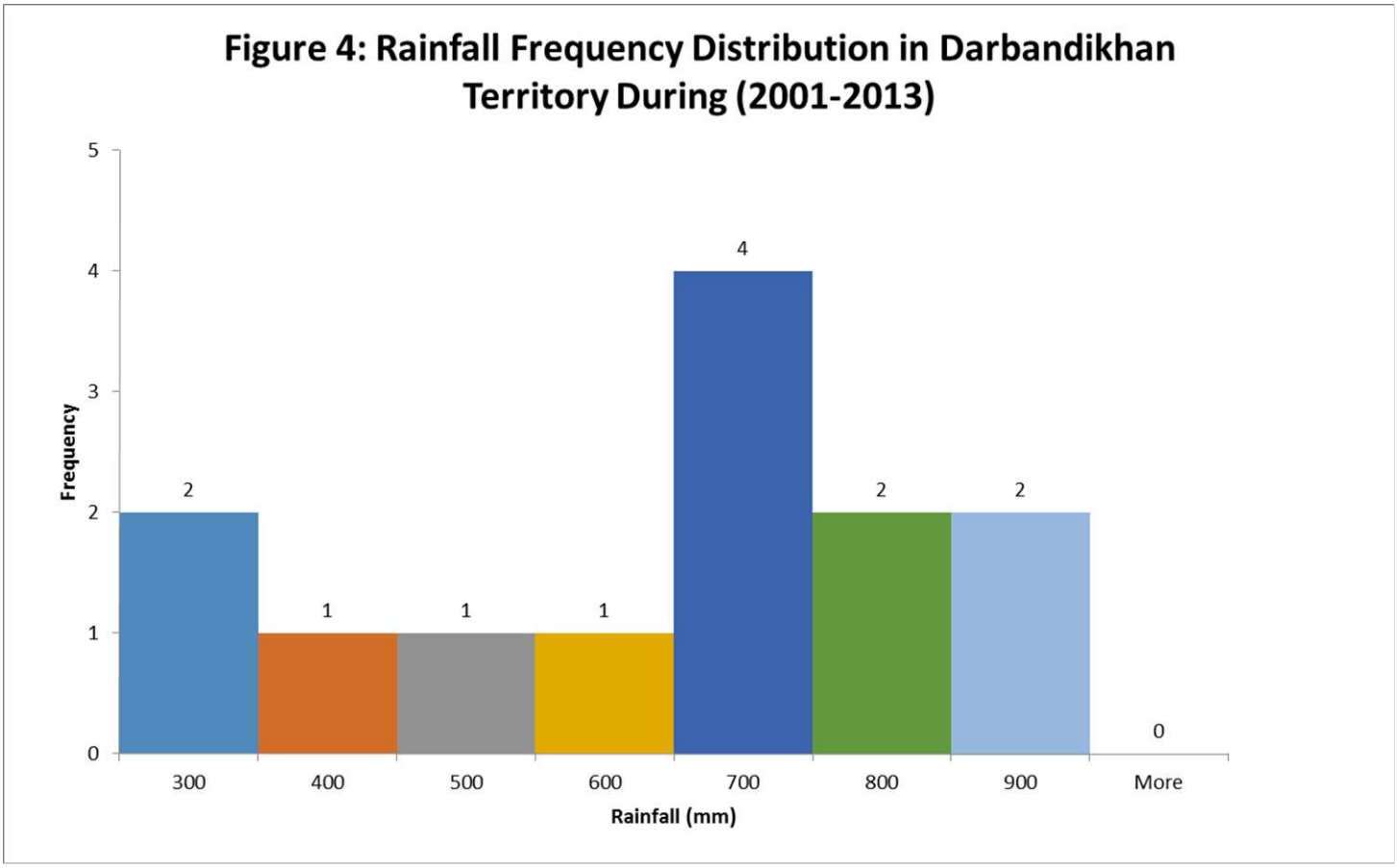
Effect of rainfall on currently distribution of lands in Darbandikhan territory:

Fig (3) show annual rainfall distribution during the last 13 years from 2001- 2013 with an average of 574.83 mm ,the lowest amounts of rainfall recorded in 2001 , 2008



and 2009 which were 317.2 mm , 207mm and 202 mm respectively. Fig (4) shows the frequency distribution of annual rainfall distribution during 2001 - 2013 . It is obvious from Fig (4) that among 13 years, only one year the annual rainfall was 600 mm and four years below 600 mm with percentage of 38.46 % in which below that is considered as drought year and that amount of rainfall is not enough for annual reactivation of water inflow of the springs in the region (Mohammed Ali, 2008). The years in which annual rainfall is 650 mm and above are considered wet season which are very good for both summer and winter cultivation.

The amount of rainfall in 2001,2007 and 2008 were below the minimum water requirements of winter crops (Amine,2000 and Mohammed Ali. 2008) such as strategic winter cereals (wheat, and legume pulses like broad beans lentil) in which they require around 400 mm annual rainfall(Amin,2005 and Mohammed Ali , 2008) with homogenise distribution over the growing season. The above years were not only drought years for winter crops but it was more worse for summer crops too due to dried up inflow discharge of springs and ghanats which require more than 650mm annual rainfall for full reactivation of



water inflow (Mohammed Ali 2008). Thus the current distribution of the agricultural land in the studied area is attributed to the amount of annual rainfall. Beside that the topography of the mountainous regions also have a role in the classification of the land to rangelands forest land (Tabl,1), in which only some of those lands can be invested for agricultural activities with animal power .

Table 1. shows land classification in Darbandikhan territory according to water resources and topography.

Land Categories	Area (Ha)	%
Irrigated lands	516.0	0.84

Rain fed lands	10712.0	17.52
Marginal lands	19989.75	32.69
Rangelands	22540.25	36.80
Orchards	137.00	0.22
Forests	7253.25	11.86
Total	61148.25	-

The above table shows land classification and its percentages in the studied area in which agricultural lands are divided to irrigated lands with 0.84% which are the lands that irrigate through available water from springs and ghanats with elevation below the mentioned water resources. Whereas, rain fed lands recorded 17.52% which are the lands that depend entirely on rainfall up to now for their cultivation (Sulaimani agricultural Dept). Rainfall beside topography have divided some lands to range lands as pasture which is the area located near villages and forest areas which are the lands with higher elevation occupied by natural forests.

Effect of rainfall on winter land use in Darbandikhan territory in growing season 2013 .

It is obvious from Table 2 , that growing area with strategic winter crops which are considered as basic of national security are very low and never coincide with the population requirement of the territory which is currently about 47328 capita and with that high amount of water resources .

Table 2 shows growing areas with some strategic winter crops with their biological water harvest in Darbandikhan territory in winter season 2013.

Crops	**Area (Ha)**	**Water Requirement (mm/season)**	**Biological Water Harvest (m^3/season)**	**%**
Wheat	5000.00	400	20000000	90.58
Barley	500.00	400	2000000	9.06
Broad bean	20.00	400	80000	0.36
Lentil	0.25	400	1000	0.0024
Total	-	-	22081000	-

Effect of rainfall on some strategic summer crops in the studied area:

It is clear from Table 3 that growing area with summer crops are very low, while the studied area is the richest area with surface water resources mentioned above. This might be attributed to non - organization of water resources in the territory (Mohammed Ali , 2008).

Table 3 shows growing area with some strategic summer crops and their biological water harvest in Darbandikham territory in 2013.

Crops	**Area (Ha)**	**Water Requirement (mm/season)**	**Biological Water Harvest (m^3/season)**	**%**

Rice	20	880	76000	45.73
Sunflower	9	720	64800	16.84
Summer Vegetables	20	720	144000	37.42
Total	-	-	384000	-

Table 4 shows summary table of currently land distribution, investment area, biological water harvest and land per capita in Darbandikham territory during 2013.

Current Land Classification (Ha)	**Area (Ha)**	**Currently Cultivated Area (Ha)**	**% Investment**	**Biological Water Harvest (m^3/season)**	**Land/capita (Ha)**
Irrigated Lands	516.0	49.0	9.50	384800	0.011
Rain fed Lands	10712.0	5703.25	53.24	**-2208100 0**	0.14
Marginal Lands	19989.75	-	-	-	0.422
Rangeland	22540.25	-	-	101431125	0.476
Orchards	137.0	-	-	959000	0.003
Forests	7253.25	-	-	32639625	0.153
Total	61148.25	5752.25	62.74	157494750	-

It is obvious from table ,4 that cultivated area and investment area in both irrigated lands and rain fed land in 2013 were very low. The cultivated lands in irrigated lands were 49.0 Ha with land investment of 9.50% and the cultivated lands in rain fed lands were 5703Ha with land investment of 53.24%. The reasons for that are attributed to non organizing of water resources ,non construction of modern irrigation network system for providing irrigation water to agricultural lands , annual and seasonal rainfall shortage , employment of most works in gove mental offices ,immigration of young peoples to Europian countries and non mechanization of agricultural process in the region, in addition to poor marketing of agricultural products from farmers (Amin,2005 ,Mohammed Ali, 2008) .Biological water harvest was also very low due to low cultivation area. The land distribution per capita as it is shown in table, 4 vary from 0.011Ha in irrigated areas to 0.476 Ha in rangeland. The total annual renewable water in 2013 calculated with implying the formula. Annual renewable water = Area in m x rainfall in m, which was 389 .82 million m^3 with renewable water per capita =8236.56m3, which is very high.

Effect of rainfall and topography on rangeland area

As it is shown in Table, 5, rangelands area is recorded the highest area among land categories in studied area due to available rainfall amounts in most years with an average overall of 13 years (574.82mm) which was above minimum seasonal water

requirement of rangelands 450mm(Amin, 2005, and Mohammed Ali , 2008). The studied area in 2013 possessed around 163,865 animals including 66,042 cows , 13, 788 goats and 8,435 sheep with an average of 7.30 animal / Ha while each hectare in the region can provide foliage for 8-16 animals. Thus it is possible to increase the number of animals in the area beside possibility of growing foliage legumes under irrigation system (Mohammed Ali, 2008).

Effect of annual rainfall on biological water harvest in non agricultural lands in 2013.

Table, 5 shows Biological water harvest in rangelands sand forests. Range lands was recorded the highest percentage of biological harvesting which was 75.58%, while forest area recorded 24.32% from total biological water harvest, due to large area of rangelands which is around 3 fold of forest area .

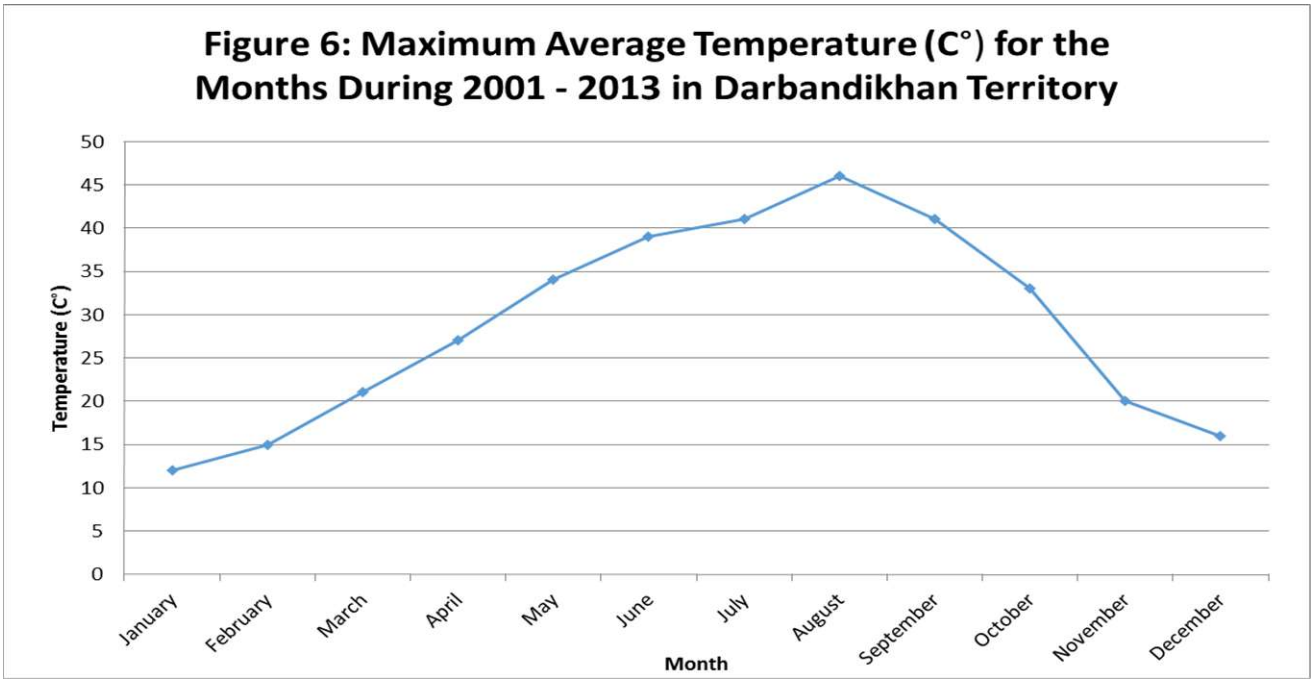
Table 5. shows biological water harvesting from non-agricultural lands in 2013 .

Land Category	Area (Ha)	Minimum Water Requirement (mm/season)	Biological Water Harvest (m^3/year) %
Rangelands	22540.25	450	101,431,125 75.58
Forests	7253.25	450	32,639,625 24.32
Total	29930.5	-	134,187,250

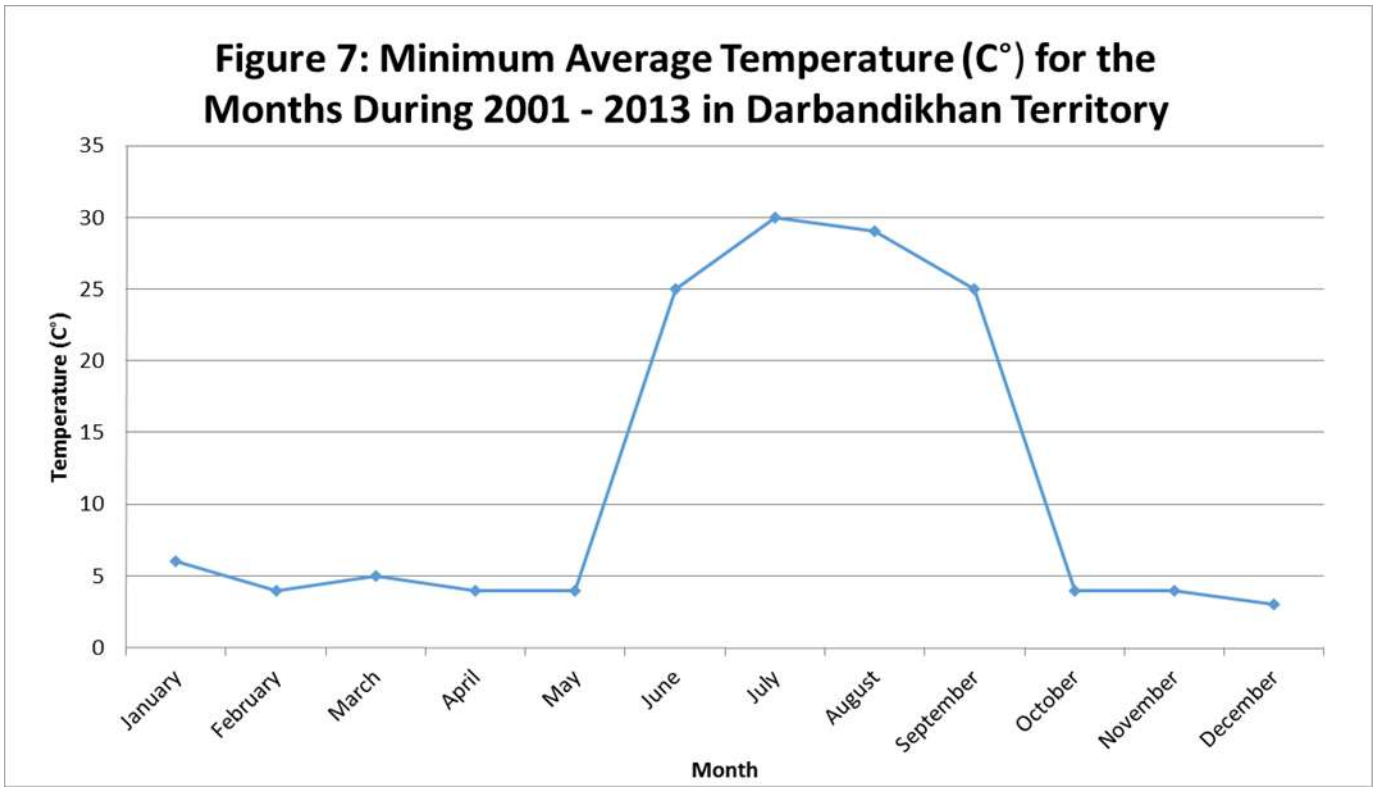
Effect of temperature on future agricultural development:

Beside the richness of the studied area with surface water resources, the temperature of the territory is characterized by its warmness in winter in which the temperature rarely drops down to below 0c and if it it happens it will be for ashort time, thus winter is suitable for growing tropical fruits such as Loquat and citrus like orange , sour orange and lemons . Figures, 5, 6 and 7 show average monthly temperature , average maximum temperature and average minimum temperature at Darbendikhan dam (Meteorological station of Dabandikhan station).

Water harvesting in Marginal lands : Marginal lands are areas in which its soil had eroded, thus biological water harvest in most of that area is zero due to its non-suitability for cultivation for growing natural plants . There are many natural plants



that can grow in such environments including wild almond which possesses deep tap root and can penetrate through rock cracks and absorb water even from geological formations, such as sand stone, conglomerate . Moreover wild almond can be grafted and budded with peaches , apricots and almonds (Kaim et al 2000, Mohammed Ali and Rashed 2015)



Policy dialogue models for future development of agriculture in Darbandikhan territory:

There are many scenarios for agricultural development in the studied territory among them:

1 -cultivation of half of the whole agricultural land (5614 Ha) with rice with water requirement (880 mm) and other half95614Ha) with summer vegetables with water requirements (720 mm) and cultivation the whole area in winter with strategic crops such as wheat , barley , lentil and broad bean with 2 supplementary irrigations each with 50 mm. The biological water harvest in summer for rice will be 49,403.200 million m^3 , for summer vegetables , 40,420,800 m^3 while for winter crops in the whole area from rainfall will be 44,912,000 m^3 and from 2 supplementary irrigations 11,228,000 m^3 with total of 89,824,,000 million m^3 and the total biological water harvesting for summer and winter will be 179,648,000 million m^3.

2- Cultivation of the whole area in winter with wheat under 2 supplementary irrigations with 50 mm for each irrigation and in summer with strategic crops like sunflower, corn, cotton and soybean with seasonal water requirement 720 mm . The biological water harvesting for whole area 11228 Ha with wheat from rainfall 44,912,000 and from 2 supplementary irrigation 11,228,000 m^3, with total of 56,140,000 m^3. Biological water harvest for summer cultivation with area of 11228 Ha and with water requirement of 720 mm will be 80,841,600 m3. The total biological water harvest will be 136,981,600 m^3.

The expected production of wheat in the whole area 11228 Ha with 1000 kg/Ha will be 11,228,000 Kg

which is sufficient for 93556 capita on the basis of 120 kg flour / capita / year (FAO,2001).

DISSCUSSIONS

Results show that water resources supposed the current classification of lands in the studied area and the annual rainfall is still in front of the reasons of that classification, since annual rainfall is the only source for providing water for rangelands, rain fed areas and forests . orchard lands and irrigated lands comprise the lowest area in that classification. The investment of irrigated lands and rain fed lands were very low ,9.5% ,53.24% respectively. The total agricultural area (11228 Ha) can be transformed to full irrigation area in summer with water requirement of 720 mm/season , i.e .(80 ,841,600) million m^3 and with four supplementary irrigations (50 mm) for winter crops (22,456,000,) million m^3 if necessary, the total water requirements will be 103,297,600 million m^3 which comprise 1.99% of the available water in Sirwn river with annual discharge of 5.2 billion m^3 .

ACKNOWLOGMENT

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الخلاصة

آنجزت هذه الدراسة خلال سنة2013 لدراسة تـآثير الموارد المائيـة علـى آسـتثمار الآرض ، حصـاد الميـاه و التطور المستقبلى لمنطقة دربنديخان.

تثير نتائج الدراسة الى ان الآمطار المصدر الرئيسى للنشاطات الزراعية لحد لآن رغم كون منطقة دربنديخان من آغنى مناطق محافضة السليمانية بعد قضاء دوكان و إن كميات الآمطار الساقطه فرضت نمط تقسيم الآراض في المنطقة الى آراضي سيحية و ديمية و سجلت الآراضي الهامشية و المراعى الطبيعية آكبر مساحة فيها.

من الممكن تحويل الآراضي الهامشية الى آراضي منتجة عن طريق زراعتها باالوز البرى ومن ثم تطعيمها بالخوخ و الآجاص والمشمش. كانت نسبة الآستثمار بالمحاصيل الصيفية الئستراتيجية قليله جدا (9,50٪) ، والشتوية 53,24٪.

يمكن تحويل جميع الآراض الزراعية(11228)هكتار فى منطقه الدراسة إلى آراضي مروية ذات آنتاجية في الصيف وعند الحاجة بمقدار ريتيين إنقاذيتين فى فصل شتاء بآستثمار حوالى (1,99٪) فى مياه نهرسيروان.

پوختەی باسەکە

ئەم تۆژینەوەیە ئەنجامدرا لە ساڵی 2013 بەمەبەستی لێکۆڵینەوە لە کاریگەری سەرچاوە ئاوییەکان لەسەر بەکارهێنانی زەوی و دروێنەی ئاو و گەشەی ئایندەی دەربەندیخان.

ئەنجامی لێکۆڵینەکە ئاماژە دەکات کە باران تا ئێستا سەرچاوەی سەرەکی چالاکییە کشتوکاڵییەکانیە سەرەڕای دەوڵەمەندی ناوچەکە بە سەرچاوەی ئاو کە پلەی دووەم دێیت دوای قەزای دوکان لە پارێزگای سلێمانی . وە بڕی دابارینی ساڵانە شێوازی جۆری چاندنی زەوی سەپاندووە بۆ زەوی دێم و بەراو زەوی بەردەڵانی و لەوەڕگەی سروشتی کە بەرزترین ڕێژەی تۆمارکردووە.

دەتوانرێت زەوییە بەردەڵانیەکان بکرێتە زەوی بەرهەمدار بەچاندنی بە ڕووەکی باییف پاشان پێوەندکردنی بەقۆخ و هەڵوژە و قەیسی. ڕێژەی وەبەرهێنانی زەوی بە بەروبوومە ستراتیجییە هاوینەکان زۆر کەمبوو (50,9٪) وە زستانەش بەهەمان شیوە کەمبوو (24,53٪)، دەتوانرێت هەموو زەویە کشتوکاڵیەکانی ناوچەکە (11228) هەکتار زەوی بکرێتە زەوی بەراوی بەردەوام لە هاوین وهەروەها لە زستاندا لە کاتی پێویستدا بە وەبەرهێنانی (99,1٪) ئاوی ڕووباری سیروان.