Effects of land use change on surface water regime
(Case study Orumieh Lake of Iran)

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ABSTRACT

Land use change from rangeland and forest to agriculture and orchard areas which affected water regime, are widely occurred in many parts of Iran.
The above mentioned problem has happened in Orumieh Lake basin for an area of 1146 km2 which is located in northwest of Iran. The recent land use map was resulted through satellite images of 1990, 1998 and 2006 as well as field observations and the previous period map was performed by using the aerial photographs of 1955 (which is considered as the oldest documents). In this period 14% of rangeland is changed into dry farming and 7% of irrigated farming is converted to orchard.
The results show that due to land use change in this area, the mean annual discharge has not changed but maximum daily discharge increased and minimum daily discharge reduced.

Key words: Land use change; water regime; dry farming; daily discharge; Orumieh Lake; Iran

1. INTRODUCTION

There are complex processes such as climatic variables and environment parameters that convert rainfall to runoff. Historical researches proved the effects of forest on water regime. The effects of suburban development have been characterized in several studies; increased flood frequencies in areas with impervious surfaces werereported in the late 1960s and early 1970s (Leopold, 1968; Seaburn, 1969; Anderson, 1970). More recent studies have focused on the effects of engineered aspects of catchments, (e.g. detention basins, riparian buffers and septic systems) on runoff volume and water quality (Robertson et al., 1991; Griffin, 1995; Chin and Gregory, 2001; Booth et al., 2002).

Land use change can have significant effects on rainfall-runoff processes. For example, research indicated that deforestation can amplify flood risk (e.g. Laurance, 2007; Bradshaw et al., 2007) through decreasing infiltration capacity, transpiration and interception (Clark, 1987). Urbanization decreases the infiltration capacity and transpiration as well through the removal of vegetation and the creation of impervious surfaces (e.g. Dow and DeWalle, 2000; DeWalle et al., 2000). In the Eururalis project (Verburg et al., 2006), four land use change scenarios for Europe were developed, which are based on the story lines described by the SRES scenario families.

In this paper we are going to prove the effects of land use change on water regime in Orumieh Lake of Iran.

2. METHODOLOGY

2.1. Study area

Orumieh lake located in northwest of Iran Barandoozchai basin, with an area of 114565 ha is one of the main rivers and situated between 44:45 E to 45:13 E and 37:06 N to 37:28 N. The climate of study area is mostly semi-arid. Based on river branches the basin divided to 7 sub-basins. Fig.1(a) shows the location of sub-basins on satellite ASTER image.

2.2. Methods

The satellite ASTER 2006 was used for preparation of new period of land use and its results was checked by field observations. The aerial photographs and topography maps in 1956 were used to determination of old period land use map and the results were completed by native's knowledge.

Babarood gauging station is located in the outlet. Its data from 1953 up to now was utilized to determination of changing river regime. To compare the trend of annual discharge with annual rainfall first of all they became dimensionless using dividing to their average. The trend of peak discharge compared with maximum daily precipitation after dimensionless them.

3. RESULTS

Use of land use maps for present and previous period various land use area measured (table 1)

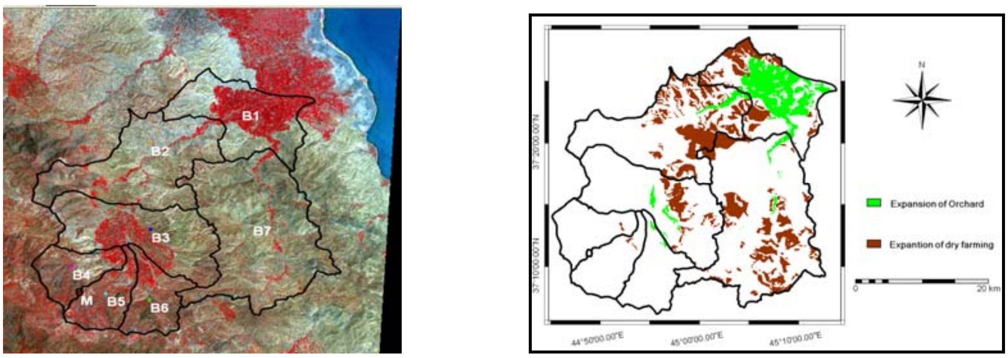
Table 1: Area of land use at present (new) and previous (old) period (ha)

sub-basin	B1		B2		B3		B4		B5		B6		B7	
land use	new	old	new	old	new	old	new	old	new	old	new	old	new	old
Rangeland	3990	6845	12513	18183	11561	13202	6314	6365	6035	6025	6153	5986	24927	30935
Irrigated arming	85	6090	3390	3669	5263	5796	725	717	782	693	1307	1692	1112	1575
Dry farming	4804	1951	6649	1296	1843	151	55	-	118	229	47	-	6716	902
Orchard	7000	1176	623	26	409	-	-	16	-	-	130	-	617	6
Urban	257	74	101	17	156	30	5	1	16	4	55	11	67	20
Others	101	101	172	257	330	383	23	23	33	33	82	85	-	1
Sum	16237	16237	23448	23448	19562	19562	7122	7122	6984	6984	7774	7774	33439	33439

Comparison of the columns in table 1 shows the land use change in this region (table 2). In this table negative and positive shows the reduction and increase of land use change respectively. Fig. 1(b) shows the expansion of dry farming and orchards during 1955 to 2006.

Table 2 : Percent of land use change during periods

sub-basin / land use	B1	B2	B3	B4	B5	B6	B7	sum
Rangeland	-18	-24	-8	-1	0	2	-18	-14
Irrigated	-37	-1	-3	0	1	-5	-1	-7
Dry farm	18	23	9	1	-2	1	17	14
Orchard	36	3	2	0	0	2	2	7
Urban	1	0	1	0	0	1	0	0
Others	0	0	0	0	0	0	0	0
Sum	0	1	1	0	-1	1	0	0



(a) (b)

Figure 1 : a) Aster satellite image of area b) Map of expansion of Orchard and dry farming

Wet and dry periods using 5 year moving average of discharge data were determined. (Dry periods: 1953 to 1967 and 1980 to 1988 and wet periods: 1968 to 1979 and 1985 to 2000). Inasmuch as the rainfall data started from 1970 the parameter indexes calculated only for wet periods (Table 3).

Table 3 : Comparison of Barandoozchai River statistical characteristics before and after land use change in wet period

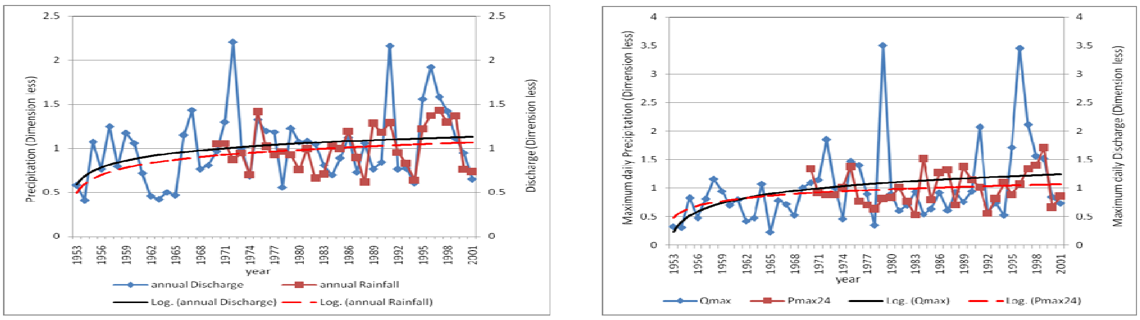
Parameter	wet period	Discharge		
		Mean	Max Daily	Min daily
max	68-79	19.35	215.28	0.61
	85-00	18.98	212.2	0.22
min	68-79	4.9	21.34	0
	85-00	5.27	32	0
mean	68-79	9.67	75.24	0.18
	85-00	9.76	74.63	0.02
Sd	68-79	3.77	51.6	0.25
	85-00	4.06	47.69	0.05
Cv	68-79	39.01	68.58	143
	85-00	41.61	63.9	335

3.1. Mean Annual Discharge Trend

Mean annual discharge has a rising trend of course the annual rainfall has to consider. Both parameters divided by their mean to ignore their dimensions (Fig 2(a)).

3.2. Maximum daily Discharge (Qmax24)Trend

To analysis the change in Qmax24 trend, it compared with maximum daily precipitation (Pmax24) (both dimensionless). (Fig 2(b))



(a) (b)

Figure 2: Comparison of Discharge and Precipitation. a) Annual b) Maximum daily

3.3. Minimum daily Discharge (Qmin24) Trend

Fig 3 shows the minimum daily discharge and Trend line.

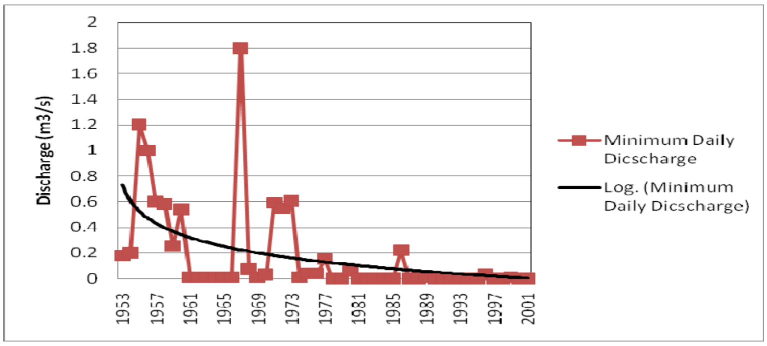


Figure 3 : Minimum daily discharge and Trend line

4. CONCLUSION

Previous and present land use map show that the range land area is reduced from 87500 ha to 71500 ha and change to dry farming. In this region due to high slop land is tiled downward which increase runoff rate and decrease infiltration.

Comparison of the results show that this rate of land use change could not have a significant change on mean annual discharge (same trend gradient) but maximum daily discharge is being increased and minimum daily discharge is being decreased. The continuous of this approach may cause to decry of ground water level, increase water salinity of Orumieh Lake and its land surround.

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