Available online at www.sciencedirect.com
ScienceDirect
Procedia Environmental Sciences 2 (2010) 256–261
Procedia Environmental Sciences

International Society for Environmental Information Sciences 2010 Annual Conference (ISEIS)

EFFECTS OF LAND USE CHANGE ON SURFACE WATER REGIME (CASE STUDY ORUMIEH LAKE OF IRAN)

Shahram Khalighi Sigaroodi[a]*, Shiva Ebrahimi

[a]*Natural Resources Faculty, University of Tehran, Iarn*

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.

Keyword: Land use change; water regime; dry farming; forest, 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.

* Corresponding author. Tel.: +98-261-2223044; fax: +98-261-2249313
E-mail address: khalighi@ut.ac.ir.

1878-0296 © 2010 Published by Elsevier Open access under CC BY-NC-ND license.
doi:10.1016/j.proenv.2010.10.031

In this paper we are going to prove the effects of land use change on water regime in Orumieh Lake in 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 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 data from 1953 up to now was utilized or 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 dimensionlessing them.

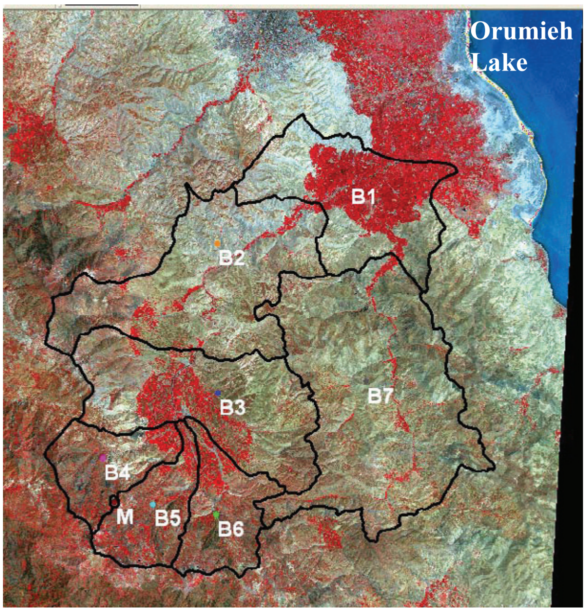

Fig 1: location of the study area on Aster satellite image

3. Results

Make use of land use maps for present and previous period various land use area measured (table 1 and 2)

Table 1: area of land use at present period (ha)

sub-basin land use	B1	B2	B3	B4	B5	B6	B7
Rangeland	3991	12513	11562	6313	6034	6153	24990
Irrigated farming	85	3390	5263	725	782	1307	1112
Dry farming	4804	6649	1843	55	118	47	6716
Orchard	7000	623	409	-	-	130	617
Urban	257	101	156	5	16	55	67
Others	101	172	330	23	33	82	-
Sum	16238	23448	19563	7121	6983	7774	33438

Table 2 : Area of land use at previous period (ha)

sub-basin land use	B1	B2	B3	B4	B5	B6	B7
Rangeland	6845	18183	13202	6365	6025	5986	30935
irrigated	6090	3669	5796	717	693	1692	1575
Dry farm	1951	1296	151		229		902
Orchard	1176	26		16			6
Urban	74	17	30	1	4	11	20
Others	101	257	383	23	33	85	1
Sum	16237	23448	19562	7122	6984	7774	33439

Comparison of these tables (1,2) shows the land use change in this region (table 3). In this table negative and positive shows the reduction and increase of land use change respectively.

Fig. 2 shows the expansion of dry farming and orchards during 1955 to 2006.

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: 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

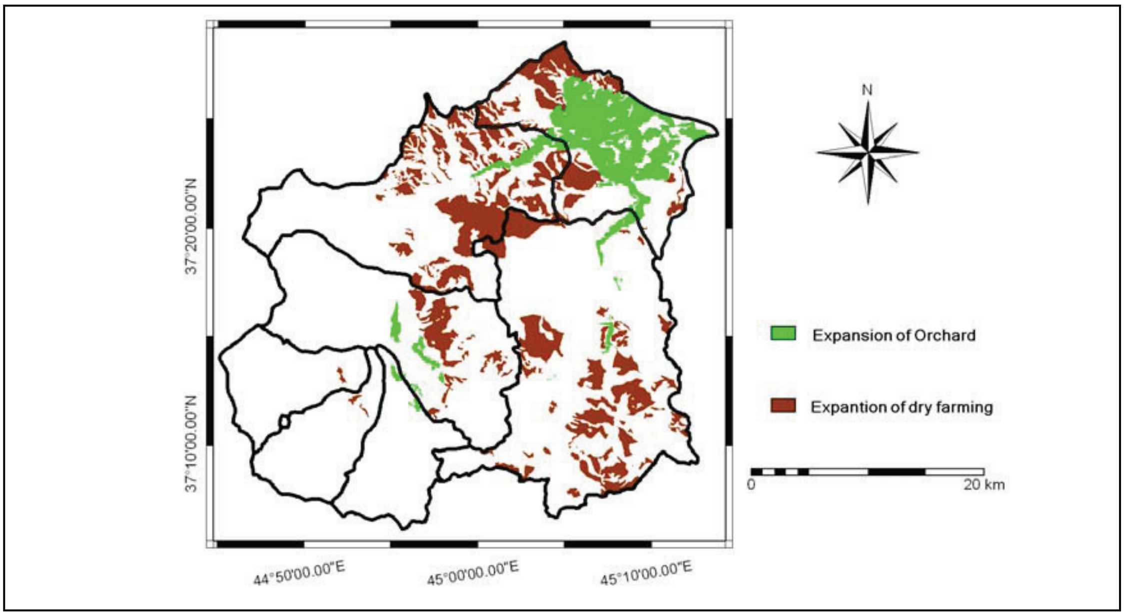

Fig 2: Map of expansion of Orchard and dry farming

Table 4: Comparison of Barandoozchai River statistical characteristics before and after land use change

Parameter	wet period	Discharge		
		Mean	Max Dairy	Min dairy
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 3).

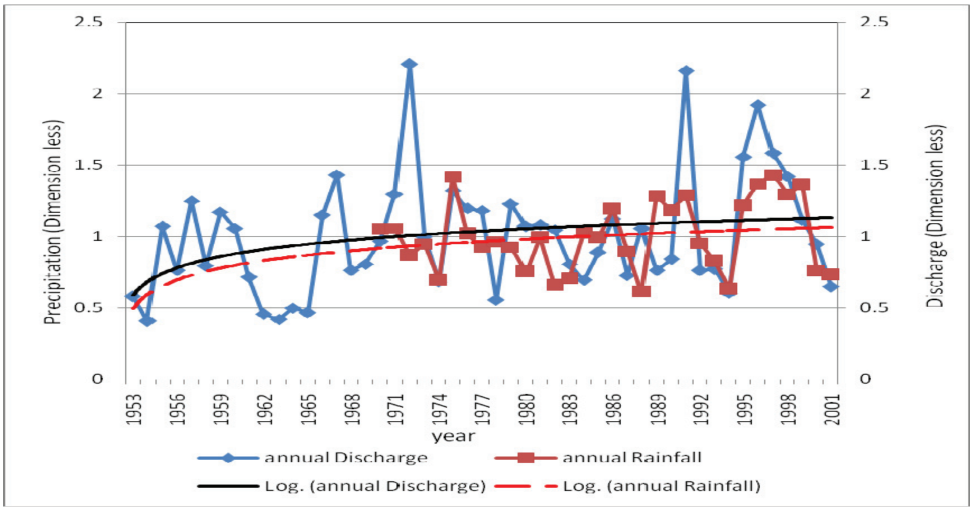

Fig 3: Comparison of Discharge &Precipitation

3.2. Maximum daily Discharge (Qmax24)Trend:

To analysis the change in Qmax24 trend, it compared with maximum daily precipitation (Pmax24) (both dimensionless). (Fig 4)

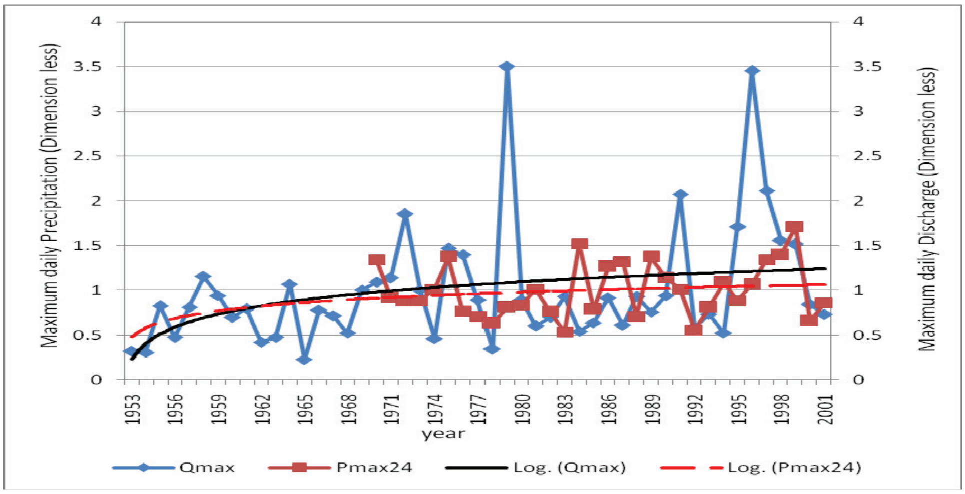

Fig 4: Comparison of Maximum daily Discharge &Precipitation

3.3. Minimum daily Discharge (Qmax24)Trend:

Fig 5 shows the minimum daily discharge and Trend line.

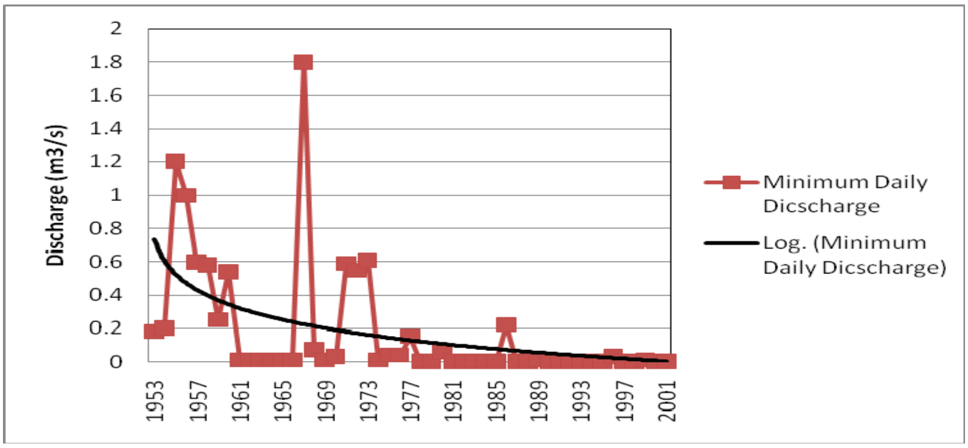

Fig 5 shows the minimum daily discharge and Trend line.

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.

References

[1] Booth, D.B., Hartley, D., Jackson, R., 2002. Forest cover, impervious-surface area, and the mitigation of stormwater impacts. J. Am. Water Resour. Assoc. 38, 835–845.

[2] Bradshaw, C. J. A., N. S. Sodhi, K. S.-H. Peh, and B. W. Brook (2007), Global evidence that deforestation amplifies flood risk and severity in the developing world, Global Change Biol., 13, 1–17, doi:10.1111/j.1365- 2486.2007.01446.x.

[3] Chin, A., Gregory, K.J., 2001. Urbanization and adjustment of ephemeral stream channels. Ann. Assoc. Am. Geogr. 91, 595–608.

[4] Clark, C. (1987), Deforestation and floods, Environ. Conserv., 14(1), 67–69.

[5] Dow, C. L., and D. R. DeWalle (2000), Trends in evaporation and Bowen ratio on urbanizing watersheds in eastern United States,Water Resour. Res., 36(7), 1835–1843.

[6] Griffin, C.B., 1995. Uncertainty analysis of BMP effectiveness for controlling nitrogen from urban nonpoint sources. Water Res. Bull. 31, 1041–1050.

[7] Laurance,W. F. (2007), Forests and floods, Nature, 449, 409–410.

[8] Leopold, L.B., 1968. Hydrology for urban land planning—a guidebook on the hydrologic effects of urban land use. US Geological Survey Circular 554, 18 pp.

[9] Robertson, W.D., Cherry, J.A., Sudicky, E.A., 1991. Ground-water contamination from two small septic systems on sand aquifers. Ground Water 29, 82–92.

[10] Seaburn, G.E., 1969. Effects of urban development on direct runoff to East Meadow Brook, Nassau County, Long Island, New York. US Geological Survey Professional Paper 627-B, 14 pp.

[11] Verburg, P. H., C. J. E. Schulp, N. Witte, and A. Veldkamp (2006), Downscaling of land use change scenarios to assess the dynamics of European landscapes, Agr. Ecosyst. Environ., 114, 39–56, doi: 10.1016/j.agee.2005.11.024.